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Young university spin-off firms' internationalization

The influence of founding teams and networks

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University spin-off firms' internationalization: Importance of skills

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Abstract

Internationalization of knowledge intensive SMEs, particularly of born-globals, is well documented, but the specific class of university spin-off firms has seldom been included in such studies. To fill this gap, this paper maps patterns of export and knowledge collaboration abroad among these firms, and explores the influence of specific types of skills in the management team in the context of born-global development. A sample of 85 university spin-off firms and five in-depth case studies from various European Union countries are used. The results indicate that not being active or being only sporadic active in export is associated with missing a wider set of task-specific internationalization skills that encompass preparing/managing the changes, like attraction of financial capital and gaining access to market and knowledge channels abroad. Of particular interest tend to be skills to negotiate and establish satisfactory arrangements abroad as these skills have received a too small attention to date. Insufficient skills at the system level are also important, indicated by a limited understanding of macro-economic principles, such as market dynamics, and of micro-level principles such as cost-profit readings and risk calculation. Aside from skills, size of the university spin-off firms also matters. Due to different stages in born-global development, the differentiation in missing skills tends to be remarkably large, indicating that training to improve skills requires a multi-faceted and customized approach, without a one-size-fits-all solution.

Key words: internationalization, export, knowledge, university spin-off, born-global, skills, training

1. Setting the Scene

Universities as knowledge creators in a global world are in the core of attention of many researchers and policy-makers today (e.g., Etzkowitz, 2008; Van Looy et al., 2011; Knockaert et al., 2012; Ranga and Etzkowitz, 2013; Trencher et al., 2013; Audretsch et al., 2014). From a European perspective, this is mainly because Europe's future is seen as being dependent upon opportunities of science, engineering and technology, both in solving the grand societal challenges and increasing competitiveness of the European economy (EC, 2014a). University spin-off firms are an important part of this attention when it comes to a better use of opportunities of science, engineering and

technology, but what enables internationalization as part of their commercialization efforts has largely remained uncovered. This study attempts to address this deficiency.

University spin-off firms (USOs) are conceptualized in this paper as a specific class of independently established high-technology start-ups that bring university knowledge to market and that are founded by university graduates or staff members (Pirnay et al., 2003). USOs are relatively poor in resources, in particular, they lack skills beyond their technology field due to their young age and one-sided education, in particular, they tend to be in short of management and marketing skills, and skills to access investment capital and market channels (Vohora et al., 2004; Van Geenhuizen and Soetanto, 2009; Soetanto and Van Geenhuizen, 2014). Missing skills can however be gained through learning-by-doing and training, and eventually by replacing founders in the management team by experienced managers from outside (Fern et al., 2012; Visintin and Pittino, 2014). A broad spectrum of entrepreneurial skills is of significant importance, in particular during the initial phases of a USO, for example, with regard to “gaining commercial experience and spending time exploring the commercial opportunity” (Rasmussen et al., 2014, p. 92), which are seen to have major consequences for the subsequent development of USOs, networking skills being one of them (Walter et al., 2006).

The transformation of universities as actors in an increasingly global economy also affects technology transfer and interaction, and consequently USOs (e.g. Audretsch et al., 2014). Today, it is not a matter of establishing commercialization and collaboration between academia and business, but to make the actions more effective and productive (Geuna and Muscio, 2009; Bruneel et al., 2010; Van Geenhuizen, 2013) increasingly in an international field of forces. In a situation in which knowledge production and customer markets are becoming increasingly global, with interaction over larger distances from Europe towards Japan, Korea, China and Brazil (EC, 2011; EC, 2014b; OECD, 2012), research of USOs and development programs/training also need to stronger focus on the skills and competences enabling internationalization of business activities of these young firms.

Internationalization of knowledge-intensive SMEs is well documented, particularly that of born-global firms (e.g. Knight & Cavusgil, 2004; Rialp et al., 2005; Kuivalainen et al., 2012). In part of the studies, attention is paid to the knowledge/learning factor under the label of human capital, absorptive capacity, or skills (e.g. de Jong and Freel, 2010; EC, 2011; Taheri and van Geenhuizen, 2011; Clercq et al., 2012; Fletcher and Harris, 2012; Ganotakis and Love, 2012; Liu, 2012). In born-global development studies, progress has been made among others with regard to a more comprehensive classification including scale, scope and rapidity aspects of export development (Knight & Cavusgil; 2004; Kuivalainen et al., 2012).

A skills approach – taken in this study - implies that attention is mainly given to those abilities that can be developed, this in contrast to the approach that deals with abilities that are innate and largely fixed, although the two approaches cannot be fully separated. Broadly drawing on the work by Katz (2009), we consider three types of skills, in relation to technical (processes and techniques connected to the area of the firm), human (effective interaction with people inside and outside the firm) and conceptual issues (formulation of ideas, problem solving and planning, etc.). We also distinguish between task-specific skills and skills referring to various system levels in the business

environment. In this vein, this study attempts to clarify the missing skills in university spin-offs' management teams that constrain export activity and knowledge collaboration, given particular patterns of born-global development, and to clarify implications for training. The nature of the study is exploratory in that we formulate and investigate various propositions on the influence of missing skills.

To our knowledge, research has seldom focused specifically on USOs' internationalization performance, including export and knowledge collaboration. However, there is one study on USOs' international knowledge networks (Taheri and van Geenhuizen, 2011) indicating that a PhD in the founding team's education provides cross-cultural experience that enhances the building and use of international networks. Results like these, however, require a further exploration and testing. Against this background, the following questions will be addressed in this paper: To what extent are university spin-offs internationalized, in terms of export activity and knowledge collaboration, and how does a lack of skills influence the degree of internationalization? Which other factors are involved? What may be the implications of these outcomes for developing training to internationalization?

In answering these questions, we mainly use original empirical work by drawing on a sample of 85 USOs in four EU countries, Finland, Netherlands, Poland and Portugal, using data from interviews and five in-depth case studies of firms. Due to the specific 'theoretical' sampling (selection) and the small size of the entire sample and of subsamples per country, the results cannot be generalized statistically, but the results provide indications on trends on the basis of theoretical positions of USOs.

2. Theoretical background

2.1 Internationalization

Firm internationalization can be described as a firm extending its business operations abroad, crossing national borders. In a more advanced definition, emphasizing the opportunity seeking side, it is seen as a combination of innovative, pro-active and risk-seeking behavior that crosses national borders, with the intention of creating value in business activity (McDougall and Oviatt, 2000). An emphasis has also been put on the adaptation aspect of internationalization, namely, as the process of adapting firms' operations and organization to international environments (Calof and Beamish, 1995). Aside from import and export, the business activity may deal with knowledge gaining and exchange, and with outsourcing of manufacturing, etc. Further, in refining insights into the behavioral changes, particularly in born-global development, various scholars have introduced timelines and criteria on scale and scope of export leading to new classifications (Knight and Cavusgli, 2004; Jones and Coviello, 2005; Kuivalainen et al., 2012). The current paper fits the adaptation approach as it looks mainly at skills needed in dealing with new opportunities and/or barriers of which many relate to adaptation of the firms strategy and its organization, while the more detailed born-global classification will support our understanding of the differentiation between skills that are missing.

Prior research, mostly practical, has identified three broad types of barriers to internationalization (Ghemawatt, 2007; OECD, 2009; BIS, 2010). First, there are *resource barriers*, like a lack of

financial and human capital (absorptive capacity) to be able to identify opportunities and practical options, leading to a poor ‘readiness’ for internationalization (Van Geenhuizen and Ye, 2012a). Secondly, there are *information and network barriers*, indicating a lack of skill in opportunities recognition in foreign markets and market segments, and an inability to contact potential outsourcing partners and customers and establish an initial dialog, and to build trustworthy relationships with key decision-makers (e.g. Liu, 2012). This type of barrier also includes cultural barriers, like a lack of awareness and knowledge of local cultural norms abroad (Meyer, 2014) as well as language barriers. The third type of barriers are *legal and procedural barriers*, encompassing difficulties in dealing with laws, financial and tax regulations, product standards, and patent and trademark issues. The strength of such barriers may vary per economic sector, for example, in medical biotechnology, such barriers are relatively strong, due to different rules for registration, pricing, reimbursement, etc., between countries (Nooten, 2012).

All barriers have a dynamic character, meaning that they grow/change with progress in internationalization, so do the skills that are needed to remove barriers. For example, the skills needed may be different for entering export markets and for succeeding in these markets, for example being directly present in own sites or offices (Ganotakis and Love, 2012). Existing literature, however, still lacks models aimed specifically at USOs, facing unique characteristics, and existing models tend to concentrate on larger firms. However, two development models have been designed for young ventures in general, the model of incremental internationalization and the born-global model.

Gaining sufficient resources and skills to ‘invest’ in internationalization over time is at the heart of the model of incremental internationalization (Johanson and Vahlne, 1977), in which small firms first establish domestic markets and then turn to other countries. By contrast, the born-global model assumes an immediate entry into foreign markets, when the firm is established or shortly after, often taken as within three years (e.g., Oviatt and McDougall, 1994; Andersson and Wictor, 2003; Knight et al., 2004; Knight and Cavusgil, 2004). The distinguishing characteristic that makes new ventures born-global, is their pre-existing global networks and having adopted a global view at start, but a strong pressure from relatively small domestic markets is also seen as important.

While the difference between the gradual process and the born-global development seems to have sketched in the literature somewhat ‘black and white’, later research, including analysis of time lines, distribution of internationalization over countries and share of export, has produced a more nuanced picture of the born-global development (Knight and Cavusgil, 2004; Jones and Coviello, 2005; Kuivalainen et al., 2012). Born-globals share an early internationalization, but there are different sub-patterns. We mention a limited internationalization in terms of a small share of turnover earned abroad in either a few countries (also named ‘sporadic’) or a larger number (also named ‘failed’). Next, born-globals may exceed a certain cut-off rate of turnover (e.g. 25 per cent, see Knight and Cavusgil, 2004) including two types, the ones operating in a limited geographical area (also named ‘focused’) and the ones that operate on a truly global scale. In addition, new ventures may become a born-global, after a while, e.g. more than three years after foundation (also named ‘born-again-global’) and the above-indicated differentiation also applies to this category.

We take export and knowledge collaboration abroad as two different ‘manifestations’ of internationalization. While the two clearly include different business activities, there may be an interplay between them. For example, selling abroad may go along with knowledge exchange with customers if the manufacturing is customized and knowledge collaboration precedes sales. Also, in terms of a gradual development, knowledge collaboration may precede export. Export can go, however, without knowledge collaboration and knowledge collaboration can go without export.

2.2 Skills

Prior research has called to refine our understanding of entrepreneurial skills in general and more specifically for young high-tech ventures, like connected with business creation and opportunity recognition (Markman, 2007; Chell, 2013). The underlying discussion addresses issues of delineation compared to competence and abilities which are perceived as being broader in various studies (Markman, 2007). We define skills in this study as those abilities that can be developed by cognitive activity, either by learning-by-doing (experience), taking training/courses or by learning from firms who went through similar processes. An unsolved matter is the extent in which there is overlap with abilities that are innate and connected to the personality of entrepreneur/manager (Katz, 2009).

In this study, we distinguish between skills in terms of subject or domain, this because of the different learning that is involved. Accordingly, we make a difference between technology, human interaction and conceptual issues, and between skills at different system level in the business environment. For example, we expect that if skills in export and knowledge interaction abroad are of the human interaction type, some personality traits of the manager are critical and that training may have a limited impact. A main point of discussion is the causal reasoning connected to skills (Chell, 2013), like ‘appropriate or sufficient skills would implicate a better firm performance’. Such reasoning seems ‘bold’ in a business context in which firm performance is influenced by many internal and external factors. This is the reason why we develop and test a multifactor model on degree of internationalization.

2.3 Model development and propositions

The model has a focus on skills in the USOs management team, addressed in a mainly broader literature as founding teams’ skills (Colombo and Grilli, 2005, 2010; Walter et al., 2006; Clarysse et al., 2011; Ganotakis and Love, 2012). We take the management team at the time of the survey, knowing that most of the members are the original founders, and we focus on 1) one task-specific skill, 2) a set of such skills under the umbrella of ‘internationalization’ and 3) a set of system-level skills, both macro-economic and micro-economic. These skills were identified in the preparation stage of this study as those showing a relatively strong single correlation with export or knowledge collaboration.

Sales is task-specific and it is key in export activity. Customer segments need to be identified, value propositions designed, prices fixed and contracts arranged, and a distribution organization established, etc. Therefore, we assume that absent sales skills will hinder export, and make the following proposition:

Proposition 1: Absent skills in sales have a negative influence on export.

Our next type of skills – internationalization-related – contains a broad set of task-specific skills ranging from preparing the organization and operations for export (or knowledge collaboration) to increasing or sustaining export shares of a ‘true born-global’. Accordingly, we put forward the following proposition.

Proposition 2. Absent skills in internationalization-related issues have a negative influence on export and on foreign knowledge collaboration.

We assume that the degree of export is also influenced by conceptual skills, namely, concerning particular economic principles, macro with regard to understanding trade systems, monetary systems and market dynamics, and micro with regard to understanding (foreign) accounting systems (profit-loss, risk). Consequently, we put forward the following proposition:

Proposition 3: Absent skills in understanding economic principles have a negative influence on export.

Among founders of USOs, there is a fair chance of being already familiar with knowledge relations abroad through international research programs (as staff or graduates at the time), meaning that absence of skills concerning knowledge relations abroad is less critical compared to skills connected to export which is a completely new activity. Consequently, we make the following proposition:

Proposition 4: Absent skills have a stronger negative influence on export compared to foreign knowledge collaboration.

We also include various control factors in the model that are firm specific. Seen from a resource-based view, the shaping of internationalization by USOs requires for instance sufficient management time and investment capital. We assume differences in availability of such resources according to firm age and firm size which we include in the model. Learning capabilities are also important and these tend to increase with the age of the organization and its size as well (Lane et al., 2001; Zahra and George, 2002; Zahra, 2005; Xia, 2013). In addition, importance of pre-start working experience in the founding team, specifically its cross-cultural character, has been forwarded by various authors (Reuber and Fisher, 1997; Ganotakis and Love, 2012). Examples are knowledge of different (direct or more indirect) ‘ways of communication’ and different degrees of ‘hierarchy’ in working situations and relationships with government officials abroad (Meyer, 2014). Next, the industry sector in which the USOs are active, tends to be important because of different ways of learning and different needs for an international reach in learning. We draw a distinction between science-based sectors and other sectors (Asheim et al., 2007; Jensen et al., 2007; Tidd and Bessant, 2013). In science-based sectors, the learning involved deals with laws of nature and tends to be globally oriented due to the universal character of science, while, in other sectors, the adaptive (problem-oriented) learning - as it is pushed more strongly by demand or market context - tends to benefit more from local or regional face-to-face contacts. As a last factor, country is included as a control because internationalization may be pushed more strongly in small economies, while a global orientation is self-understanding. For example, the Netherlands and Finnish domestic economies tend to be small and globally oriented for a long time, but Portugal needs to develop a stronger global orientation due to a domestic demand that has seriously dropped during the

recession which is more recent. A similar need for developing a global orientation may apply to Poland, particularly in science-based sectors.

3. Methodological aspects of the study

We selected a sample of relatively young university spin-offs facing a fair degree of variation in particular characteristics in order to allow us to disentangle various influences on internationalization, and this happened in the context of a broader European project, the Spin-Up study (URL: www.spin-up.eu). Age was chosen between two and 10 years, with the exception of medical life sciences (around 15 years at maximum), and firm size and growth were chosen to include both small and larger firms, and growing firms as well as firms that are stable or declining. Regarding economic sectors, manufacturing and services were included, and the manufacturing firms also covered some science-based sectors. The method of selection implies that the sample cannot be considered representative for USOs in the countries involved.

We collected the data in 2011 using a semi-structured face-to-face interview with the CEO or other manager and – for a minority of 20 percent - using a condensed questionnaire in a web-based/e-mail survey including ‘triangulation’ with the USOs websites. Non-response was 14.1 percent among a total of 99 firms that were asked to participate, leading to an effective sample size of 85. The information we collected covered various skills in the management team, firm-specific characteristics, the innovation product/service, performance indicators like job growth and turnover growth, export share and knowledge collaboration abroad, and also some background information to be elaborated in the in-depth case studies. Absence/presence of skills was measured using a five point Likert-scale. The validity of the results was secured by a careful pre-testing and subsequent adjustment of some questions. The data on skills in the management team were largely derived from self-estimation (CEO or other manager) meaning that the results could have been influenced by over- or under-estimation. By posing various control questions in the interviews, the chance for self-estimation bias could be reduced.

4. Descriptive information

4.1 Indicative trends in internationalization

Among the USOs in the sample, 56 percent are not active in export while 44 percent are active (Table 1). About 20 percent of the USOs are facing a relatively small export, smaller than 30 percent, among them the ‘sporadic’ type or ‘failed’ type, and a similar share reaches a substantial export (more than 60 percent export in turnover). Compared to export, a much smaller part of the sampled USOs is not internationally active when it comes to knowledge collaboration, as indicated by 28 percent. A majority (72 percent) of the USOs does employ knowledge relationships abroad, 46 percent of which at a moderate level (some relations) and 26 per cent extensively (many relations). Knowledge networks abroad as employed by USOs tend to be mainly connected with firms, as suppliers and customers, and with universities, the last as a small minority.

Table 1. Degree of internationalization of USOs in 2011 (N=85)

Internationalization	Share of USOs (%)
Exports (% of turnover)	
- No export	56
- 1-30%	19
- 30-60%	8
- >60%	17
Knowledge relations	
- No relations	28
- Some relations	46
- Many relations	26

4.2 Independent variables

The average scores on absence/presence of the three types of skills tend to be relatively close to each other (Table 2). Internationalization-related skills have the lowest average score, but also the largest standard deviation, indicating a somewhat large variation. Further, the USOs in our sample are on average seven years old and have a size of 11 FTE's (full time equivalent), with a large standard deviation.

Table 2. Descriptive statistics

Dependent variables	
<i>Size of export</i> : share in exports in 2011 (% of turnover)	Avg.: 0.22; Sd.: 0.35; min-max: 0-1
<i>Knowledge collaboration</i> : knowledge relations abroad	No: 28%; Some: 46%; Many: 26%
Controls	
<i>Firm age</i> : continuous variable as nr of years since start	Avg.: 6.67; Sd.: 3.43; min-max: 2-17
<i>Firm size (fte)</i> (log-transformed)	Avg.: 11.45; Sd.: 21.98; min-max: 0.5-175
<i>Cross-cultural experience</i> : continuous variable as sum of years of founders' experience abroad (log-transf.)	Avg.: 14.80; Sd.: 20.75; min-max: 0-80
<i>Sector</i> : variable in two categories, science-based (1) versus non-science based (0)	Science-based: 36%; Non-science based: 64%
<i>Country</i> : dummy variable indicating country	Finland: 21%; Poland: 16%; Portugal: 29%; NL: 33%
Absent skills	
<i>Sales</i>	Avg.: 3.33; Sd.: 0.90; min-max:1-5
<i>Internationalization-related skills</i>	Avg.: 3.25; Sd.: 1.29; min-max:1-5
<i>Understanding economic principles</i>	Avg.: 3.47; Sd.: 1.03; min-max:1-5

The sampled spin-offs are mainly active in non-science-based sectors (64 percent), with a dominance of ICT, including software technology. Firms active in science-based sectors are in a minority (36 percent) and mainly involved in life sciences (14 percent), focusing on new medicines. Material science is also involved aimed to develop, for example, new batteries, diodes, and membranes. Amount of cross-cultural experience varies strongly between the sampled USOs, the average accumulated years per USO amounts to about 15 with a standard deviation of 21 (Table 2). Cross-cultural experience is often present if a PhD with part of his/her research abroad or an internationally active university professor have acted as founders and are still team-member, but also if the management team adds an experienced business professional to the team, often from

abroad. Overall, the sample seems to be sufficiently differentiated to identify trends in influences on internationalization.

5. Estimation results

In a stepwise approach, we estimate three models for export development (Table 3) and for knowledge collaboration (Table 4). The first (Model 1) includes the control variables, the second (Model 2) includes the three types of skills and the last (Model 3) includes the full model. As a preparation, we performed the standard checks to satisfy rules of multiple regression analysis, and there appears to be no reason for concern (Annex A and Annex B). Multi-collinearity draws some attention in the interpretation of the full model, witness pre-start cross-cultural experience and internationalization skills (a coefficient of 0.44), and firm size and this experience (0.41).

With regard to control variables, the beta-coefficients of firm size are positive and significant, both for export and knowledge collaboration. Among the remaining controls, none turns out to indicate significant influence on export. On the contrary, knowledge collaboration tends to be positively influenced by two other characteristics, i.e., cross-cultural experience and science-based sector. Surprisingly, the country factor yields no significant results regarding exports, but, when it comes to knowledge collaboration, some negative influences can be observed with respect to Poland and Portugal. In terms of lacking skills, the beta-coefficients of sales skills are not significant in the export models. This result does not confirm Proposition 1. Different from sales skills, the beta-coefficients of internationalization-related skills are significant and negative in all models including export and knowledge collaboration. This result clearly confirms Proposition 2. The interviews revealed a broad range of lacking skills that matter, including skills to create ‘export readiness’ like concerning gaining investment capital and achieving trust to build a sales organization abroad, and skills to develop a truly global export pattern and sustain it, eventually including skills in branding in foreign markets and skills to understand legal issues of patent protection and product certification. In terms of knowledge relationships, respondents have forwarded shorts in skills to identify a trustworthy partner and skills to convincingly present the firm as an attractive partner.

Furthermore, the estimation results regarding economic principles skills suggest a negative and significant influence on export as assumed. Therefore, Proposition 3 can be confirmed. The skills concerned are at a high system level and respondents indicated principles of international trade, for outside the EU, principles of monetary policy and dynamics of exchange rates, fiscal policy and principles of ownership protection. The missing skills also refer to systems of accounting and cost-profit analysis. Missing such skills may add to delay in take-off of export and delay in progress towards truly global patterns.

Overall, adding absent skills to the model for export and for knowledge collaboration (Model 1 versus Model 3) shows a different improvement of R^2 , namely of 0.11 and 0.03, respectively. This result indicates, as assumed, a larger impact of missing skills on increasing export compared to increasing knowledge collaboration, due to a larger relative ‘newness’ of export activity among USOs. Therefore, Proposition 4 can be confirmed. However, a comparison of the two model outcomes, for export and knowledge collaboration, requires some caution due to the use of different types of regression techniques.

Table 3 Regression estimation of export

	Export		
	1	2	3
	(s.e.)	(s.e.)	(s.e.)
Controls			
Firm age	0.12 (0.07) a)		0.13 (0.07)*
Firm size a)	0.09 (0.04)**		0.07 (0.04)*
Cross-cultural experience	0.02 (0.03)		-0.02 (0.03)
Sector (science-based = 1)	0.06 (0.09)		0.03 (0.08)
Poland b)	0.00 (0.12)		0.06 (0.12)
Portugal	-0.05 (0.11)		0.04 (0.11)
The Netherlands	0.01 (0.10)		0.04 (0.10)
Absent skills			
Sales		0.02 (0.04)	0.02 (0.04)
Internationalization		-0.09 (0.03)***	-0.09 (0.03)**
Economic principles		-0.08 (0.04)**	-0.07 (0.04)*
N b)	84	85	84
F	2.73**	6.34***	3.23***
R ²	0.20	0.19	0.31
Root MSE	0.33	0.32	0.31

* p<0.1; ** p<0.05; *** p<0.01

a) In an experiment, excluding size, age and cross-cultural experience turn out to be significant.

b) Finland as baseline.

Table 4. Regression estimation of knowledge collaboration abroad

	Knowledge Collaboration (Ordered Logistic)		
	1	2	3
	(s.e.)	(s.e.)	(s.e.)
Controls			
Firm age	0.02 (0.46)		0.08 (0.47)
Firm size	0.54 (0.26)**		0.53 (0.26)**
Cross-cultural experience	0.30 (0.16)*		0.21 (0.18)
Sector (science-based = 1)	1.08 (0.54)**		0.94 (0.55)*
Poland a)	-1.64 (0.78)**		-1.69 (0.81)**
Portugal	-1.44 (0.70)**		-1.27 (0.73)*
The Netherlands	-0.62 (0.63)		-0.72 (0.67)
Absent skills			
Sales		0.27 (0.25)	0.35 (0.27)
Internationalization		-0.61 (0.18)***	-0.40 (0.21)*
Economic principles		-0.33 (0.22)	-0.13 (0.24)
N	84	85	84
LR Chi ²	30.56***	16.99***	35.31***
Pseudo R ²	0.17	0.09	0.20
Log likelihood	-74.40	-81.98	-72.03

* p<0.1; ** p<0.05; *** p<0.01

a) Finland as baseline.

With regard to the control variables, the full models indicate the following trends. The older and larger the USO is, the higher its propensity for export, and these turn out to be the only influences that matter. With regard to knowledge collaboration, the situation is different in that the sector and country matter aside from firm size. Being active in science-based sectors correlates with a stronger knowledge collaboration abroad. Thus, USOs in science-based sectors – mainly life sciences and material sciences – tend to be globally oriented more often in knowledge collaboration compared to other spin-offs. And finally, with regard to the country of origin, USOs in Poland and Portugal tend to be involved in international knowledge collaboration less often. The barriers they face refer to language and working culture differences, as well as large geographical distance (and associated expenses) in Portugal with regard to Brazil. There tend to be no difference between the various countries when it comes to export activity.

6. In-depth analysis

The aim of the in-depth case analysis is to illustrate the born-global stage and the missing skills. A brief characterization of the selected USOs is given in Table 5. The emphasis is on export activity and each case analysis ends with some preliminary suggestions for training.

Table 5. Selection framework of in-depth case studies

Spin-off (size 2011)	Age (2011) (years)	Export/knowledge collaboration (2011)	Science-based/ Otherwise	Internat. Skills	Econ. Principles
Case study 1 (7 fte)	3	-No export -Some collaboration	Non-science	1	5
Case study 2 (7.5 fte)	7 a)	-Small export (5-10%) -Strong collaboration	Science (life- sciences)	2	3
Case study 3 (175 fte)	12	-100% export -Strong collaboration	Science (physics)	5	5
Case study 4 (8 fte)	10	-80% export -Strong collaboration	Science (material science)	5	3
Case study 5 (33 fte)	7	-90% export -Strong collaboration abroad	Science/non-science (monitoring systems)	5	4

a) Excluding predecessor firm

Case 1 - Substantial problems with starting up export (very early stage)

The spin-off (the Netherlands) is a typical combination of young age (3 years in 2011), small size, lack of cross-cultural experience, non-science-based activity, and absence of internationalization skills (score of 1), all pointing toward an absence of export and little knowledge collaboration abroad. The firm, active in design and production of hygienic products connected to a wireless notification system in elderly care, focuses entirely on the domestic market and employs some knowledge collaboration abroad. However, the firm is not yet profitable, meaning that there is no capital available to set up the activities preparing for export, and, due to a quick domestic growth, the firm is also lacking management capacity. At the same time, although the product/system has been patented – similar products could be designed abroad and become a serious threat. Instead of following the ‘stepwise’ model, the firm would be advised to develop the domestic and some foreign markets simultaneously. This means obtaining the necessary financial support from a solid

investor and adding a new manager to the team, who is familiar with the care market (elderly) and can bridge the information and network barriers. If this is not affordable, customized training/consultancy may work, particularly using the experience of colleagues, and start export to a few countries inhibiting a culture similar to the Netherlands in health care and doing business.

Case 2 – Remaining problems in escaping the ‘sporadic’ born-global situation

The spin-off (Poland) is a combination of a small size, medium age, science-based activity, a low level of internationalization skills and moderate skills regarding economic principles. So far, the spin-off has only developed small exports of its patent-based genotyping system (5-10 percent). By contrast, the firm employs a strong knowledge collaboration abroad, the most recent in the EU FP7 context. The modest export levels – perceived by the firm as being a major problem – can be ascribed to a complex interplay of shortage in skills and capabilities in the interaction between the Polish and foreign business environment (Mroczkowski, 2010), including skills in negotiation abroad, skills in attraction of venture capital to finance developing export, skills in accessing marketing channels and sales capabilities that are effective abroad, particularly in the pharmaceutical industry. Hiring a sales person from abroad is relatively expensive and not always successful. Therefore, customized training with learning from other partnerships in the sector might work, particularly personalized training on how to find a partner by well-presenting the firm and to improve negotiation ability.

Case 3 A focused born-global situation (as a born-again-global)

The spin-off (the Netherlands) is a typical combination of large size, older age, science-based activity (physics), strong internationalization skills and equally strong skills on economic principles. The spin-off sells exclusively abroad and employs a comprehensive international knowledge collaboration. It can however not be labeled as an early born-global, because its growth stagnated for various years after firm start, due to difficulty in finding an important R&D partner. Further, with its patented technology of optically ‘writing’ in chips (lithography machines), the firm’s sales are currently confined to a small global market niche and knowledge collaboration with a few global customers (a focused pattern). A globally oriented founding professor stood at the origin of this firm and the global orientation was reinforced by ‘professionalizing’ the management team over the years. With almost 200 FTE's, this USO is the largest among the case studies. No missing skills were reported for the current stage and no training needs were identified, except for effective negotiation abroad. Most recently, the firm has opened a manufacturing site in Russia (Moscow) to produce lens components.

Case 4 - True born-global, yet facing basic challenges/dangers

This spin-off illustrates a class of specific spin-offs in Poland, characterized by an early and high level of exports and foreign knowledge collaboration associated with a science-based character and advanced skills in internationalization but not in economic principles. These USOs tend to remain connected to the university or Academy of Science relatively strongly, which allows them to stay relatively small but - as a disadvantage - prevents them to build a firm-specific body of skills. It seems that after some years after foundation these USOs cannot do without strategic alliances with large firms abroad or partial ownership by an experienced venture capital firm in order to remain truly born-global. Given this context, the sometimes missing skills to negotiate (mainly foreign) financial and strategic alliances successfully, may be a serious danger even to survival. Though

falling beyond our study of skills, it is also noteworthy that a necessary requirement in Poland is improving the employees' motivation to further increase working efficiency to international levels and make the USOs more attractive as partners. The USO is active in advanced membranes, covering a global market with many applications, but it is clearly a-typical, as it is relatively small (8 FTE), a situation which follows from a strong integration with activities at the university. In terms of training, this case illustrates that training is needed not only for sustaining internationalization itself (negotiations) but also for creating conditions that make the USO more attractive as a partner in internationalization (managing changes in working culture and productivity).

Case 5 – True born-global, while facing emerging challenges. This spin-off in Portugal, exemplifies a medium size, medium age (seven years), and high scores on relevant skills, pointing to high internationalization levels. The origins of the firm are in physics, but the application is used in various practical monitoring and detection systems, like concerning vibration (power generators) and temperature (telecom satellites), inhibiting excellent performance in hazard environments. The current CEO has gained some international/cross-cultural work experience (a PhD in the US) and other international experience, through for example participation in European projects. Exports represent 96 percent of total turnover (2013) and includes a complete offering of sensors, measurement units and software packages, sold in Brazil, Germany, Portugal and Spain, etc. Remarkably, the internationalization skills were acquired through quick experience rather than by taking a course. The challenges in the current born-global stage, as consolidation and increase of international growth, include communication and promotion of the unique user advantages of the products (branding) which are still unknown, and fulfilling the certification requirements in different countries which is an expensive and time-consuming affair. This firm may require the adoption of a quite different approach to improving skills which could be derived from sharing experience and even sharing some activity with other firms abroad.

7. Discussion, suggestions for training and future research

This study addressed as one of the first the degree of internationalization among university spin-off firms and the role of skills that are lacking. What is also relatively new in the study is the adoption of a 'refined' typology of born-global development which could illustrate the relevance of different missing skills. However, the results cannot be generalized statistically, but should be seen as trends connected to 'theoretical' sampling.

As our indicative results on export development suggested, a broad set of internationalization skills and economic principles skills is missing among university spin-off firms, while results on knowledge collaboration suggested that an international orientation is missing especially among spin-off firms in Portugal and Poland. The *internationalization-related* skills that are lacking in export development mainly refer to the conceptual and human (interaction) type and encompass the gaining on information about the customer market (segments), planning the various steps and integrating them in the firm's strategy and organization (as part of 'readiness'), connecting to the right partners/networks (marketing and venture capital), and negotiate and set agreements with business actors abroad. While these skills mainly refer to the stage of starting export or escaping from a sporadic pattern, the stage of sustaining or increasing global patterns in export tends to suffer

from lacking skills on the conceptual side with some elements of technology, like in skills of branding the new product, certification and patent protection. This stage tends also to be faced with missing skills in negotiation and setting agreements necessary to sustain a true global pattern but this seems limited to USOs in the Polish system. Overall, the large differentiation in internationalization skills that were lacking made us tentatively conclude that solving barriers in particular to export, requires a multi-faceted approach in training of spin-offs.

This study identified a set of missing skills which has been somewhat neglected in previous literature, namely, presentation and negotiation skills aimed at arriving at satisfactory agreements with actors abroad. It is precisely this set of skills where personality factors may enter and training may only partially help. In addition, this study also brought to light that internationalization may be delayed or fail if USOs are not seen as an attractive party to collaborate or do business with, due to a different working culture and lower work efficiency. As the last ones are of a different order and require a more comprehensive approach for improvement, they remain beyond our next analysis which is about training. Knowing that the skills of a new venture can also be obtained through experience over the years, through learning-by-doing, although this requires quite some time, and through hiring skilled experts from outside, which is quite expensive, we present some recommendations below centered around action-based learning. They specifically address a high level of customization of training and a new emphasis on sharing of experiences and networks.

Entrepreneurship education is becoming increasingly action-oriented, emphasizing learning-by-doing, activities in a group setting and using a network context (Rasmussen and Sorheim, 2006; Lans et al., 2014). A group setting and a network context could signify, for example, benefiting from alternations of theoretical reflection with an analysis of action in practice. With regard to the latter, “hands-on” initiatives, where CEOs can network with peers that are facing the same initial barriers to internationalization and those that have overcome these barriers, and where CEOs can present their export project or supply chain project to financial backers and trade companies, are preferred. The sessions involved should be interactive, using different methods and media (e.g. Gardner, 2006), such as storytelling, debates, dialogs and role-plays, with real accountability, and using real case USO examples. These types of settings enable to better combine theory or economic principles with an analysis of practical actions and solutions.

Customized personal coaching – Spin-off CEOs tend to face different combinations of missing internationalization skills with part of these skills being related to personal characteristics. This situation may urge – aside from the learning in a group setting - a customized personal approach, which is particularly helpful in improving negotiation and persuasion skills as these are connected with traits as assertiveness, patience, charm, inspiring trust, but also ability to slightly manipulate, etc. Good negotiators need to have unlimited patience, be able to dissemble without lying, inspire trust while realizing they cannot always trust others, be assertive and modest at the same time, and be charming while remaining uncharmed (Ghauri, 2003). Such a mindset is needed to convince venture capitalists or other investors in the firms’ internationalization steps and to convince sales persons abroad.

Sharing with experienced peers – Spin-offs can clearly benefit from other spin-offs that are already experienced in their attempts to internationalize. This is particularly true with regard to overcoming

network obstacles and increasing financial resources, which is important for USOs opting in favor of a gradual development in internationalization but feel the need for speeding up in view of increasing global competition. The key is to motivate experienced USO CEOs to share their knowledge and experience in a trusting environment, in a win-win scenario. In this context, it can also be enhanced to share some more resources with experienced USOs or other companies. Examples are sharing networks or intermediaries abroad, and sharing experienced ‘internationalization managers’, which could also be an option in sectors facing regulatory barriers (certification) and challenges of branding abroad.

It needs to be acknowledged that the study is based on a relatively small sample, not allowing statistical analysis and generalization. The spin-offs were, however, carefully selected to represent various contrasting ‘structural positions’ of university spin-off firms, like the young and small firms, the science-based firms and other ones, and connected trends. In future research, the sample size could be increased to yield results that can be generalized statistically, enabling a thorough *testing* of the results of this study. The modeling could also be extended to include more dimensions of internationalization, like rapidity and pace, and scope in the sense of number of countries/markets involved (e.g. Kuivalainen et al., 2012), as well as more influences that have remained outside our analysis, such as differences in innovation level of USOs (e.g. Love and Roper, 2013). In addition, adopting a longitudinal approach over a longer period of time would make it possible to identify the impact of improving skills on exports and to better picture the change in required skills over time when internationalization is progressing and skills are achieved by extending the management team with skilled members.

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Annex A

		1	2	3	4	5	6	7	8	9
1	Export	1.00								
2	Knowledge collaboration	0.50*	1.00							
3	Firm age	0.28*	0.15	1.00						
4	Firm size	0.38*	0.31*	0.28*	1.00					
5	Cross-culture experience	0.25*	0.37*	0.13	0.41*	1.00				
6	Sector (science-based=1)	0.19	0.39*	0.06	0.14	0.28*	1.00			
7	Country of location	-0.03	-0.09	-0.08	0.00	-0.09	-0.11	1.00		
8	Internationalization	0.38*	0.39*	-0.00	0.24*	0.44*	0.31*	-0.05	1.00	
9	Sales	0.09	0.03	-0.01	0.10	0.24*	0.02	-0.22*	0.30*	1.00
10	Economic principles	0.31*	0.25*	0.13	0.22*	0.37*	0.13	0.13	0.29*	0.24*

* p<0.05

Annex B

Diagnostic	Description			
Model		1	2	3
Detecting unusual and influential data	Residuals, leverage, Cook's D and DFBETA, etc.	Checked	Checked	Checked
Test for normality of residuals	Inter-quartile range (iqr) test and Shapiro-Wilk test	iqr test: 7 outliers Shapiro-Wilk test: z: 4.156 p-value: 0.00	iqr test: 5 outliers Shapiro-Wilk test: z: 4.221 p-value: 0.00	iqr test: 7 outliers Shapiro-Wilk test: z: 6.195 p-value: 0.00
Test for heteroscedasticity of residual	(1) White's test; (2) Breusch-Pagan test	(1) χ^2 : 56.17 p-value: 0.0173 (2) χ^2 : 8.35 p-value: 0.0039	(1) χ^2 : 38.64 p-value: 0.0002 (2) χ^2 : 13.19 p-value: 0.0003	(1) χ^2 : 87.97 p-value: 0.0615 (2) χ^2 : 12.21 p-value: 0.0005
Test for multicollinearity	Variance inflation factor	Mean VIF: 1.53	Mean VIF: 1.14	Mean VIF: 1.55
Test for model specification error	ovtest	F: 0.13 p-value: 0.9427	F: 0.30 p-value: 0.8231	F: 0.56 p-value: 0.6437

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