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'Barriers to international research programs as perceived by Dutch SMEs'

Master Science and Innovation Management

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Summary

This study analyses potential barriers that prevent Dutch Small and Medium-sized Enterprises (SMEs) from participating in international research programs. Despite the existence of these programs, a general notion exists for the need to improve the European ability to commercialize innovations related to key technologies. This study assumes that an important role can be played by SMEs through their ability to commercialize the knowledge spillovers arising from the consortia within research programs. SME participation within international research programs however follows a downward trend.

A conceptual model containing potential barriers as well as incentives to participate in international research programs selected from literature is empirically tested. A sample of 1.500 Dutch SMEs is drawn from the databases of the Seventh Framework Program (FP7), the Eurostars program, and the Dutch Research & Development tax credit program (WBSO). This approach enables a comparison of two groups of SME WBSO participants that either **do** or **do not** participate in international research programs. A questionnaire was used to obtain data for each group. Factor analysis is used to test the robustness of the conceptual model and logistic regression analysis is used to test the hypothesized relations in the conceptual model.

Important incentives emerging from the analysis are access to new markets and networks. Important barriers emerging from the analysis are the complexity and required time for the application process, a mismatch between program themes and the core competences of a SME, the research within programs being too scientific, and a low chance of success of a potential application. Lower levels of bureaucracy as well as a sufficient match between the technological capabilities of SMEs and the requirements and structure of international research programs would significantly benefit SME participation. Policymakers should target science-based SMEs, which have a larger chance of possessing the capabilities needed to participate in international research programs.

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1. Introduction

In the overall pursuit of the Lisbon targets the European commission has addressed the importance of development of 'key-technologies'. These technologies are said to represent the main areas of technological development that are considered essential for creating a knowledge based sustainable economy within the European Union as stimulated by the Lisbon targets. Examples of these technological areas are biotechnology, ICT and nanotechnology. Whereas the European Union scores relatively well on the R&D aspect for some of these multi-disciplinary knowledge intensive technological areas, the commercialization aspect remains subject for improvement (EC, 2009a).

Concerns about the ability to commercialize key technologies thus arise despite the existence of various programmatic initiatives that aim to strengthen European ability in terms of science and technology, mostly by stimulating international R&D cooperation between enterprises and scientific organizations. These research programs should present significant entrepreneurial opportunities according to the theory of knowledge spillover entrepreneurship of Audretsch and Keilbach (2007:1249): "Contexts rich in knowledge should generate more entrepreneurship, reflecting more extensive entrepreneurial opportunities. By contrast, contexts impoverished in knowledge should generate less entrepreneurship, reflecting less extensive entrepreneurial opportunities". Strengthening European abilities in terms of investing in R&D and knowledge creation can be considered a necessary condition to facilitate economic growth. These investments should however be complemented by mechanisms that ensure that knowledge actually spills over to facilitate commercialization and innovative activity (Audretsch et al., 2009). Small and Medium-sized Enterprises (SMEs) can thereby play an important role "…by serving as a key conduit for the spill-over of knowledge" (Audretsch et al., 2009:39). SMEs are overall more likely to commercialize inventions compared to their larger counterparts (van Praag & Versloot, 2007).

Considering this specific role of SMEs, it becomes interesting to analyze the participation of SMEs in international research programs. Sufficient SME participation in these programs, thereby facilitating their potential role in terms of commercialization, might be beneficial in terms of the underlying objective of improving the commercialization of key technologies. The participation of industry as a whole in the successive editions of the European Framework Programs (FPs) however follows a downward trend compared to the increased participation of research institutions (Technopolis, 2009). The amount of subsidy received by SMEs in particular has not yet reached the desired target of 15% of total budget (SenterNovem, 2008). Questions thus arise regarding the barriers that prevent SMEs from participating in international research programs. The following main research question is therefore formulated:

What barriers prevent SMEs to participate in international research programs?

Substantial national differences in research- and industrial landscapes still exist and cause different national perceptions of what constitutes 'key-technologies' (EC, 2009a). Accounting for these differences lies outside the scope of this study. This study applies a national perspective focusing on the Netherlands. This is induced first of all by limited availability of data. Also, Dutch SME participation in the Seventh Framework Program (FP7) can be said to be relatively low. Dutch SMEs receive 11% of the total funding received by all Dutch participants in FP7 (SenterNovem, 2008). European SMEs on average receive 13,4% of total funding. The European commission has set a target for SMEs to be granted 15% of total funding. Furthermore, recent research indicates that of a total of 40% of Dutch SMEs that cooperate with other enterprises, only 8% cooperate on an international basis (van Essen & Bhansing, 2009).

Several studies exist that address potential barriers that prevent SMEs from pursuing international R&D cooperation activities (e.g. Hagedoorn et al., 2000). Only a few studies have explicitly addressed the participation of enterprises in international research programs (Barajas & Huergo, 2010; Protogerou et al., 2010). No studies have been found that explicitly address the barriers preventing SMEs to participate in international research programs. According to Barajas and

Huergo (2010), the complexity of the topic of international R&D cooperation has prevented the emergence of a commonly accepted explanatory model. This study aims to contribute to this topic by selecting potential barriers from existing literature with the goal of analyzing which barriers prevent Dutch SMEs from participating in international research programs. For that purpose, a sample is drawn from the FP7 and Eurostars program databases, as well as from the Research & Development tax credit (WBSO) database, which is the largest Dutch initiative to stimulate innovation. This approach enables a national-international comparison of SME research program participants. Specifically focusing on Dutch SMEs that participate in the WBSO program is justified by the fact that performing R&D activities is a requirement to be able to participate in the WBSO. In this respect, international research programs can be considered most relevant for these so-called New Technology-Based (NTB) SMEs. These SMEs are said to provide the largest economical contribution due to differences in pace of change, the importance of R&D and their networks (Keogh & Evans, 1999; Colombo & Grilli, 2005). In addition, the results of this study will provide insights for Dutch policymakers aiming to stimulate the participation of SMEs in international research programs.

The remainder of this paper is structured as follows. Section 2 presents the context of this study and provides a short overview of the analyzed research programs. Section 3 will position this research with respect to existing literature. Section 4 presents the methodology and research methods applied. Section 5 presents the results. Section 6 presents the conclusions and discusses the findings.

2. Background

Current initiatives in terms of international research programs began to emerge out of concerns over the innovative potential of European enterprises in global markets (Protogerou et al., 2010). The main aim of these programs is to stimulate cross-border R&D cooperation between enterprises and scientific organizations, thereby strengthening the European ability in terms of science and technology. In line with the increased recognition of the contribution of Small and Medium-sized Enterprises (SME) to economic growth and prosperity (Gilroy et al., 2008), international research programs specifically stimulate SME participation. As mentioned in the introduction, this study will draw a sample from three different programs: the Seventh Framework Program (FP7), the Eurostars program, and the Dutch Research & Development tax credit program (WBSO).

2.1 Seventh Framework Program (FP7)

The main European instruments that stimulate cross-border R&D cooperation are the Framework Programs (FP). The most recent FP, launched in 2007, is the seventh edition since the launch of the first framework program in 1984. The FPs were introduced with the aim to support and provide a general framework for cooperative R&D initiatives within the EU (Barajas & Huergo, 2010). With the emergence of viewing the innovation process as a system involving a wide set of actors, the emphasis of the FPs has shifted over time from "supply-side factors to diffusion-oriented projects, greater learning skills and increased knowledge diffusion among Europeans" (Protogerou et al., 2010: 352). Within the overall framework of initiatives within FP7, the 'Cooperation' program is the largest and represents two-thirds of the total budget of more than 50 billion Euros. Cooperation consists out of ten different research themes each with individual working programs. Within these working programs, SME participation is stimulated through, for example, specific SME calls or the earmarking of a budget for SMEs within calls. SME participation is however not uniform across the themes, which is caused by differences in ways of promoting SME participation. The overall aim is to make at least 15% of the budget within 'Cooperation' available to SMEs (Techweb, 2010).

Next to 'Cooperation', the 'Research for the benefit of SMEs' (or SME associations) initiative within the 'Capacities' program is specifically aimed at improving the innovating capacity of European SMEs or SME associations. The main difference with 'Cooperation' is the focus on SMEs with little or no innovative capacity by providing the ability to subcontract research activities to R&D performers such as universities. Furthermore, there are no specific research themes but projects must have exploitation potential and provide sufficient economic benefits for the SMEs involved (Techweb, 2010).

2.2 Eurostars

The Eurostars program was launched to stimulate SMEs to lead international collaborative research and innovation projects. The Eurostars program is based on the EUREKA framework in which, in contrast with FP7 that is funded with European money, projects are funded by the participating national governments. A Eurostars project can address any technological area but must have a civilian purpose and be aimed at the development of a new product, process or service. In addition, a Eurostars project must involve at least two participants from different participating Eurostars countries of which the main participant is a SME also performing research (Eurostars, 2009).

2.3 WBSO

The Research and Development tax credit (WBSO) provides a fiscal facility for companies, knowledge centers and self-employed persons within the Netherlands who perform R&D work. The program provides a reduction of payroll tax and social security contributions for employees directly involved in R&D and an increase in tax deductions for self-employed persons. R&D is thereby defined as "...technical/scientific research, the development of technologically new physical products or physical production processes (or parts thereof) and the development of technologically new software (or parts thereof)" (SenterNovem, 2010).

Dutch SMEs are selected within the above-mentioned programs. This study will thereby not go into further detail on the specifics of the different programs as the program databases purely serve as a basis for the sample selection. Important to accentuate however is that the selection of SMEs within the WBSO provides a means to include SMEs in the analysis that conduct R&D activities. Whereas innovation in principle applies to all types of SMEs, it are mainly the so called New Technology-Based (NTB) SMEs that are said to provide the largest economical contribution due to differences in pace of change, the importance of R&D and their networks (Keogh & Evans, 1999; Colombo & Grilli, 2005). These NTB-SMEs are assumed to form the most important target group of international research programs since established SMEs might, for example, be constrained by a limited 'absorptive capacity' in terms of being able to understand and process new types of knowledge developed within these programs.

3. Theoretical framework

While previously large corporations were mostly seen as the main drivers of economic development, a significant change has occurred over the last few decades as reflected in "the 'entrepreneurial society' where knowledge-based entrepreneurship has emerged as a driving force for economic growth, employment creation and competitiveness in today's global markets" (Audretsch, 2009: 253). In the face of these global markets, the entrepreneurial small and medium-sized enterprise (SME) faces both opportunities and threats due to increased competition causing these firms to explore and participate in international business activities (Fink et al., 2008; Ruzzier et al., 2006).

3.1 Opportunities

In terms of opportunities, the literature on internationalization states that SMEs are more innovative and adaptive and have quicker response times than large enterprises (Knight, 2001). Literature on entrepreneurship indicates that the entrepreneurial firm shows relatively higher levels of commercialisation compared to their larger counterparts (van Praag & Versloot, 2007). Although equally important for innovation, the creation of knowledge within research institutes and large corporations does not always lead to exploitation of the related economic opportunities. Reasons include the uncertainty accompanying new knowledge, asymmetries between researchers and decision-makers and/or an insufficient connection between new ideas and the core competence of an organization (Wennekers et al., 2009). Because of this, the development of new ideas and knowledge might eventually be abandoned leaving these new ideas and knowledge uncommercialized. According to Audretsch and Keilbach (2007), this is where a significant entrepreneurial opportunity arises. An essential distinction is therefore made between the entity that produces the knowledge and the entity that attempts to commercialize this knowledge. If the latter is fulfilled by a SME, this organization then serves "… as a key conduit for the spill-over of knowledge" (Audretsch et al., 2009:39). Overall, Audretsch and Keilbach (2007:1249) make the following proposition in their theory of knowledge spillover entrepreneurship: "Contexts rich in knowledge should generate more entrepreneurship, reflecting more extensive entrepreneurial opportunities. By contrast, contexts impoverished in knowledge should generate less entrepreneurship, reflecting less extensive entrepreneurial opportunities". This notion becomes especially interesting when considering possible improvements in the European ability to commercialise innovations related to 'key-technologies' as mentioned in the introduction (EC, 2009a). Assuming that international research programs provide a context rich in knowledge, entrepreneurial opportunities should arise that can potentially be exploited by SMEs. From this perspective, it may be assumed that high participation levels of SMEs in international research programs will benefit the European ability of commercializing key technologies.

Whereas research programs such as FP7 are yet mainly focussed on knowledge development, a relevant aspect to note is that this more or less assumes the existence of a technology-push based linear model of innovation. The linear model assumes that knowledge development automatically leads to innovation. This linear model of innovation is, however, widely questioned by the notion that innovation develops from interactions between multiple actors in a system (Edquist, 2001; Hekkert et al., 2007). Related to this notion is the so-called "European paradox", which stresses the fact that investment in new knowledge does not automatically lead to exploitation of the related economic opportunity. This commercialisation step requires an extra effort, which can thus potentially be fulfilled by the entrepreneurial firm (Audretsch & Keilbach, 2008).

3.2 Threats

Increasing international activity also poses threats for a SME, which are related to their so-called 'liabilities of smallness and/or newness' (Fink et al., 2008). A SME usually has limited internal resources, capabilities and market power in terms of the ability to influence and shape their external environment, which overall creates a more uncertain environment for a SME than for a larger company (North et al., 2001; Knight, 2001). To compensate for these liabilities, cooperative strategies are considered critical for the survival and growth of a SME, especially in an international context (Street & Cameron, 2007; Suarez-villa, 1998). Reasons for cooperation include the

creation of a 'critical mass' to be able to compete with larger firms, the creation of economies of scale, the creation of more efficiency by exploiting complementarities between resources, and access to foreign knowledge and markets when cooperating internationally (van Essen & Bhansing, 2009).

A possible way of engaging in cooperative arrangements is through participation in research programs such as FP7, which specifically stimulate research cooperation between firms and scientific organizations from different countries. Justification for providing such policy support to SMEs is also related to their liabilities of smallness and/or newness (North et al., 2001). In terms of R&D, a SME obviously has limited capabilities due to lack of human and financial resources and can therefore substantially benefit from specific support. From a resource-based view (RBV), combining firm specific heterogeneous resources can lead to significant competitive advantage (Nooteboom et al., 2007). From the perspective of the firm, the resource-based view stresses the importance of unique firm specific resources, which are difficult to imitate, in the creation of sustained competitive advantage (Mahoney & Pandian, 1992).

Next to limited resources, small firms often have a distinctive organizational culture. It is important to understand the role of the entrepreneur therein. Recent research has put more emphasis on the role of the entrepreneur in the internationalization process reflected in, for example, the recognition of the importance for a SME of having an international entrepreneurial orientation (Knight, 2001). Such an orientation reflects the pro-activeness of a SME regarding international opportunities (Arranz, 2009).

3.3 Incentives

From the opportunities and threats mentioned, both incentives and barriers arise that respectively cause or prevent a SME from pursuing international business activities such as participation in research programs. Research has widely addressed different incentives and barriers for a SME for engaging in international R&D cooperation (e.g. Hagedoorn et al., 2000). The absence of a common model that explains the various factors involved indicates, however, the complexity of the topic (Barajas & Huergo, 2010). Different classifications of possible incentives and barriers exist. According to Gilroy et al. (2008: 332), incentives can be classified into three broad categories:

- Resources, *i.e. to expand existing resources and obtain external resources*.
- Efficiency, *i.e. to reduce risk and costs, increase flexibility, and achieve economies of scale.*
- Competition, *i.e. to sustain competitive advantages and overcome market entry barriers.*

3.3.1 Resources

Acquiring new and expanding existing resources is one of the key incentives for a SME to participate in international business activities in general (Zahra et al., 2009). Examples are acquiring new knowledge and addressing the need for complementary resources to be able to innovate (Narula & Hagedoorn, 1999). Also in terms of participation in international research programs, the possibility to obtain resources forms a relatively straightforward incentive (Siune et al., 2005). The gathering of firms and research institutions from different countries within international research programs obviously provides a significant source of new knowledge. Associated with new knowledge is a high degree of uncertainty as well as a high propensity of knowledge to spill over (Audretsch & Keilbach, 2007). Cooperation within international research programs can provide a means for a SME to avoid the high costs of internalizing R&D activities as well as a means to internalize knowledge spillovers arising from the consortia (Hagedoorn et al., 2000; Cassiman and Veugelers, 2002).

3.3.2 Efficiency

Examples of incentives in terms of efficiency are related to a reduction of risk and a better ability to deal with the high costs associated with innovation (Narula & Hagedoorn, 1999). Participation in international research programs with the associated financial aid can assist firms with limited financial resources, such as SMEs, to pursue otherwise unachievable R&D activities (Barajas & Huergo, 2010).

Participation in international research programs can also lead to network extensions in terms of finding new contacts/relations (Siune et al., 2005). These new contacts/relations might provide a SME with access to new knowledge and technologies, leading to a more efficient business practice.

3.3.3 Competition

Incentives in terms of competition can be related to foreign market access (Hagedoorn, 1993). Participation in research programs that stimulate international cooperation can provide an opportunity for a SME to explore and access otherwise inaccessible or more difficultly accessible markets. A SME can thus expand the scope of its business activities thereby providing the possibility to sustain or strengthen their competitive position.

3.4 Barriers

In order to be effective in stimulating SME participation, policy initiatives such as research programs need to address the barriers that arise from the limitations faced by a SME. As with the incentives, different classifications exist of potential barriers for a SME to conduct international R&D cooperation activities. The OECD (1997) has proposed a general classification of barriers; their existence has been indicated by more recent research (Lloyd-Reason and Mughan, 2008):

- Finance
- Capability
- Access
- Business Environment

3.4.1 Resources

Whereas the OECD classification uses the term finance, this research will label this variable as resources. Limitations in terms of both human and financial resources can be said to create significant barriers (Keogh & Evans, 1999). With respect to the overall role of R&D within SMEs the basis of these barriers lies in the tension between the uncertainty of R&D and innovation and the resource limitations of SMEs (Ortega-Argiles et al., 2009). Apart from providing financial aid, participation in international research programs also requires financial investment from the side of the SME. If these investments do not outweigh the perceived chance of receiving financial aid, a SME will not attempt to participate. Participation in international research programs also requires human resources, for example in terms of managing the progress of project consortia. The limited number of employees of a SME may create significant barriers in this respect. Related to this, the required time for participation may also prevent a SME from participating in international programs (Siune et al., 2005).

3.4.2 Capability

Participation in international research programs obviously requires a certain amount of capabilities available within the SME. Capability is interpreted as the ability of a SME to execute a certain strategy, in this case participation in international research programs. Participation in international research programs has certain requirements that need to align with the internal capabilities of a SME. Two requirements for participation are assumed to be of influence in terms of capability: (1) cooperation with other enterprises and/or research institutions and (2) compliance with the (thematic) structure of research programs. There is always a risk of opportunistic behaviour associated with cooperation. A SME must be willing to share firm-specific knowledge or intellectual property in order to be able to participate in international research programs, which partly reflects the international orientation of a SME (Knight, 2001). The perceived risk of losing firm-specific knowledge or intellectual property thus forms a significant barrier.

As mentioned in section 2, international research programs are structured according to specific program themes. Being able to participate and profit from the knowledge generated within these research programs thus requires a certain match between these themes and the internal capabilities of a SME (Barajas & Huergo, 2010). It may very well be that the knowledge developed in a specific research program does not receive any interest from a SME due to a large cognitive distance (Nooteboom et al, 2007). Too little cognitive distance is thereby said to cause insignificant renewal and too much cognitive distance causes difficulties for a SME to ‘internalize’ the new

developed knowledge. Furthermore, the mainly scientific character of international research programs might form a barrier for SMEs requiring short time to market topics (Siune et al., 2005).

3.4.3 Access barriers

Significant barriers might also arise in terms of the design and accessibility of international research programs (Siune et al., 2005). First of all, sufficient and clear information is required for a SME to be able to participate. Furthermore, access barriers are also related to the effort it takes to apply for a specific research program. Too much time consuming and complex formal arrangements can cause a SME to withstand participation in research programs and are barriers that have received significant attention from policymakers. Barriers faced by SMEs regarding the accessibility of research programs also relate to the process of consortium building (Siune et al., 2005). Difficulties with joining existing projects or finding potential foreign consortium partners might in this respect also form barriers. Another barrier in terms of the accessibility of international programs relates to the perceived chance of success of a potential application. Research has shown that these success rates differ among specific elements of research programs, due to, for example, different research priorities and the amount of SME specific calls (e.g. SenterNovem, 2008). A perceived low chance of success will obviously prevent a SME from participation.

3.4.4 Business environment

Barriers in terms of relations and culture can be positioned within this variable. The most obvious barrier within this variable is a difference in language. Foreign business practices and habits can also differ which may in turn cause difficulties in enforcing contracts and resolving potential disputes. Furthermore, the existing network of foreign contacts and relations of a SME might also be of influence. The choice of a SME to participate in international research programs might depend on whether or not the SME is approached by an existing partner (Technopolis, 2009). A lack of foreign contacts and relations might thereby limit the chance of participation of a SME.

3.4.5 Dependent variable

The categories of incentives and barriers discussed are all assumed to affect the choice of a SME to participate in international research programs. In this study, the dependent variable 'participation' is interpreted as whether Dutch SMEs (1) do not participate in international research programs or (2) do participate in international research programs. It is thus tested which of the proposed incentives and barriers influence the decision to participate in international research programs.

3.4.6 Control variables

It may be assumed that the different incentives and barriers are not experienced in an identical manner by all SMEs (Lloyd-Reason and Mughan, 2008). Addressing the influence of different incentives and barriers on the choice of SMEs to participate in international research programs thus requires controlling for both internal and external factors that might be of influence. Internal firm specific factors relate to the notion that a certain 'critical mass' is required for conducting R&D activities in general and to be able to participate in the often complex and long term projects of, for example, FP7 (Barajas & Huergo, 2010). The age of the SME is therefore taken into account as it is assumed that older SMEs can more easily deal with the requirements of participating in international programs. The size of the SME is also taken into account since larger SMEs can be conceived to have acquired a larger mass. Besides age and size, experience in terms of international activities can be said to change the perception of incentives and barriers (Keogh & Evans, 1999). Experience with international R&D cooperation in terms of participation in international research programs will improve the probability of a firm conducting these activities again (Barajas & Huergo, 2010). SMEs with international experience in general may be assumed to find more easily partners and be better able to manage the process associated with participation in international research programs.

External factors in turn can be related to differences in innovativeness of an industry related to the technology intensity of different industries (Hagedoorn, 1993). Programs such as FP7 are structured according to different themes and aim to strengthen the European position in terms of these themes. SMEs within a industry of operation that does not relate to these themes can thus be assumed to be less likely to participate.

3.5 Conceptual model

Combining all concepts and their hypothesized effects on the participation of SMEs in international research programs results in the conceptual model depicted below. The hypothesized effects will be tested statistically for their validity later in this study.

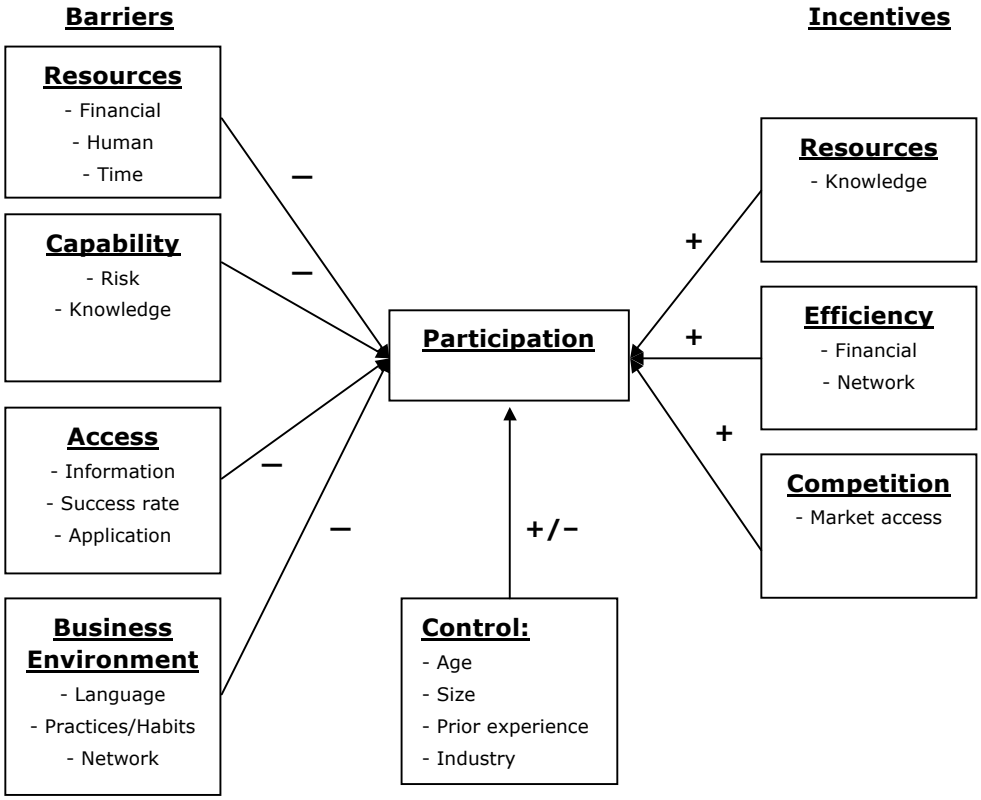

Figure 1: Conceptual model

3.6 Variables & operationalization

In this section, indicators are derived for the different variables of the conceptual model depicted in figure 1.

3.6.1 Participation

As mentioned above, the dependent variable of this study is formed by the participation of SMEs in international research programs. Participation is thereby interpreted as whether a SME solely participates in national research programs or participates both in national- and international research programs. Participation was measured by asking the respondents to indicate whether or not they participated in national- and/or international research programs[1] at the moment of responding to the questionnaire. Respondents that solely participate in national programs were coded '0'. Respondents that participate both in national- and international programs were coded '1'.

3.6.2 Barriers

Resources

The first category of potential barriers relates to the resource limitations of a SME possibly preventing its participation in international research programs. This concept is measured on three different potential barriers: availability of financial resources, the required time for participation,

[1] National programs: WBSO, Innovation Vouchers, Innovation Performance Contracts. International programs: FP7, Eurostars, Eureka.

and availability of employees. 5-point Likert scales ranging from 'not important' to 'very important' were used to indicate the extent to which these barriers are perceived as important.

Capability
The second category of potential barriers relates to the amount of capabilities required for a SME to participate in international research programs. Capability is hereby interpreted as the ability of a SME to execute a certain strategy, in this case participation in international research programs. Participation in these programs has certain requirements and capability is measured on two dimensions of these requirements: (1) cooperation with other enterprises and/or research institutions, and (2) compliance with the thematic structure of research programs. The first dimension is measured on two indicators of barriers that might arise in terms of, respectively, the perceived risk of losing firm-specific knowledge or intellectual property when cooperating with other enterprises and/or research institutions. The second dimension is measured on two indicators of barriers that might arise on the one hand in terms of the match between research program themes and the available knowledge and core competences within a SME, and on the other hand in terms of the research program being too scientific for SME participation. 5-point Likert scales ranging from 'not important' to 'very important' were used to indicate the extent to which these barriers are perceived as important.

Access
The third category of potential barriers relates to the accessibility of international research programs. This concept is measured on three different potential barriers: the limited availability of information and assistance during application, the chance of success of potential application, and the application procedure itself. Barriers in terms of the application procedure itself were measured on four indicators: (1) the application procedure might be either too complex or (2) too time consuming, (3) difficulties might arise in terms of joining running projects or (4) finding potential international cooperation partners. 5-point Likert scales ranging from 'not important' to 'very important' were used to indicate the extent to which these barriers are perceived as important.

Business environment (cultural/relational)
The fourth and final category of barriers relates to the foreign business environment that a SME has to deal with through participation in international research programs. This variable is measured on three different observable barriers: a difference in language of foreign partners, different habits and practices of foreign partners, and a lack of foreign contacts. Three 5-point Likert scales ranging from 'not important' to 'very important' were used to indicate the extent to which these barriers are perceived as important.

3.6.3 Incentives

Resources
The first category of incentives relates to the possibility of obtaining (additional) resources through participation in international research programs. This variable is measured on a 5-point Likert scale ranging from 'not important' to 'very important' indicating the extent to which 'access to new knowledge' is perceived as an important incentive.

Efficiency
The second category of incentives relates to the possible gains in efficiency through participation in international research programs. Both efficiency improvements in terms of a contribution to the high costs of conducting research and developing new products/services as well as efficiency improvements in terms of extending the current network of relations/contacts are assumed to be of influence. These indicators are measured on 5-point Likert scales ranging from 'not important' to 'very important', indicating the extent to which these incentives are perceived as important.

Competition
The third category of incentives relates to the possibility of obtaining competitive advantages through participation in international research programs. This variable is measured on a 5-point Likert scale ranging from 'not important' to 'very important' indicating the extent to which 'access to new and larger markets' is perceived as an important incentive.

3.6.4 Control variables

Age

The age control variable first of all takes into account the influence of accumulated knowledge and experience of a SME on its choice to participate in international research programs. This variable is measured as the number of years of existence of a SME.

Size

The size control variable takes into account the influence of accumulated resources and capabilities of a SME on its choice to participate in international research programs. This variable is measured as an ordinal variable with three different size categories in terms of number of employees as proposed in the European SME definition: 1-10 employees, 11-50 employees, and 51-250 employees (EC, 2009b).

Experience

The experience control variable takes into account the amount of international experience of a SME. This variable is measured on two indicators. For one indicator, 4 dummy variables are created that take the value 1 when respectively a SME has conducted import, export, international cooperation, or other international activities in the past three years. For the other indicator, a dummy variable is created that takes the value 1 when a SME has made an earlier attempt to participate in either the FP, the Eurostars program, or the Eureka program.

Industry

The industry control variable takes into account the specific type of industry in which a SME operates. This variable is captured using an industry classification based on SBI codes. The Dutch SBI coding is identical to the European NACE rev.1.1 industrial classification (CBS, 2010; Fifo, 2010). The classification applied for this study can be found in appendix 1.

Table 1 provides an overview of the operationalization.

Table 1. Variables and operationalization.

Variable	Dimension	Indicator	
Dependent			
Participation		Is your firm participating in one of these programs at this moment?	0 = Participates solely national 1 = Participates both national and international
Barriers			
Resources	Financial	Availability of financial resources.	Not important – Very important
	Time	Required time.	Not important – Very important
	Human	Availability of employees.	Not important – Very important
Capability	Risk	Sharing of intellectual property.	Not important – Very important
		Sharing of firm specific knowledge.	Not important – Very important
	Knowledge	The research within the programs is to theoretical and leads to insufficient applicable knowledge.	Not important – Very important
		The themes within the research program do not 'align' with the core competence of the firm.	Not important – Very important
Access	Available information	To little information and assistance to help coordinate a potential application.	Don't agree – Fully agree
	Chance of success	The success-rate of potential application is to low.	Not important – Very important
	Application	The procedure of application is complex.	Don't agree – Fully agree
		The procedure of application requires too much time.	Don't agree – Fully agree
		Difficulties in joining existing projects	Don't agree – Fully agree
		Difficulties in finding potential foreign cooperation partners.	Don't agree – Fully agree

(Continued)

Table 1. *(Continued)*.

Variable	Dimension	Indicator	
Business environment	Language	Unfamiliarity with language of potential foreign partners.	Not important – Very important
	Practices/Habits	A difference in business practices or habits.	Not important – Very important
	Network	A lack of foreign contacts/relations.	Not important – Very important
Incentives			
Resources	Knowledge	Access to new knowledge.	Not important – Very important
Efficiency	Financial	To better deal with high costs related to conducting fundamental research.	Not important – Very important
		To better deal with high costs related to the development of new products/services.	Not important – Very important
	Network	Extending of the recent network of contacts/relations.	Not important – Very important
Competition	Market access	To gain access to new and larger markets.	Not important – Very important
Control			
Firm characteristics	Age	How long does your company exist?	Years
	Size	How many employees did your firm have in the past year?	1 = 1-10 employees 2 = 11-50 employees 3 = 51-250 employees
Firm experience	International activities	Has your firm conducted one of the following activities in the past three years?	- Import (0 = No; 1 = Yes) - Export (0 = No; 1 = Yes) - International cooperation (0 = No; 1 = Yes) - Other international activities (0 = No; 1 = Yes)
	Research program participation	Has your firm made a previous attempt to participate in one of these programs?	- FP7 (0 = No; 1 = Yes) - Eurostars (0 = No; 1 = Yes) - Eureka (0 = No; 1 = Yes)
Industry		Which industry classification best describes your firm?	25 categories according to SBI-codes

4. Methodology

This section explains the data and methodology used to operationalize the conceptual model for this study. Two main steps can be differentiated. First of all, relevant samples are obtained by means of database-research. The second step consists of testing the effects of the incentives, barriers and control variables on the participation of SMEs in national- and international research programs by applying appropriate statistical methods.

In order to identify SMEs in the various databases used, the SME definition as formulated by the European Commission has been applied throughout this research: "… enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro. Possible existing relations with other enterprises also need to be taken into account" (EC, 2009b). A further subdivision according to size can be made as presented in the table below:

Table 2. SME definition (EC, 2009b).

Enterprise Category	Headcount	Turnover	(or)	Balance sheet total
Medium-sized	< 250	≤ € 50 million		≤ € 43 million
Small	< 50	≤ € 10 million		≤ € 10 million
Micro	< 10	≤ € 2 million		≤ € 2 million

4.1 Sample selection

4.1.1 The Seventh Framework Program (FP7)

The available data consisted first of al of the ECORDA database of the Seventh Framework Program with the cut-off date on October 15, 2009. Since FP7 is the youngest program for which data are available, this research covers a time span from the start of the program in 2007 up until the cut-off date[2]. Although of great value, the information in de ECORDA database has its limitations, which need to be taken into account as is also indicated by various existing studies (e.g. Protogerou et al., 2010). The main challenge for this study was to extract a coherent sample of Dutch SMEs from the database. A number of steps were taken in consultation with EG-Liaison[3] for this purpose, which are explained in appendix II. Applying these steps resulted in a selection of 1.606 proposals with the participation of at least one Dutch SME. The same SME can participate in multiple proposals and multiple SMEs can also participate in one single proposal. Unique organization IDs have been applied to all 1.606 project proposals indicating that 880 different Dutch SMEs participate in these proposals.

4.1.2 Eurostars

Next to FP7, online data were available for this study from the first three calls of the Eurostars program. The online data did not require extra correction steps. Dutch SMEs and the corresponding projects in which they participate could be selected through a search engine. This resulted in a selection of 79 project proposals with the participation of at least one Dutch SME. Application of unique organization IDs indicated that 67 Dutch SMEs, additional to the FP7 participants, participate in these proposals. Table 3 provides a summary of the selections made within the FP7 and Eurostars program databases. The first part of the database-research has thus resulted in a selection of 947 Dutch SMEs that participate in FP7 and/or Eurostars.

[2] It should be noticed that the data within the FP7 database will not be 100% complete up to this date due to the size of the program which causes delay in the processing of the information about specific projects. Although worth mentioning, this problem cannot be circumvented.

[3] The Dutch national contact point for FP7.

Table 3. Data selection.

	FP7	Eurostars
Proposals with NL SME participation	1.606	79
Number of SMEs	880	67

4.1.3 WBSO

For the second part of the database-research, all 947 Dutch SMEs that participate in FP7 and/or Eurostars were checked regarding their participation in the research and development tax credit program (WBSO). For this purpose, each SMEs was compared on a name basis with the database of the WBSO containing 14.845 SME WBSO participants[4] in the year 2009. This step resulted in a selection of 479 SMEs that participate both in the WBSO and in one of the international research programs.

Because a national register of all SMEs in the Netherlands is missing, a control group for non-WBSO SME participants cannot be included in the analysis. The only way to be able to test the influence of different incentives and barriers on the choice of a SME to participate in international research programs is thus to include only WBSO SME participants in the analysis.

4.1.4 Participation groups

In sum, two different groups of SMEs are derived from the database-research. Their group membership is determined by whether or not a SME participates in international research programs as indicated in table 4:

Table 4. Results sample selection.

	International	
	N	Y
WBSO participants	14.366 (**group 1**)	479 (**group 2**)

- Group 1:

Dutch SMEs within group 1 **do** participate in the WBSO but **do not** participate in one of the international programs. Group 1 consists of 14.366 SMEs that are obtained by subtracting the 479 SMEs of group 2 from the total number of 14.845 SMEs registered in the WBSO database in 2009.

- Group 2:

Dutch SMEs within group 2 **do** participate in the WBSO **as well as** in one of the international programs. As mentioned above, group 2 consists of the 479 SMEs resulting from the comparison of the program databases of FP7 and Eurostars to the database of the WBSO.

Additionally, a sample was drawn from group 1 due to its size (14.366 SMEs) after a first stratification of this group based on SBI code and number of employees. This stratification was done to obtain a similar spread in the response regarding the industry and size classes, which are included as control variables in the conceptual model[5]. All SMEs within group 2 were included in the sample, which resulted in a total sample of 1.500 SMEs. The questionnaire was created online and SMEs were contacted by email whereby anonymity of the respondents was guaranteed. The questionnaire contained questions on the indicators presented in table 2 (section 3.6). Overall, a total of 246 SMEs completed the questionnaire of which 197 SMEs in group 1 and 50 SMEs in group 2 as depicted in table 5 with the corresponding response percentage.

[4] Organizations with 250 or less employees.

[5] Data on the other control variables (age and prior experience) were not available and prevented further stratification.

Table 5. Obtained response.

	Group 1	Group 2	Total
# SMEs	197	50	247
Response	16%	10%	16%

4.2 Analysis

The second step consisted of testing the effects of the incentives, barriers and control variables on the participation of SMEs in national- and international research programs. First of all, the proposed operationalization of the conceptual model is tested using factor analysis. Secondly, the hypothesized effects of the incentives, barriers and control variables are tested using logistic regression analysis.

4.2.1 Factor analysis

Factor analysis is a method to combine variables into factors that are correlated with one another but are largely independent of other subsets of variables (Tabachnick & Fidell, 2007). Exploratory factor analysis (EFA) is used in this study to test if the proposed indicator variables (the 26 items of the questionnaire) loaded on the concepts of incentives and barriers as specified in the conceptual model. The *à priori* assumption is that each concept (the factor) is associated with the subset of indicator variables as proposed in section 3.6 (Garson, 2010). Both principal components analysis (PCA) and principal factor analysis (PFA) are applied. PCA is used prior to PFA to estimate the likely number of factors based on eigenvalues larger than 1. PFA is used to find the final solution in terms of factors with eigenvalues larger than 1. The resulting factor solution is assumed to represent the dataset best and the proposed conceptual model is partly adjusted to represent the factor solution within its original specification. The factor scores were saved as variables for use in the logistic regression procedure described below.

4.2.2 Logistic regression analysis

Binomial logistic regression was applied because 'participation' is measured as a dichotomous dependent variable and the factors resulting from the factor analysis are measured as continuous independent variables. The control variables included were age, size, experience and industry. The analysis was performed using SPSS. Logistic regression estimates the odds of a certain event occurring. In this case the effect is tested of the different incentives and barriers on the odds of a SME participating both in the WBSO and in international programs, relative to solely participating in the WBSO.

5. Results

The results of this study will be presented in two parts. The first part presents relevant descriptive results. The second part presents the analytical results including both the results of the factor analysis and the results of the logistic regression analysis.

5.1 Descriptive results

Table 6 presents descriptive statistics for the obtained answers to the questionnaire for the different incentives, barriers and control variables. The means as well as the standard deviations are included for the total dataset as well as for the individual participation groups. This overview provides a general idea of how the respondents perceive the different incentives, barriers and control variables.

Table 6. Descriptive statistics.

	Total			Non-Participants[b]			Participants[c]		
Indicator	N	Mean	Std.[a]	N	Mean	Std.	N	Mean	Std.
NL incentives									
Access to new knowledge and technology	241	3,95	0,96	191	3,93	0,97	50	4,04	0,90
Contribution to costs of doing research	238	4,47	0,70	188	4,44	0,75	50	4,60	0,50
Contribution to costs of new products/services	239	4,52	0,68	190	4,49	0,69	49	4,61	0,64
To extent network of relations/contacts	241	3,80	1,03	191	3,74	1,06	50	4,02	0,89
To gain access to new and larger markets	240	3,79	1,01	191	3,80	1,02	49	3,73	1,00
INT incentives									
Access to new knowledge and technology	234	4,03	0,88	185	3,98	0,93	49	4,20	0,65
Contribution to costs of doing research	234	4,32	0,80	185	4,25	0,84	49	4,57	0,54
Contribution to costs of new products/services	235	4,34	0,81	186	4,30	0,83	49	4,49	0,71
To extent network of relations/contacts	235	4,06	0,83	186	3,98	0,86	49	4,35	0,60
To gain access to new and larger markets	235	4,00	0,89	186	3,98	0,89	49	4,08	0,89
INT barriers									
Sharing of firm specific knowledge	226	2,76	1,07	182	2,77	1,06	44	2,70	1,09
Sharing of intellectual property	224	3,22	1,15	180	3,19	1,14	44	3,36	1,18
Mismatch program themes and daily practice of SME	224	3,48	0,97	180	3,43	0,95	44	3,66	1,03
Too much scientific and too little practical content	225	3,28	1,09	181	3,36	1,06	44	2,95	1,14
Perceived low chance of success of application	225	3,79	0,97	181	3,77	0,97	44	3,84	0,96
Required time	230	3,66	0,99	185	3,71	0,98	45	3,44	0,99
Availability of employees	229	3,57	0,96	185	3,59	0,98	44	3,50	0,88
Availability of financial resources	227	3,80	0,96	182	3,80	0,96	45	3,80	0,97
Differences in language of potential partners	227	1,96	0,96	182	2,04	1,01	45	1,62	0,65
Differences in practices and habits of potential partners	227	2,03	0,98	182	2,08	0,99	45	1,82	0,91
A lack of international contacts	227	2,52	1,20	182	2,62	1,24	45	2,16	0,95
Application procedure is too complex	225	3,82	0,87	180	3,82	0,89	45	3,84	0,80
Application procedure requires too much time	223	3,94	0,88	178	3,93	0,88	45	3,98	0,89
A lack of information and help during the application	221	3,31	0,94	177	3,41	0,93	44	2,93	0,90
Difficulty in joining existing projects	224	3,52	0,87	179	3,63	0,83	45	3,07	0,89
Difficulty in finding potential foreign partners	224	3,24	0,95	179	3,32	0,93	45	2,91	0,97

(Continued)

[a] Standard deviation

[b] Group 1

[c] Group 2

Table 6. *(Continued)*.

Control		Total			Non-Participants			Participants		
		N	Mean	Std.	N	Mean	Std.	N	Mean	Std.
Age		239	15,91	13,26	190	16,63	13,56	49	13,10	11,73
Size		246	1,67	0,72	196	1,68	0,74	50	1,64	0,66
	'1-10 employees'	117			94			23		
	'11-50 employees'	92			70			22		
	'51-250 employees'	37			32			5		
Experience	Import	247	0,49	0,50	197	0,50	0,50	50	0,46	0,50
	'Yes'	121			98			23		
	Export	247	0,65	0,48	197	0,65	0,48	50	0,64	0,49
	'Yes'	160			128			32		
	International cooperation	247	0,70	0,46	197	0,63	0,48	50	0,96	0,20
	'Yes'	173			125			48		
	Other international activities	247	0,38	0,49	197	0,35	0,48	50	0,50	0,51
	'Yes'	94			69			25		
Earlier attempt to participate		247	0,35	0,48	197	0,18	0,39	50	1,00	0,00
	'Yes'	86			36			50		
Industry		246	16,01	7,78	196	16,17	7,78	50	15,36	7,83
	'Agriculture, forestry and fishing'	12			9			3		
	'Mining and quarrying'	0			0			0		
	'Manufacture of food products, beverages and tobacco'	3			3			0		
	'Manufacture of textiles- and leather (products)'	3			3			0		
	'Manufacture of pulp, paper and paper products'	1			0			1		
	'Publishing, printing and reproduction of recorded media'	0			0			0		
	'Manufacture of coke, refined petroleum products and nuclear fuel'	0			0			0		
	'Manufacture of chemicals and chemical products'	21			14			7		
	'Manufacture of rubber and plastic products'	11			9			2		
	'Manufacture of basic metals and fabricated metal products'	21			21			0		
	'Manufacture of machinery and equipment n.e.c.'	18			13			5		
	'Manufacture of electrical and optical equipment'	20			11			9		
	'Manufacture of transport equipment'	4			3			1		
	'Other industries'	7			7			0		
	'Electricity, gas and water supply'	6			5			1		
	'Construction'	4			4			0		
	'Wholesale, repair and hospitality'	3			3			0		
	'Transport, storage and communication'	2			2			0		
	'Financial intermediation'	1			1			0		
	'Computer and related activities'	25			24			1		
	'Research and development'	30			20			10		
	'Legal and economic consultancy'	0			0			0		
	'Architectural and engineering activities and related technical consultancy'	8			6			2		
	'Renting and other business activities'	1			1			0		
	'Governmental'	0			0			0		
	'Health and social work'	10			8			2		
	'Environmental services'	3			2			1		
	'Other services'	32			27			5		

Considering the rating of the different incentives, a number of observations can be made. First of all the means of the different answers are all around 4 or higher. All analysed incentives thus seem to be considered as important reasons to participate in national and international research programs. Furthermore, only small differences seem to exist in average ratings of the incentives to participate in national programs and the incentives to participate in international programs. Access to new knowledge, for example, receives similar ratings. The incentives in terms of costs reduction receive a slightly higher average rating for participation in national programs. Network extension and access to new markets receive a slightly higher average rating for participation in international programs. These observations could be explained by the fact that SMEs participate in national research programs mostly for financial reasons. Non-financial aspects apparently become more important when a SME also participates in international programs. The average rating of the barriers shows relatively more variety. A relatively high average rating is given to barriers regarding the application procedure, 'the availability of financial resources', and 'the perceived low chance of success of application'. The lowest average rating is given to 'sharing firm specific knowledge, 'the difference in language of potential partners', 'different practices and habits of

potential partners', and 'a lack of international contacts'. These barriers receive an average rating lower than '3'.

5.2 Analytical results

5.2.1 Factor analysis

Principle factors analysis (PFA) with varimax rotation was performed in SPSS on 26 items of the questionnaire representing the various incentives and barriers specified in the conceptual model. Table 7 presents the results on the loadings of variables on factors, communalities, eigenvalues and percentage of explained variance. To facilitate the intepretation of the table, the variables are ordered by size of loading and zeroes replace all loadings in the table under the applied cut-off value of 0.45 (Tabachnick & Fidell, 2007)[6].

Table 7. Results factor analysis.

Item	F1[a]	F2	F3	F4	F5	F6	F7	F8	F9	h^2
Contribution to costs of research I	**0.84**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78
Contribution to cost of developing I products/services	**0.84**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74
Contribution to cost of developing products/services	**0.78**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65
Contribution to costs of research	**0.76**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64
Gain access to new markets I	0.00	**0.82**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70
Gain access to new markets	0.00	**0.74**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60
Gain access to networks I	0.00	**0.64**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52
Gain access to networks	0.00	**0.58**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
Application requires to much time	0.00	0.00	**0.85**	0.00	0.00	0.00	0.00	0.00	0.00	0.77
Application is complex	0.00	0.00	**0.84**	0.00	0.00	0.00	0.00	0.00	0.00	0.79
Different habits and practices	0.00	0.00	0.00	**0.87**	0.00	0.00	0.00	0.00	0.00	0.77
Language differences	0.00	0.00	0.00	**0.83**	0.00	0.00	0.00	0.00	0.00	0.73
Lack of foreign contacts	0.00	0.00	0.00	**0.50**	0.00	0.00	0.00	0.00	0.00	0.44
Availability of employees	0.00	0.00	0.00	0.00	**0.81**	0.00	0.00	0.00	0.00	0.72
Required time	0.00	0.00	0.00	0.00	**0.77**	0.00	0.00	0.00	0.00	0.68
Availability of financial resources	0.00	0.00	0.00	0.00	**0.51**	0.00	0.00	0.00	0.00	0.36
New knowledge & technology I	0.00	0.00	0.00	0.00	0.00	**0.80**	0.00	0.00	0.00	0.73
New knowledge & technology	0.00	0.00	0.00	0.00	0.00	**0.78**	0.00	0.00	0.00	0.70
Knowledge sharing	0.00	0.00	0.00	0.00	0.00	0.00	**0.82**	0.00	0.00	0.73
Sharing of intellectual property	0.00	0.00	0.00	0.00	0.00	0.00	**0.80**	0.00	0.00	0.70
Difficulty in finding foreign cooperation partners	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.69**	0.00	0.52
Difficulty in joining running projects	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.63**	0.00	0.56
Lack of information and help during application	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.39**	0.00	0.30
Mismatch program themes/core competences	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.68**	0.49
Research being to scientific	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.59**	0.45
Low chance of success	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.45**	0.40
Eigenvalue	2.79	2.12	1.84	1.83	1.77	1.50	1.44	1.41	1.22	15.95
% of variance	10,7	8,2	7,1	7,0	6,8	5,8	5,5	5,4	4,7	61,3
Cronbach's Alpha	0,94	0,90	0,92	0,89	0,87	0,88	0,90	0,80	0,80	
Kaiser-Meyer-Olkin = 0,65										

(Continued)

[6] Except for the 'lack of information and help during application' item, which is explained below.

Table 7. *(Continued)*.

[a]Factor labels:	F1 Cost incentives	F4 Cultural/Relational barriers	F7 Risk barriers
	F2 Strategic incentives	F5 Resource barriers	F8 Access barriers
	F3 Administrative barriers	F6 Resource incentives	F9 Program specific barriers

Principle components analysis (PCA) was used prior to PFA to estimate the number of factors. A total of 9 factors was extracted via PFA thereby only retaining factors with eigenvalues larger than 1 (Kaiser, 1960). All variables seem well defined by the factor solution. The Kaiser-Meyer-Olkin criterium showed a value of 0,65 indicating an acceptable fit (Kaiser, 1974). The Chronbach's Alphas, providing an indication of the internal consistency of the individual factors, showed values of 0,80 and higher. A value of 0,80 is typically employed as an acceptable level of internal consistency although existing studies have employed levels as low as 0,60 (Bryman, 2008). Communality values tended to be high with only two variables showing a value under 0.40. Applying a cut-off loading value of 0.45, which indicates a fair loading (Tabachnick & Fidell, 2007), for the inclusion of a variable in the interpretation of a factor resulted in only one item that did not load on any factor. Considering the loading of 0.39 and the assumed importance of this variable for this study, a 'lack of information and help during application' is still included in the factor solution. According to Tabachnick and Fidell (2007), the minimum factor loading is 0.32 or higher. The factor solution furthermore combines the incentives for participation in respectively national- and international programs into single factors. This is coherent with the earlier observation that within the obtained dataset only small differences in rating seem to exist between these national- and international incentives. As is shown in table 7, the interpreted labels for the 9 extracted factors ordered by the size of the corresponding eigenvalues are '*financial incentives*', '*strategic incentives*', '*administrative barriers*', '*cultural/relational barriers*', '*resource barriers*', '*resource incentives*', '*risk barriers*', '*access barriers*', and '*program specific barriers*'.

According to the factor solution, the analysed incentives are thus be explained by 3 factors and the analysed barriers are explained by 6 factors. A conceptual model with only 7 variables was proposed following from the literature study of chapter 3. In the following the factor solution will be discussed in relation to the operationalization of this conceptual model. The results and revisions made to the conceptual model are summarized and presented in table 8 and figure 2.

Financial incentives: A first factor is extracted for the incentives of 'a contribution to the costs of doing research' and 'a contribution to the costs of developing new products/services'. This factor is thus labelled as *financial incentives*. These incentives were associated to the efficiency variable in the conceptual model but are better represented as a separate category. Interesting to note is that the dataset apparently does not show a significant difference in rating between the costs of doing research and the costs of developing products/services.

Strategic incentives: The second factor is extracted for the incentives of 'gaining access to new markets' and 'gaining access to new networks'. This factor is labelled as *strategic incentives* since both incentives relate to gaining access to a foreign business environment either in terms of markets or in terms of networks. 'Access to new markets' was associated to the competition variable in the conceptual model whereas 'access to new networks' was associated to the efficiency variable. Both incentives apparently are better represented by a separate *strategic incentives* variable.

Administrative barriers: The third factor is extracted for the barriers of 'the application procedure requiring too much time' and 'the application procedure being too complex'. This factor is labelled *administrative barriers* since both barriers relate to the amount of bureaucracy required to participate in international research programs. Both barriers were associated to the application dimension of the access variable in the conceptual model but are better represented as a separate variable.

Cultural/relational barriers: The fourth factor is extracted for the barriers of 'different habits/practices of potential partners', 'a difference in language of potential partners', and 'a lack of foreign contacts'. This factor is labelled *cultural/relational barriers* and corresponds to the proposed variable in the conceptual model.

Resource barriers: The fifth factor is extracted for the barriers of 'a limited availability of employees', 'the required time for participation', and 'a limited availability of financial resources'. This factor is thus labelled as *resource barriers* and also corresponds to the proposed variable in the conceptual model.

Resource incentives: The sixth factor is extracted for the incentive of 'access to new knowledge and technology'. This factor is thus labelled as *resource incentives* and corresponds to the proposed variable in the conceptual model.

Risk barriers: The seventh factor is extracted for the barriers of 'sharing firm specific knowledge' and 'sharing intellectual property'. This factor is labelled *risk barriers* since both barriers relate to the perceived risk of losing either firm specific knowledge or intellectual property through participation in international research programs. These barriers were associated to the capability variable of the conceptual model but are better represented as a separate variable.

Access barriers: The eighth factor is extracted for the barriers of 'difficulties in finding foreign cooperation partners', 'difficulties in joining running projects', and 'a lack of information and help during the application procedure'. All three barriers can be associated to the accessibility of international research programs and this factor is thus labelled *access barriers* accordingly. These barriers were associated to the access variable of the conceptual model although a lack of information and help was assumed to form a separate dimension of this variable. A separate access barriers variable apparently best represents these three barriers.

Program specific barriers: The ninth and final factor is extracted for the barriers of 'a mismatch between program themes and the core competences of a SME', 'the research being too scientific', and 'a low chance of success of a potential application'. This factor is labelled *program specific barriers* since all three barriers relate to specific elements of international programs that might prevent a SME from participating in these programs. The first two barriers were associated to the capability variable of the conceptual model whereas the chance of success was associated to the access variable. All three barriers apparently are better represented by a separate program specific barriers variable.

Table 8. Comparison conceptual model.

	Results factor analysis	Theoretical construct
Incentives	Resource incentives	Resources
	Financial incentives	Efficiency
	Strategic incentives	Efficiency/Competition
Barriers	Resource barriers	Resources
	Risk barriers	Capability
	Program-specific barriers	Capability/Access
	Access barriers	Access
	Administrative barriers	Access
	Cultural/Relational barriers	Business environment

To summarize, the factor analysis has resulted in 9 factors. A number of differences thereby exist between the factor solution and the proposed conceptual model. In terms of incentives, the *efficiency* and *competition* variable of the conceptual model seem better represented by a separate *financial incentives* and *strategic incentives* variable. In terms of barriers, the *resources* variable and the *business environment* variable of the conceptual model correspond to the factor solution. The *capability* variable and the *access* variable however require some adjustments. The *capability* variable is better represented by a separate *risk barriers* and *program-specific barriers* variable. The *access* variable corresponds to the factor solution, however a separate *administrative barriers* variable emerges from the factor solution. These results provide a first indication of the validity of the measurement scales. Figure 2 presents the adjusted conceptual model resulting from the factor analysis, which will be modelled using logistic regression analysis as described in the next section.

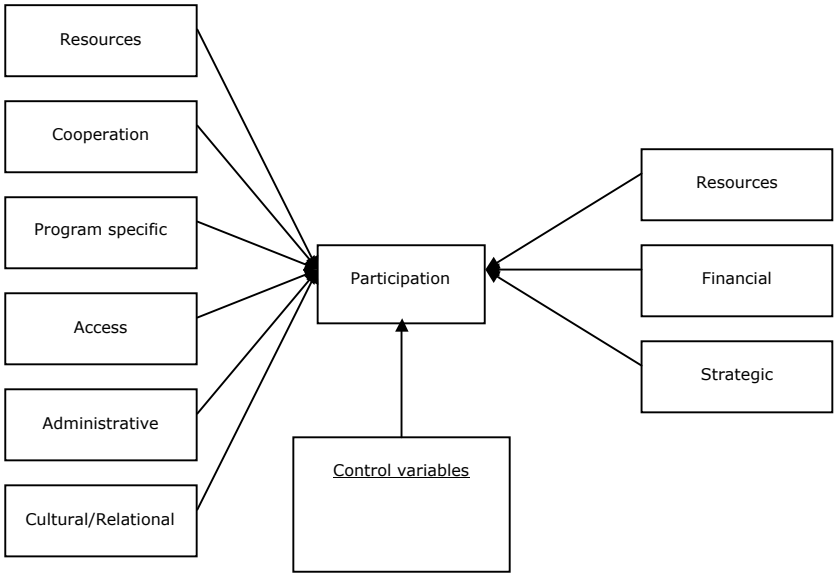

Figure 2: revised conceptual model

5.3.1 Regression analysis

Binomial logistic regression was performed using SPSS in order to assess the prediction of the *participation* variable on the basis of the different incentives and barriers. All 9 factors resulting from the previous section were therefore saved as variables and included in the model. The control variables added were age, size, industry, and experience (both in terms of international activities in general and in terms of earlier attempts to participate in international programs). Table 9 presents the regression coefficients, Wald statistics, and the odds ratios (exp(B)) for: (1) the constant; (2) the constant + control variables; and (3) the constant + control variables + independent variables.

Table 9. Results regression analysis.

	B	S.E.	Wald	Sig.	Exp(B)
Constant	-1,374	0,177	60,235	0,000	0,253
Constant	-23,919	238,146	0,010	0,920	0,000
Age	-0,060	0,048	1,524	0,217	0,942
Industry			5,437	1,000	
'Manufacture of food products, beverages and tobacco'	5,431	2015,210	0,000	0,998	228,406
'Manufacture of textile- and leather (products)'	8,086	1136,345	0,000	0,994	3248,023
'Manufacture of pulp, paper and paper products'	12,401	2001,091	0,000	0,995	243133,692
'Manufacture of chemicals and chemical products'	0,491	1,823	0,073	0,788	1,634
'Manufacture of rubber and plastic products'	10,302	192,591	0,003	0,957	29798,730
'Manufacture of basic metals and fabricated metal products'	8,366	491,878	0,000	0,986	4299,725
'Manufacture of machinery and equipment n.e.c.'	-0,892	1,703	0,274	0,601	0,410
'Manufacture of electrical and optical equipment'	0,221	1,661	0,018	0,894	1,247
'Manufacture of transport equipment'	9,688	232,585	0,002	0,967	16122,076
'Other industries'	-14,531	717,849	0,000	0,984	0,000
'Electricity, gas and water supply'	-0,976	2,086	0,219	0,640	0,377
'Construction'	9,146	945,022	0,000	0,992	9372,207
'Wholesale, repair and hospitality'	7,587	1423,283	0,000	0,996	1972,468
'Transport, storage and communication'	6,158	1434,333	0,000	0,997	472,368
'Computer and related activities'	7,250	464,267	0,000	0,988	1408,580
'Research and development'	-1,239	1,668	0,552	0,458	0,290
'Architectural and engineering activities and related consultancy'	0,708	2,044	0,120	0,729	2,029
'Renting and other business activities'	-15,712	2001,091	0,000	0,994	0,000
'Health and social work'	-2,784	2,277	1,494	0,222	0,062
'Environmental services'	-1,924	2,197	0,767	0,381	0,146
'Other services'	-1,078	1,816	0,353	0,553	0,340
Size			0,388	0,824	
'1 – 10 employees'	-0,220	1,573	0,020	0,889	0,803
'11 – 50 employees'	-0,655	1,481	0,196	0,658	0,519
Import experience	-0,877	0,886	0,981	0,322	0,416
Export experience	-0,501	0,991	0,256	0,613	0,606
International cooperation experience	3,684	1,636	5,069	0,024	39,819
Other international activities	-0,258	0,658	0,154	0,695	0,773
Earlier attempt to participation	23,933	238,134	0,010	0,920	2,477E10
Chi-square (df = 29)			138,039	0,000	
Hosmer and Lemeshow (df = 8)			2,319	0,970	
Nagelkerke R^2 = 0,791					

(Continued)

Table 9. *(Continued)*.

	B	S.E.	Wald	Sig.	Exp(B)
Constant	-26,910	268,850	0,010	0,920	0,000
Cost incentives	1,243	1,024	1,474	0,225	3,465
Strategic incentives	1,649	0,794	4,311	0,038	5,201
Administrative barriers	-2,266	1,167	3,769	0,052	0,104
Foreign barriers	0,888	1,219	0,531	0,466	2,431
Resource barriers	-0,606	0,945	0,412	0,521	0,545
Knowledge incentives	1,490	1,082	1,894	0,169	4,437
Risk barriers	0,934	0,785	1,414	0,234	2,544
Other barriers	0,003	0,706	0,000	0,997	1,003
Program-specific barriers	-1,291	0,732	3,109	0,078	0,275
Age	-0,099	0,084	1,400	0,237	0,905
Industry			7,993	0,995	
'Manufacture of food products, beverages and tobacco'	5,665	3310,176	0,000	0,999	288,563
'Manufacture of textile- and leather (products)'	8,295	1662,425	0,000	0,996	4002,477
'Manufacture of pulp, paper and paper products'	14,051	3299,242	0,000	0,997	1,265E6
'Manufacture of chemicals and chemical products'	0,536	2,466	0,047	0,828	1,709
'Manufacture of rubber and plastic products'	9,412	343,812	0,001	0,978	12231,575
'Manufacture of basic metals and fabricated metal products'	4,727	567,265	0,000	0,993	112,924
'Manufacture of machinery and equipment n.e.c.'	-2,431	2,578	0,889	0,346	0,088
'Manufacture of electrical and optical equipment'	1,876	2,330	0,648	0,421	6,525
'Manufacture of transport equipment'	9,196	208,339	0,002	0,965	9856,533
'Other industries'	-14,026	1089,743	0,000	0,990	0,000
'Electricity, gas and water supply'	6,776	4,527	2,240	0,134	876,682
'Construction'	4,982	1314,013	0,000	0,997	145,700
'Wholesale, repair and hospitality'	8,992	2145,078	0,000	0,997	8039,050
'Transport, storage and communication'	4,071	2099,390	0,000	0,998	58,638
'Computer and related activities'	2,992	539,996	0,000	0,996	19,922
'Research and development'	-0,846	2,155	0,154	0,695	0,429
'Architectural and engineering activities and related consultancy'	6,193	3,574	3,003	0,083	489,291
'Renting and other business activities'	-13,465	3299,242	0,000	0,997	0,000
'Health and social work'	-8,559	11,585	0,546	0,460	0,000
'Environmental services'	-6,970	3,334	4,370	0,037	0,001
'Other services'	-0,310	2,308	0,018	0,893	0,734
Size			3,444	0,179	
'1 – 10 employees'	-4,010	2,638	2,310	0,129	0,018
'11 – 50 employees'	-5,104	2,751	3,443	0,064	0,006
Import experience	-4,125	2,094	3,881	0,049	0,016
Export experience	0,809	1,700	0,226	0,634	2,245
International cooperation experience	8,748	3,410	6,580	0,010	6300,165
Other international activities	-0,966	1,130	0,731	0,393	0,381
Earlier attempt to participation	27,886	268,810	0,011	0,917	1,291E12
Chi-square (df = 38)			158,040	0,000	
Hosmer and Lemeshow (df = 8)			0,746	0,999	
Nagelkerke R^2 = 0,867					

A Chi^2 test of a model including only the control variables against a constant-only model was statistically significant (Chi^2 = 138,039; df = 29; $p < 0.001$). A Chi^2 test of the complete model including all variables against the model including the constant and control variables was also statistically significant (Chi^2 = 158,040; df = 38; $p < 0.001$). The addition of the independent variables to the model also proved to be statistically significant (Chi^2 = 20,001; df = 9; $p < 0.05$). These tests indicate that the model including all variables better fits the data than the constant-only model or the model including both the constant and control variables. Good model fit is also indicated by Nagelkerke's pseudo R^2 value improving from 0.791 to 0.867 after the addition of the independent variables to the model. Hosmer and Lemeshow Goodness-of-Fit Tests showed non-significance indicating a good model fit for both the model without the independent variables (Chi^2 = 2,319; df = 8; $P > 0.9$) and the model including the independent variables (Chi^2 = 0,746; df = 8; $p > 0.9$). The overall classification of cases was quite high with 94,9% as the overall correct classification rate, as pictured in table 10. Interesting to note is that the model without the independent variables also has a high overall correct classification rate of 92,9%. A SME that participates in international research programs can thus for a large extent be distinguished on the basis of solely the control variables added to the model. This observation may be related to the relatively small amount of respondents in group 2. The statistically significant improvement of adding the independent variables to the model however justifies analysing the results of the full regression model.

Table 10. Classification rates of the three models tested.

	Observed	Predicted		
		'Participation'		
		0	1	Percentage correct
Constant only	0	158	0	100,0%
	1	40	0	0,0%
	Overall			79,8%
Constant + controls	0	148	10	93,7%
	1	4	36	90,0%
	Overall			92,9%
Constant + controls + independents	0	152	6	96,2%
	1	4	36	90,0%
	Overall			94,9%

Overall, according to the results of the regression analysis, the two groups of SMEs indicated by the *participation* variable can be distinguished on the basis of one category of incentives ('*strategic incentives*') and two categories of barriers ('*administrative barriers*' and '*program-specific barriers*'). In terms of the control variables added, the industry dummies '*architectural and engineering activities and related consultancy*' and '*sewage and refuse disposal, sanitation and similar activities*', the size dummy for '*11-50 employees*', and the dummies for '*import experience*' and '*international cooperation experience*' all turn out to be statistically significant.

The '*strategic incentives*' variable first of all raises the odds of participating in international research programs (B = 1,65; $p < 0.05$; Exp(b) = 5,20). An odds ratio of 5,20 indicates that the odds of being a member of 'group 2' increase by a factor larger than 5 with a change in unit of the '*strategic incentives*' variable, when all other variables are held at constant. Referring back to the factor analysis, the *strategic incentives* variable includes the incentives of access to new markets and access to new networks through participation in international research programs. A SME that gives a higher rating to these incentives is thus more likely to participate in international programs. This observation is first of all coherent with the supposed theoretical relation that gaining access to new markets as well as access to new networks are incentives for a SME to participate in international programs. Participation in these programs can apparently facilitate entrance to otherwise inaccessible or more difficultly accessible (foreign) markets and/or networks. Following from the literature study, the two incentives were however associated to two different variables namely *competition* and *efficiency*. The results of the factor analysis and the significant outcome of the regression analysis however point to the existence of a separate variable concerning access to foreign business activities through participation in international research programs. According to the analysis, a SME that participates in international research programs can be distinguished on the basis of the rating given to the '*strategic incentives*' variable. Thus although *knowledge incentives* and *financial incentives* are seen as important according to the description of the dataset, only the *strategic incentives* variable has a statistically significant influence on the choice of a SME to participate in international programs.

The '*administrative barriers*' variable is one of the two variables that lower the odds of participating in international research programs (B = -2,27; $p = 0.05$; Exp(b) = 0,10). The odds of being a member of 'group 2' decrease by a factor of 0,10 with a change in unit of the '*administrative barriers*' variable, when all other variables are held at constant. The *administrative barriers* variable includes the barriers of the application procedure being to complex and requiring too much time. A SME that gives a higher rating to these barriers is thus less likely to participate in international programs. The two barriers thus have the expected effect of forming a barrier for a SME to participate in international programs. One obvious explanation is that the administrative requirements for participation in international research programs are much larger than the requirements for participation in national research programs. The emergence of a separate variable

for these barriers from the factor analysis and the indicated statistical significance however point to the relatively important influence of these barriers. Although having to deal with too much bureaucracy was expected to create barriers, these barriers were associated to other barriers in terms of access to international programs such as difficulties in joining existing projects and finding potential cooperation partners. Administrative barriers on their own however have a significant influence on the choice of a SME to participate in international programs.

The '*program-specific barriers*' variable is the second variable that lowers the odds of participating in international research programs (B = -1,29; $p < 0.1$; Exp(b) = 0,28). The odds of being a member of 'group 2' decrease by a factor of 0,28 with a change in unit of the '*program-specific barriers*' variable, when all other variables are held at constant. Comparing odds ratios indicates that the effect of the '*administrative barriers'* variable is however larger[7]. The *program-specific barriers* variable includes the barriers of a mismatch between program themes and the core competences of a SME, the research being too scientific, and a low chance of success of a potential application. A SME that gives a higher rating to these barriers is thus less likely to participate in international programs. All three proposed barriers of this variable thus have the expected effect of forming a barrier for a SME to participate in international programs. The factor analysis however resulted in one separate variable whereas the chance of success was associated to the access variable of the conceptual model and the other two variables were associated to the knowledge dimension of the capability variable. The outcome of the regression analysis however points to the existence of one '*program-specific barriers*' variable, which has a statistically significant influence on the choice of a SME to participate in international programs in contrast to solely participating in national programs. This result provides confirmation for the importance of a 'fit' between the structure and layout of international research programs and the daily practice of SMEs. No matter how state-of-the-art the knowledge development within international research programs might be, a SME will obviously only participate if it can obtain benefits related to this knowledge. The results also provide confirmation for the earlier stated influence of the mainly scientific character of a program like FP7 on preventing SME participation. A low chance of success of a potential application thereby obviously further limits the chance of a SME applying for participation.

Most of the dummy variables added for the different industry categories are not statistically significant. Only the dummy variables for '*architectural and engineering activities and related consultancy*' and '*sewage and refuse disposal, sanitation and similar activities*' show a significant influence. These results should however be interpreted with caution since only a limited number of respondents belong to these categories. As mentioned earlier, the same holds true for the obtained industry categories for group 2 in general thereby limiting the overall spread. This provides a possible explanation for the mainly insignificant effects of industry categories resulting from the regression analysis. Additionally, the industry categories for which a relatively larger number of respondents was obtained such as '*manufacture of electrical and optical equipment*' also turn out not to be statistically significant.

Of the size dummies added to the model, the dummy for '11-50 employees' is statistically significant (B = -5,10; $p < 0.1$; Exp(b) = 0,01). The odds of participating in international programs thus decrease by a factor of 0,01 if a SME has '11-50 employees' compared to a SME that has '51-250 employees', when all other variables are held at constant. The '1-10 employees' dummy variable also shows a negative coefficient, which is however not statistically significant. According to these results, smaller SMEs are less likely to participate in international research programs. The requirements for participating in international programs thus seem more difficult to handle for smaller SMEs.

Of the experience dummies added to the model, '*import experience*' first of all is statistically significant (B = -4,13; $p < 0.05$; Exp(b) = 0,02). The odds of participating in international programs thus decrease by a factor of 0,02 if a SME has import experience compared to a SME that does not have any import experience, when all other variables are held at constant. The negative coefficient somewhat contradicts the expected relation that international experience has a positive

[7] The effect of the variable is larger when the corresponding odds ratio is closer to zero.

effect on the chance of a SME participating in international programs. A possible explanation could be that SMEs that conduct import activities approach international markets with a different objective than SMEs that conduct international cooperation activities for which the dummy, as is shown below, also is statistically significant. SMEs that approach international markets for reasons related to vertical supply chain management apparently have less interest in knowledge development by means of horizontal partnerships in international research programs.

The dummy for '*international cooperation experience*' also turns out to be statistically significant (B = 8,75; p = 0.01; Exp(b) = 6300,17). The odds of participating in international programs thus increase by a factor of 6300,17 if a SME has international cooperation experience compared to a SME that does not have any international cooperation experience, when all other variables are held at constant. The very large odds ratio should however be interpreted with caution. A possible explanation is the existence of a low variance of this dummy. Referring back to the description of the dataset, this is indeed the case. Nearly all SMEs within group 2 have had earlier experience with international cooperation. The same observation holds for experience in terms of an earlier attempt to participate in international programs, although this variable does not turn out to be statistically significant. Overall, these results provide confirmation for the statement that SMEs having experience in terms of international cooperation, whether or not in terms of an earlier attempt to participate in international programs, are more likely to participate in international research programs.

6. Conclusions & Discussion

The objective of this study has been to analyse potential barriers that prevent Dutch SMEs from participating in international research programs. Considering the need to improve the European ability to commercialize innovations related to key technologies, an important role could be played by SMEs.

A conceptual model containing potential barriers as well as incentives to participate in international research programs selected from literature was empirically tested. A sample of 1.500 Dutch SMEs was therefore drawn from the databases of the Seventh Framework Program (FP7), the Eurostars program, and the Research & Development tax credit program (WBSO). This approach enabled a national-international comparison of two different groups of Dutch SME research program participants. By means of a questionnaire, data were obtained on the perceived incentives and barriers experienced by these SMEs.

A factor analysis was used to test the robustness of the operationalization of the proposed conceptual model. The results indicated a good fit of the proposed model to the factor analysis results. In terms of incentives, a separate variable emerged for financial incentives as well as strategic incentives (access to new market, access to new networks). In terms of the barriers, a separate variable emerged for administrative barriers, risk barriers, and program-specific barriers. The emergence of these separate categories resulting from the factor analysis indicated the relative importance of these barriers and enabled improvements to be made to the conceptual model.

Regression analysis was applied to test the improved conceptual model resulting from the factor analysis. According to the results of the regression analysis, the two groups of SMEs indicated by the *participation* variable can be distinguished on the basis of one category of incentives (‘*strategic incentives*’) and two categories of barriers (‘*administrative barriers*’ and ‘*program-specific barriers*’). Access to new markets and networks (‘*strategic incentives’*) thus form an important incentive for Dutch SMEs to participate in international research programs.

The complexity and required time for the application process are furthermore seen as important barriers to participate in international research programs. The amount of bureaucracy required to participate in international research programs provides an obvious explanation for this result. The emergence of a separate administrative barriers variable from the factor analysis and the indicated statistical significance of this variable in the regression analysis points to the relative importance of this variable.

Besides administrative barriers, other barriers that are perceived as important by Dutch SMEs are a mismatch between program themes and the core competences of a SME, the research within programs being too scientific, and a low chance of success of a potential application. These results indicate the importance of a ‘fit’ between the capabilities of a SME relative to the priorities set by the different research programs. A similar conclusion emerges from the work of Barajas and Huergo (2010: 107) who state that the ability of a firm to participate in an FP “… seems to depend more on their ability to fit corporate R&D strategies with EC priorities than on the amount of public funds available”.

In terms of the control variables added, this study was not able to indicate the influence of different industries. This was mainly due to a limited response of the two different groups of SMEs. The proposed effect of firm age also did not emerge as statistically significant from the analysis.

The effect of size was shown to be statistically significant for the size class of ’*11-50 employees*’. Compared to SMEs with 51-250 employees, SMEs with 11-50 employees are less likely to participate in international programs. These results provide some confirmation for the statement that a certain critical mass is required to be able to participate in international programs. Larger SMEs are more likely to possess this critical mass and are thus more likely to participate in international programs.

In terms of experience '*import experience*' and '*international cooperation experience*' turned out to be statistically significant. A SME that has earlier experience in terms of import activities seems less likely to participate in international research programs. Furthermore, earlier experience in terms of international cooperation plays a significant role in the choice of a SME to participate in international research programs. The same holds true for an earlier attempt to participate in international research programs.

The results of the regression analysis do, however, point to the presence of selective response within the dataset. The regression model including only the control variables was able to predict 93% correct cases. The data indeed indicate that the obtained sample of 50 SMEs that participate in international research programs, all made an earlier attempt to participate in these programs or have experience with international R&D cooperation in general. As a consequence, this study is only able to present results related to SMEs that have had earlier experience. Overall, only three categories of incentives and barriers emerged from the analysis as statistically significant. This would imply that the other categories of incentives and barriers play a less important role in terms of influencing the choice of a SME to participate in international research programs. The chance however thus exists that the influence of the other incentives and barriers becomes more important when the dataset is extended with SMEs that do not have earlier experience with international R&D cooperation. The influence of '*strategic incentives', 'administrative barriers*', and '*program-specific barriers*' that do emerge as statistically significant can be assumed to only become more important when the dataset is extended.

Apart from the observation of selective response, this study has shown that two groups of Dutch SMEs, that either participate solely in national research programs or both in national- and international research programs, can be additionally differentiated based on the influence of three categories of barriers and incentives. These results may benefit Dutch policy makers interested in the targeted stimulation of Dutch SMEs to participate in international research programs.

First of all, the indicated importance of strategic incentives (access to new networks and markets) for Dutch SMEs might facilitate a more targeted stimulation by specifically approaching SMEs that are currently active in research networks, for example within Dutch research program initiatives. Although the topic of administrative barriers is known and has received attention by policymakers, the present results indicate that improvements still can be made. Creating lower levels of bureaucracy would significantly stimulate the participation of SMEs in international programs. Furthermore, special attention should be given to the match between the technological capability of SMEs and the requirements and structure of international research programs. Both a mismatch between program themes and core competences of a SME, as well as the scientific character of international programs are seen as important barriers. Attention should thus be given to possible ways to align the important technological areas on a national- and international level. More specifically, an attempt to improve the SME participation in international programs should target science-based SMEs. These SMEs posses a certain amount of capabilities that are more likely to be related to important technological areas on an international level. In addition, following a recommendation from Barajas and Huergo (2010), firms with prior experience in research programs should be encouraged to participate again considering the large influence of experience.

Although the approach of this study has provided some useful insights, further recommendations can be made. First of all this study has only focussed on the Netherlands. Similar analysis, incorporating data on other countries, could lead to more specific knowledge on whether the influences of the incentives and barriers are specific to Dutch SMEs or in general are important. Furthermore, this study was only able to provide insights for SMEs that have prior experience in terms of participation in international research programs. Further studies could also incorporate SMEs without prior experience. In addition, further studies could look for possible ways to incorporate the group of non-WBSO participants that emerged from the database-research, for example, through the development of a general registration of SMEs in the Netherlands.

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Appendices

Appendix I

Table 11. Industrial classification.

	Industry	NACE
1	'Agriculture, forestry and fishing'	'Agriculture, hunting and forestry' 'Fishing'
2	'Mining and quarrying'	'Mining and quarrying'
3	'Manufacture of food products, beverages and tobacco'	'Manufacture of food products, beverages and tobacco'
4	'Manufacture of textiles- and leather (products)'	'Manufacture of textiles and textile products' 'Manufacture of leather and leather products'
5	'Manufacture of pulp, paper and paper products'	'Manufacture of pulp, paper and paper products'
6	'Publishing, printing and reproduction of recorded media'	'Publishing, printing and reproduction of recorded media'
7	'Manufacture of coke, refined petroleum products and nuclear fuel'	'Manufacture of coke, refined petroleum products and nuclear fuel'
8	'Manufacture of chemicals and chemical products'	'Manufacture of chemicals and chemical products'
9	'Manufacture of rubber and plastic products'	'Manufacture of rubber and plastic products'
10	'Manufacture of basic metals and fabricated metal products'	'Manufacture of basic metals and fabricated metal products'
11	'Manufacture of machinery and equipment n.e.c.'	'Manufacture of machinery and equipment n.e.c.'
12	'Manufacture of electrical and optical equipment'	'Manufacture of electrical and optical equipment'
13	'Manufacture of transport equipment'	'Manufacture of transport equipment'
14	'Other industries'	'Manufacture of wood and wood products' 'Manufacture of other non-metallic mineral products' 'Manufacturing n.e.c.'
15	'Electricity, gas and water supply'	'Electricity, gas and water supply'
16	'Construction'	'Construction'
17	'Wholesale, repair and hospitality'	'Wholesale and retail trade; repair of motor vehicles, motocycles and personal and household goods' 'Hotels and restaurants'
18	'Transport, storage and communication'	'Transport, storage and communication'
19	'Financial intermediation'	'Financial intermediation'
20	'Computer and related activities'	'Computer and related activities'
21	'Research and development'	'Research and development'
22	'Legal and economic consultancy'	'Legal, accounting, book-keeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; holdings'
23	'Architectural and engineering activities and related technical consultancy'	'Architectural and engineering activities and related techical consultancy'
24	'Renting and other business activities'	'Real estate activities' 'Renting of machinery and equipment without operator and of pesonal and household goods' 'Other business activities'
25	'Governmental'	'Public administration and defence; compulsory social secuity' 'Education'
26	'Health and social work'	'Health and social work'
27	'Environmental services'	'Sewage and refuse disposal, sanitation and similar activities'
28	'Other services'	'Activities of membership organizations n.e.c.' 'Recreational, cultural and sporting activities' 'Other service activities' 'Activities of households' 'Extra-territorial organizations and bodies'

Appendix II

The limitations of the ECORDA database relate to the registration of participants. Important to note first of all is that data on project proposals and data on signed contracts are separated in two different tables. The main difference is that the data on signed contracts is checked and corrected by the EC. These data are therefore more consistent than the data on project proposals. The data on project proposals thus requires several correction steps.

First of all, one large database was created from the data on proposals and contracts to create a more coherent dataset. This step was possible by means of a project ID, which is identical for both proposals and contracts. Flag-criteria are available in the database to select organization types. These criteria are however filled in by the participants and are only checked in the signed contract database. Furthermore, the SME definition applied also includes, for example, research institutes. For this study SMEs were therefore selected using both the 'SME' and the 'PRC' (private commercial) criteria. In addition, the possibility exists that the same participant can be found under slightly different formulations of their name in different places in the database. Unique organizations IDs were therefore applied to all selected proposals.

Selections could thus be made despite the limitations of the data. Improvements in terms of the registration of project participants could significantly benefit future studies using these data.