8th International Research Meeting in Business and Management,
IPAG Business School Nice Campus, 5-6 July 2017

Team versus Network Diversity
University Spin-off Firms' Determinants of Early Growth

Marina van Geenhuizen*and Mozhdeh Taheri*
*Faculty of Technology, Policy and Management, Delft University of Technology, The Netherlands.
E-mail: m.s.vangeenhuizen@tudelft.nl

Abstract
Diversity in knowledge that a firm owns or accesses is often regarded as beneficial to firm growth. Diversity in knowledge opens new horizons and can be combined to develop inventions. University spin-off firms, established to develop new products/services towards market introduction, are typically exposed to diversity in knowledge, through the founding team's background and/or through external networks. Despite the local support given to these firms in various European countries, their growth is generally modest. This situation raises questions on what matters most for university firms, diversity in the founding team or diversity in the network. And what precisely the impact of diversity would be, positive or negative, and if positive whether there would be a 'ceiling' in diversity pointing to decreasing returns. Our results derived from a sample of 105 firms and the estimation of various regression models of growth (linear and curvilinear) provide the following trends in employment and turnover. First, diversity in the networks is much stronger influencing employment growth compared to diversity in the founding team, and this concerns positive influence. With regard to turnover, the influence of diversity in the networks is positive again, but the influence of diversity in the team is now clearly negative, with the exception of diversity in innovation experience. In addition, with regard to curvilinear patterns, we find that diversity in social networks, concerning different partners, produces increasing returns in both employment and turnover growth, while diversity in working experience in the team gives decreasing returns for turnover. This study confirms relatively strong and more positive influence from network diversity (social network) in early years as forwarded in the 'cognitive resource perspective', and potential harm from founding team diversity as forwarded in the 'separation' perspective.

1 INTRODUCTION

Knowledge economies in Europe and North America are facing trends towards more openness and interaction between universities and other knowledge institutes and society. The recently addressed Science 2.0 or 'Open Science' is a holistic approach towards science-

related processes, ranging from framing of problems, conceptualization of research ideas and data gathering and analysis, to the publication and use of scientific outcomes (EC, 2014; 2015). The aim is to make research more open, global, collaborative, creative and closer to society, through the use of ICT tools, media and networks. Accordingly, citizens and society participate as contributors and direct beneficiaries of new knowledge. Compared to the past, there will be a significant increase of scientific production, data-intensive science and number of stakeholders in science, which enable interactive processes of co-creation and knowledge commercialization. The changes are specifically important when it comes to finding solutions to persistent social (sustainability) problems in cities, mainly in domains closely related to people's health and lifestyles, energy, daily living (environment), work, transport, etc. (Goddard and Valance 2013; Trencher et al. 2014).

For universities and their spin-off firms these new developments would implicate that more stakeholders are involved in incubation and development of new product/services to market (including customers) and that more information is needed to use design of strong user-friendly products/services. The new developments also mean that on-campus collaboration with (large) industry and societal organizations will increase, and that numbers of accelerators, entrepreneurship garages, university-industry employee exchanges, and mixed public/private incubators hosting a variety of start-ups will grow (Siegel and Wright, 2015; Taheri and van Geenhuizen, 2016). Overall, the result is a higher diversity in the environment of university spin-off firms and also a higher diversity in information and knowledge flows in their networks.

Among the various channels used in the commercialization of university knowledge, spin-off firms established by university staff and/or graduates have attracted a relatively strong attention (D'Este and Patel, 2007). This is not only because spin-off firms produce knowledge-based employment, they are also clearly visible and thought to contribute to a larger diffusion of new knowledge and improvement of regional business ecosystem (Huggins and Johnston, 2009; Lowe, 2002; Stam and Spigel, 2016; Mack and Mayer, 2016). Nevertheless, despite high expectations, spin-off firms' growth in Europe has remained relatively low (Mustar et al., 2008; Taheri, 2013; Rodriguez-Gulias, 2017). The modest growth level constitutes the first reason to identify and better understand the causes and circumstances that inhibit or delay growth among university spin-off firms, other than spin-off policies, availability of venture capital and external support which is already addressed, e.g. Niosi (2006), Rasmussen and Borch (2010), Rodriguez-Gulias et al. (2017). Diversity in the founding team and diversity in the networks are often seen as beneficial for growth. In

general, diversity in experience, learning and information causes a broader knowledge base with more unique ideas and viewpoints, and a broader variety in (access to) resources (e.g., Beckman et al., 2007; Furlan and Grandinetti, 2014). The trend that diversity in knowledge networks is increasing in the recent past, constitutes the second reason for our research, in particular whether it is the diversity in the networks or in the founding team that matters for growth of young spin-off firms.

Drawing on an extensive body of studies on start-ups and diversity in their management teams and networks it can be concluded that empirical analyses have produced contrasting evidence on impact of diversity on start-up growth. The controversy can be summarized as 'benefits from rich information and complementarity from different team members and sources' versus 'lack of integration (separation) between different team members and between own knowledge and external bodies of knowledge and partners' (Chowdury, 2005; Horwitz and Horwitz, 2007; Colombo and Grilli, 2010; Shrivastava and Rao, 2015). Further, by adopting an evolutionary perspective, taking ideas on increasing/decreasing returns and path dependency into account (Arthur, 1994; Grabher, 1993), we may expect decreasing returns on the influence of diversity on firm growth. As absorptive capacity is limited at early age, diminishing returns and lock-in effects may arise as diversity in knowledge and information increases (Fried et al., 2006; Maurer and Ebers, 2006). Laursen and Salter (2006) and Leiponen and Helfat (2010) have identified decreasing returns, be-it not for growth, but for innovation.

In sum, first, there is a knowledge gap about what matters more in determining growth, diversity in the founding team or diversity in the network, and secondly, there is a knowledge gap on the precise impact of diversity, positive or negative and on patterns of increasing or decreasing returns. Given the changes that are ahead in the knowledge economy and the slow growth of university spin-off firms, the aim of the study is to fill the two knowledge gaps on the influence of diversity in knowledge and experience on growth. We understand growth as employment growth as this is an important performance indicator in policy aimed at increasing knowledge-based jobs in the region, but we also take growth in turnover into account as spin-offs increasingly source-out main parts of activity to other organizations, thereby missing own job increase (van de Vrande et al., 2009).

The paper unfolds as follows. First, in section 2, attention will be given to the concept of diversity and theoretical approaches that help understanding influence on growth (model design), and accordingly six hypotheses will be forwarded. Next, methodological aspects of the empirical study are discussed (section 3) and results of the model estimations, both linear

and curve-linear, and results of hypotheses testing are presented (section 4). Implications of the results and ideas on further research conclude the paper (section 5).

2 THEORY AND MODEL BUILDING

2.1 Founding team diversity and growth

According to the upper-echelon perspective on firms, the quality of the founding team and subsequent management team are perceived to have main impacts on the performance of start-up firms (e.g. Agarwal et al., 2004; Fern et al., 2012). Given the absence of hierarchal structures in new ventures, the tasks of coordination and strategic planning are mainly performed by the founding team and team decisions in the initial stages may condition the creation of and access to resources at subsequent stages (Heine and Rindfliesch, 2013; Rasmussen et al., 2014). A large number of studies in recent years has focused on diversity in the founding team (e.g. Ensley and Hmieleski, 2005; Amason, 2006; Fern et al., 2012) and these have looked at a wide range of differences, including age, gender, cultural background (nationality), education, functional and industry experience, academic/non-academic members, etc. (Beckman et al., 2007). According to the cognitive resource perspective, diversity in education and working experience has an overall positive impact through the increase in skills and abilities from complementary disciplines and social circles providing a higher level of information richness (Hambrick et al., 1996; Williams and O'Reilly, 1998; Aspelund, 2005; Chowdury, 2005; Horwitz, 2005; Hennike and Lüthje, 2007; Shrivastava and Rao, 2015). Accordingly, effective teams take advantage of different skills and abilities and integrate them (Delmar and Shane, 2006; Fern et al., 2012). By contrast, particularly caused by different discipline backgrounds, group fault lines may emerge and team members face difficulty in understanding each other's language and narratives, causing hinder, e.g. delay or lack of effective decision-making at higher levels of diversity (Pelled, 1996; Colombo and Grilli, 2010; Shrivastava and Rao, 2010; Shrivastava and Tamvada, 2011). This situation conforms to the 'separation' perspective. We phrase hypotheses according to the two perspectives, with a focus on team diversity in the sense of education and pre-start experience domains, and invention experience after start. Other aspects of founding team diversity show minor differences within the sample.

1a Diversity in pre-start education has a positive influence on growth (linear model).

1b Diversity in pre-start education has a curvilinear influence on growth (inverted U-

shape).

2a Diversity in pre-start working experience has a positive influence on growth (linear model).
2b Diversity in pre-start working experience has a curvilinear influence on growth (inverted U-shape).

We now focus on more recent experience with invention activity. Invention is a process of combining different pieces of knowledge and thinking 'out of the box', but there are differences between low level inventions, as incremental improvements and high level inventions that can be seen as radical and require an original combination of different knowledge (Ettlie et al., 1984; Mohr et al., 2010). An optimistic view would be that young firms grow more if their inventions get more complicated and radical and more diverse information is utilized. A contrasting, more negative, view would be that if diversity in information use becomes higher (more radical inventions) the benefits for growth will decrease as markets are still in development.

3a Diversity in recent invention experience has a positive influence on growth (linear).
3b Diversity in recent invention experience has a curvilinear influence on growth (inverted U-shape).

2.2 Network diversity and growth

The establishment of external networks is seen as a vital way for young high-technology firms to access missing resources, including new competences (e.g. Lavie 2006). In the literature, there seems consensus about the effect of diversity in networks on firms' performance, namely, *positive*, and such positive influence would be the more true if the gained resources allow being simultaneously active in research-oriented and market-oriented activity important for spin-offs in early stages (e.g., Gargiulo and Benassi 2000; Grandi and Grimaldi 2003; Reagans and McEvily 2003; Simsek 2009; Onkelinxs et al., 2016). However, a contrasting view states that university spin-off firms in early years are facing limited resources (experience and time) in managing networks and taking advantage from them. Diversity in external networks introduces new information that is *beyond* the current cognitive horizon of the firms, meaning a need for additional effort and challenge in learning and absorbing the new information, preventing an easy benefit (Parida et al., 2016). Also,

dealing with different types of partners, unknown so-far, may pose a burden on management. Specifically, international networks with larger reach, e.g. beyond Europe and US, come with cultural and institutional differences that need to be bridged, before benefits can be gained, causing diminishing returns after some point (Oviatt and McDougall, 1994; Prashantham, 2005).

We include two types of networks in our model, first, the social network that typically develops in the early years with different degrees of diversity in social background of the partners and interaction with the local/regional community (Brüderl and Preisendörfer, 1998; Johansson et al., 2005) and secondly, the international, more formal networks based on efficiency-oriented business relationships (Hite and Hesterley, 2004) with supplying firms, customers and research centers. The previous arguments make us formulate hypotheses on networks as follows, with the limitation that for international networks (different reach) curvilinear relations cannot be explored due to low measurement level.

4a. Diversity in social networks has a positive influence on growth (linear model).
4b. Diversity in social networks has a curvilinear influence on growth (inverted U-shape).

5. Diversity (larger reach) in international networks has a positive influence on growth (linear model).

2.3 Control variables

In the growth model, a set of firm-specific factors are controlled for, namely age and initial ambition level (entrepreneurial orientation) (Wiklund et al., 2009). In addition, we control for size of the founding team and highest education level. In terms of region in which the firm is founded, the type of regional business ecosystem is also thought important in facilitating team and network diversity and growth, with large cities in metropolitan core-areas being better endowed compared to regions at a distance from such areas, in terms of agglomeration advantages. We mention the following examples of such advantages: knowledge-based services, launching customers, knowledge brokers (Audretsch and Feldman, 1996; Gordon and McCann, 2000; Isaksen et al., 2015). Such difference between regions could even interact with diversity in the networks. One viewpoint says, in accordance with agglomeration advantages, that there is a positive interaction effect between agglomeration advantages and

networking, because networks work better and more beneficial in metropolitan core-areas, with supporting organizations and knowledge spillovers here. There is also a contrasting view, namely that young firms in 'thin regions' compensate for their 'poor' environment and use their sparse networks more efficiently in a stronger in-firm 'workplace' learning (Flåten et al., 2015) causing absence of interaction effects.

6a There is a positive interaction effect between business ecosystem and diversity in networks (social networks and internationalization).

6b There is no interaction effect between business ecosystem and diversity in networks (social networks and internationalization).

3 METHODOLOGY ASPECTS OF THE STUDY

The sample used in the study, is a given sample drawn from two universities in Europe, Delft University of Technology (Delft, the Netherlands) and the Norwegian University of Science and Technology (NTNU) (Trondheim, Norway). Except for a different urban location (metropolitan versus non-metropolitan and more peripheral), there are no significant differences, particularly not in the national innovation systems of the two countries, in most of the observation period used on the study. They share a somewhat risk-avoiding entrepreneurship culture (GEM, 2010), show similar scores on the European Innovation Scoreboard indicators (ProInno Europe, 2012), and both have relatively small domestic markets.

All firms in the population of spin-offs from the two universities (150) were contacted in 2006/7 giving an overall response rate of 70 per cent. In 2006/7, data were collected using a semi-structured questionnaire in face-to-face interviews with the firms' principal manager(s) (founding team), using a focus on firm characteristics (e.g. product/service, sector, firm size, R&D, profile of the founding team members and profiles of the knowledge networks, particularly the social network and international network. Next, in 2011, data were collected on firm growth with regard to employment and turnover using a concise email questionnaire and, wherever necessary, telephone calls and websites.

We apply multiple regression analysis to explore the influence of diversity in founding teams and networks on growth. Employment growth is measured on a continuous scale, while turnover growth is measured in five classes; the last requires another type of regression modeling (ordered logistic regression). The model results are presented in a stepwise

approach, differentiating between the model with controls, the model including merely team diversity, the model including merely network diversity, the full model including both team and network diversity, and there is a model including interaction effects. As a final step, we explore curve-linearity in relationships between various diversity and growth.

Table 1 Measurement of model variables and descriptive results

Variables	Measurement	Descriptive statistics
Dependent variables		
Employment growth since start	Continuous variable as annual growth until 2010 (fte)	Average: 1.20; s.d.: 2.57; Median: 0.55; Min-max: -1-16.3
Turnover growth since start	Rank variable in five classes (Euro)	1)Failed without turnover: 15.5% 2) X <100,000: 13.5% 3) 100,000 <=X <300,000: 13.5% 4) 300,000 <=X <500,000: 11.5% 5) X >500,000: 46%
Controls		
Age	Continuous variable difference between year of foundation	Average: 4.9; s.d.: 3.1; Min-max: 1-10
Business ecosystem of foundation	Variable in two categories	Core, metropolitan (58%) versus small city (peripheral) (42%)
Early entrepreneurial orientation	Variable in three categories	Large and international (37%) Small and international (53%) Small and local (10%)
Founding team size	Continuous variable as number of team members	Average: 2.29; s.d.:1.19; Min-max: 1-5
Founding team education level	Continuous variable as number of doctorate degrees among members	Average: 0.61; s.d.: 0.88; Min-max: 0-3
Founding team diversity		
Education diversity	Continuous variable derived from three types of education; calculated using $(1-\sum p_i^2)$, where p is the proportion of team members in a category and i is the number of categories	Average: 0.51; s.d.: 0.32; Min-max: 0 - 0.89
Pre-start experience diversity	Continuous variable derived from experience of founders, i.e. technical, managerial and others; calculated using $(1-\sum p_i^2)\backslash$, where p is the proportion of team members in a category and i is the number of categories	Average: 0.48; s.d.: 0.39; Min-max: 0 – 0.89
Recent invention experience	Continuous variable (derived from factor analysis using R&D expenditure, newness in innovation, owning patents, having a breakthrough)	Average: -0.00; s.d.: 0.83; Min-max: -0.84 – 3.06
Network diversity		
Social network diversity	Continuous variable as explained in Appendix 1	Average: 0.34; s.d.: 0.18; Min-max: 0-0.88
International reach diversity	Three rank categories with different reach a)	1.Not internationalized (38.7%); 2. Europe, US and China (38.7%; 3. Wider global reach (22.6%)

a) For statistical reasons it was necessary to merge some categories.

With regard to the employment growth model and endogeneity, the diagnostic tests are passed. We also check for multi-collinearity as common routine in preparation for modellings (Appendix 2 and 3). The measurement of the variables and the results are given in in Table 1.

4 TEAM VERSUS NETWORK

We first pay attention to the question which influence on growth is stronger, the set of team diversity or the set of network diversity and consider that both for employment growth and turnover growth. Next we identify in more detail the different types of diversity, again for employment and turnover growth (Table 2 and Table 3). As a final step we explore curve-linearity (inverted U-shaped relations).

The modeling involves various steps. First, the set of control variables is entered and this is followed by inserting the set on founding team diversity (Model 2) and the set on network diversity (Model 3) separately. The changes in model power, as evidenced by the increase of R^2 (employment) and Pseudo R^2 (turnover), show a strong difference in influence for employment and absence of any difference for turnover. Employment growth tends to be *relatively* strongly influenced by network diversity, as the model power is 0.11 in the case of team diversity and 0.27 in the case of network diversity (Model 2 versus Model 3).

In more detail, regarding employment, the coefficient of invention experience among team diversity is positive and significant, while education diversity and pre-start experience diversity tend to play no role (Model 2). In addition, both coefficients of network diversity are positive and significant (Model 3). In the turnover growth model, we also find a positive and significant coefficient for invention experience (Model 2). In addition, both types of network diversity are positive and significant, social networks and internationalization diversity (reach). And finally, with regard to interaction effects between network diversity and business ecosystem, we only observe such effects for employment, not for turnover. The last could be explained by the higher measurement level of employment growth (continuous variable) compared to turnover growth (rank variable).

A negative influence of diversity in founding teams, as observed for turnover growth, is in line with several studies, for example, Chowdhury (2005) and Visintin and Pittino (2015). It indicates that among young spin-offs, diversity in knowledge that is owned by founding team members yields no benefits from complementarity, rather causes separation enhancing potential conflicts and difficulty in coherent decision-making on growth (Pelled 1996;

Simsek 2009). Such situation may be temporary as it is enhanced by lack of management ability at very young age (Van Geenhuizen and Soetanto, 2009). However, achieving diversity in knowledge through networks, tends to be overall favorable for growth. A positive impact of knowledge networking with a variety of firms (customers, suppliers, competitors) and organizations on a global level has also been observed in other studies (Knight and Cavusgil, 2004; Clercq et al., 2012). Young high-technology firms may be better in balancing exploration and exploitation through their diverse networks, which is in line with earlier studies (Reagans and McEvily, 2003; Simsek et al., 2009).

With regard to control variables, the one on early entrepreneurial orientation is consistently significant in all models, meaning that the dominant trend of small size preference (mainly with an international orientation) has an influence on actual employment and turnover size.

Table 2 – Estimation of employment growth (linear models incl. interactions)

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
	β-coeff. (s.e.)	*β-coeff. (s.e.)*	*β-coeff. (s.e.)*	*β-coeff. (s.e.)*	*β-coeff. (s.e.)*	*β-coeff. (s.e.)*
Controls						
Year of foundation	0.16 (0.09) *	-0.009 (0.08)	0.03 (0.07)	0.04 (0.07)	0.08 (0.06)	0.03 (0.07)
Business ecosystem (metropolitan =1)	1.19 (0.47) **	1.63 (0.53) †	1.77 (0.46) †	2.02 (0.50) †	-1.22 (0.88)	-1.30 (1.24)
Initial EO	0.65 (0.36) *	1.01 (0.36) ***	0.77 (0.34) **	0.82 (0.35) **	0.76 (0.32)**	0.81 (0.33)**
Founding team education level	-0.29 (0.37)	-0.82 (0.48)	-0.71 (0.37) *	-1.08 (0.46) **	-0.88 (0.43) **	-0.75 (0.46)
Founding team size	1.16 (0.33)	0.40 (0.26)	0.20 (0.18)	0.20 (0.24)	0.25 (0.22)	0.18 (0.23)
Founding Team						
Pre-start experience diversity	-	-0.43 (0.70)	-	-0.25 (0.66)	-0.34 (0.60)	-0.63 (0.64)
Education diversity	-	1.01 (0.96)	-	-0.06 (0.91)	-0.19 (0.83)	-0.23 (0.88)
Innovation experience diversity	-	0.65 (0.39)*	-	0.51 (0.36)	0.41 (0.33)	0.29 (0.36)
Network						
Social network diversity	-	-	4.04 (1.36) †	3.73 (1.42) **	-0.94 (1.70)	4.12 (1.37) †
Internationalization reach	-	-	0.70 (0.33) **	0.76 (0.34) **	0.83 (0.32) **	-0.11 (0.45)
Interaction						
Social network diversity* Business ecosystem	-	-	-	-	9.51 (2.21) †	-
Internat. networks* Business ecosystem	-	-	-	-	-	1.72 (0.59)***
N	105	105	105	105	105	105
F	6.04 †	2.72 **	6.47 †	4.69 †	6.74 †	5.36 †
Adjusted R^2	0.20	0.11	0.27	0.26	0.38	0.31
ΔR^2	-	-0.09	+0.07	+0.06	+0.18	+0.11
Root MSE	2.31	2.41	2.20	2.21	2.03	2.12

* P<0.1, ** P<0.05, *** P<0.01, †P<0.005.

Table 3 – Estimation of turnover growth (linear models incl. interactions)

Variables	**Model 1**	**Model 2**	**Model 3**	***Model 4***	***Model 5***	***Model 6***
	Logit coeff. (s.e.)	*Logit coeff. (s.e.)*	*Logit coeff. (s.e.)*	*Logit coeff. (s.e.)*	*Logit coeff. (s.e.)*	*Logit coeff. (s.e.)*
Controls						
Year of foundation	-0.23 (0.06) †	-0.25 (0.07) †	-0.21 (0.07) †	-0.23 (0.07) †	-0.22 (0.07) †	-0.25 (0.07) †
Business ecosystem (metropolitan=1)	0.64 (0.40)	0.87 (0.43)	0.86 (0.41) **	1.08 (0.45)**	-0.01 (0.98)	-0.60 (1.17)
Initial EO	0.94 (0.29) †	0.93 (0.31) †	0.86 (0.29) †	0.87 (0.32) ***	0.84 (0.32) ***	0.89 (0.32) ***
Founding team education level	0.10 (0.31)	-0.19 (0.38)	-0.22 (0.34)	-0.52 (0.42)	-0.48 (0.42)	-0.41 (0.43)
Founding team size	0.20 (0.16)	-0.005 (0.20)	0.22 (0.16)	-0.09 (0.21)	-0.09 (0.21)	-0.10 (0.21)
Founding Team						
Pre-start experience diversity	-	-1.15 (0.58) **	-	-1.04 (0.61)*	-1.14 (0.62)*	-1.30 (0.63)**
Education diversity	-	-1.12 (0.79)	-	-1.85 (0.85)**	-1.93 (0.85)**	-1.90 (0.86)**
Invention experience diversity		0.67 (0.34) *	-	0.61 (0.36)*	0.59 (0.36)	0.54 (0.36)
Network						
Social network diversity	-	-	2.10 (1.35)*	2.35 (1.42)*	1.12 (1.69)	2.77 (1.49)*
Internationalization diversity	-	-	0.52 (0.30) *	0.65 (0.32) **	0.68 (0.32) **	0.23 (0.41)
Social network diversity* Business ecosystem	-	-	-	-	3.55 (2.87)	-
Internationalization networks* Business ecosystem	-	-	-	-	-	0.92 (0.59)
N	104	104	104	104	104	104
LR Chi square	25.21 †	34.71 †	34.52 †	46.27†	47.90†	48.73†
Pseudo R^2	0.08	0.116	0.116	0.15	0.16	0.163
Log likelihood	-136.52	-131.77	-131.86	-125.99	-125.17	-124.75

* P<0.1, ** P<0.05, *** P<0.01, †P<0.005.

In a final step, the presence of curvilinear trends of team and network diversity is explored on on growth, particular inverted U-shape patterns suggesting diminishing returns as suggested in the hypotheses (Table 4). We observe just a few curvilinear trends, namely, a negative trend for the influence of pre-start experience diversity on turnover growth, pointing to decreasing returns, and a positive trend for social network diversity with regard to both employment and turnover growth, pointing to increasing returns. Once more these patterns indicate that diversity in knowledge and experience works clearly different, dependent on whether it is embodied in the founding team or in the network relationships.

Table 4. Estimation of employment and turnover growth (curvilinear model) a)

	Employment growth *β -coeff. (s.e.)*	**Adjusted R^2**	**Turnover Growth** *logit-coeff. (s.e.)*	**Pseudo R^2**
Founding team				
Pre-start experience diversity	-0.72 (0.73)	-0.0003	-1.22 (0.54)**	-0.017
Education diversity	0.31 (0.87)	-0.0085	-0.76 (0.62)	0.005
Innovation experience	0.012 (0.19)	-0.009	0.21 (0.18)	0.005
Network				
Social network diversity	6.78 (1.45) †	0.166	3.01 (1.38) **	0.02
Internationalization reach	Not on ratio scale		Not on ratio scale	

* P<0.1, ** P<0.05, *** P<0.01, †P<0.005

a) quadratic terms inserted one by one in empty model.

We close this section with a brief summary of results of exploration of the hypotheses as formulated in section 3. For hypotheses 1a, 2a, 3a, 4a and 5 we use the full models (Model 4) (Table 2 and Table 3), for hypotheses 1b, 2b, 3b and 4b we use the single curvilinear regression outcomes (Table 4), and for hypotheses 6a and 6b we use Model 5 and Model 6 (Table 2 and Table 3). Overall, our hypotheses on a positive influence of diversity in the founding team could not be confirmed (hypotheses 1a and 2a), except for invention experience (turnover growth) (hypothesis 3a). However, our hypotheses on a positive influence of diversity in networks (both social and international) could be confirmed (hypotheses 4a and 5). Confirmation is also true for our hypotheses on a positive interaction effect between social network diversity and metropolitan business ecosystem, but only for employment growth

(hypothesis 6a) and lack of interaction effects for turnover growth (hypothesis 6b). Most hypotheses on inverted U-shaped relationships could not be confirmed (hypotheses 1b, 3b, 4b), with the exception of diversity in pre-start-working experience and turnover growth (hypothesis 2b). Further, hypotheses testing has brought to light that there is not only a positive influence of diversity in social networks on growth (hypothesis 4a), but the benefits for growth tend to increase disproportionally (increasing returns).

5 CONCLUSION

With the aim to increase understanding of a rather limited growth among university spin-off firms in Europe, this study explored influence of the founding team and the external network on employment and turnover, with a focus on diversity in knowledge. Using data on 105 university spin-off firms, a trend could be observed of a positive influence of diversity in social networks (domestic) and international networks on employment and turnover growth, broadly confirming ideas on richness of information in the 'cognitive resource diversity paradigm'. In contrast, with regard to founding team diversity concerning education types and pre-start working experience, negative influence was found mainly on turnover growth, broadly confirming ideas on the rise of 'fault lines' between group members preventing the founding team to act as an integrated unit. In addition, with regard to curvilinear patterns, diversity in social networks produces increasing returns in both employment and turnover growth, while diversity in pre-start working experience in the team causes decreasing returns for turnover.

Our results would mean that being involved in exploration and/or exploitation occurs more successfully through networks than through the founding team in the early years of spin-off firms. Further, the positive influence of social networks on spin-off growth is reinforced if taking place in a metropolitan area, though this only applies to employment growth. Overall, while the founding team at young firm's age lacks the ability to benefit from diversity within the team in pursuing growth, in a collaborative environment, it is able to benefit from diversity in external networks. With these results, we address the gaps in existing literature with regard to the impact of diversity on young high-technology firms' teams and networks, partly in the context of exploration and exploitation activity, which is the first contribution of the paper to the literature (Simsek, 2009; Lichtenthaler, 2012). The second contribution of the paper, is addressing curvilinear trends in influences on growth. Existing literature identified

decreasing returns of open relationships on innovation performance (Laursen and Saulter, 2006; Leiponen and Helfat, 2010). Curve-linearity, however, tends not to be a general pattern. We found only two trends, and these reinforced our results on benefits from social network diversity and harm from team diversity, namely a U-shape relationship (increasing returns) for social network diversity and an inverted U-shape relationship (decreasing returns) for pre-start experience diversity (only turnover growth).

This paper also contributes to practical issues and policy-oriented debates. With regard to practical implications for increasing the growth of young spin-offs (Mustar et al., 2006; Wright et al., 2009; Colombo and Grilli, 2010), we recommend staffing decisions to create a low diversity in education type and pre-start experience in the founding team, while also recommending decisions to build external networks to increase diversity, regarding types of partners and regions, and reach abroad. Accordingly, awareness needs to be increased about contrasting impacts of teams and networks, particularly on potentially detrimental effects of high diversity in the founding team. The outcomes of this study can, however, only be generalized for technical universities in countries in the European Union that share some of the main characteristics of the Netherlands and Norway, i.e. a somewhat risk-avoiding entrepreneurial culture, being an 'innovation follower' and a small but open national economy. In addition, the universities in question specialize in new technology in seashore activities, mainly energy and transport, which would make the result of interest for Denmark, coastal Sweden and part of UK (North).

This study has also various limitations which can be addressed in future research. The relatively small sample and the database made us decide to exclude some factors related to firm growth, such as network characteristics like centrality. Also, the behavioral capacity of team members to collaborate across diverse social units potentially demonstrating alignment and adaptability, has remained beyond the scope of the study (Gibson and Birkinshaw, 2004). Moreover, the management team composition may change over time, after being adapted to emerging management needs and professionalization, and a firm's network characteristics may also evolve over time as the need to access external sources changes. Accordingly, a longitudinal study would yield a better understanding of the role of diversity and its 'counterpart' integration (Vanaelst et al., 2006), with several studies indicating that diversity within the firm (management team) gives way to more integrated models in later stages of development (e.g. Jansen et al., 2009).

Bibliography

Agarwal, R., Echambadi, R., Franco, A.M. and Sarkar, M.B. (2004) Knowledge transfer through inheritance: spinout generation, development and survival. *Academy of Management Journal* 47(4), 501–522.

Amason A., Shrader R.C., Tompson G.H. (2006) Newness and novelty: relating top management team composition to new venture performance, *Journal of Business Venturing*, 21, 125–148.

Arthur, W.B. (1994) *Increasing returns and path dependence in the economy*, University of Michigan Press.

Aspelund, A., Berg-Utby, T., & Skjevdal, R. (2005). Initial resources' influence on new venture survival: A longitudinal study of new technology-based firms. *Technovation*, 25(11): 1337-1347.

Audretsch, D. and Feldman M. (1996). R&D spillovers and the geography of innovation and production. *American Economic Review*, 86 (3): 630-640.

Barney, J.B. (1991) Firm Resources and Sustained Competitive Advantage, Journal of Management, 17 (1): 99-120.

Barney, J. B. and Clark D.N. (2007) *Resource-Based Theory*. Oxford: Oxford University Press.

Beckman, C. M., Burton, M.D. and O'Reilly, C. (2007) Early teams: The impact of team demography on

VC financing and going public. *Journal of Business Venturing* 22, 147-173.

Bitard, P., Edquist, C., and A., Rickne (2008) The paradox of high R&D input and low innovation output: Sweden. Lund: Lund University, CIRCLE Paper 2008/14.

Bjerregaard, T. (2010) Industry and academia in convergence. Micro-institutional dimensions of R&D collaboration, *Technovation* 30 (2): 100-108.

Bjørnåli, E.S. and Aspelund, A. (2012). The role of the entrepreneurial team and the board of directors in the internationalization of academic spin-offs. Journal of International Entrepreneurship, 10(4): 350-377.

Bolzani, D., Fini, R., & Grimaldi, R. (2015). The internationalization of academic spin-offs: Evidence from Italy. Bologna: University of Bologna.

Breznitz, S. M., & Feldman, M. P. (2012). The engaged university. *Journal of Technology Transfer*, *37*(2), 139-157.

Bruderl, J. and Preisendorfer, P. (1998). Network Support and Success of Newly Founded Businesses. *Small Business Economics*, 10, 213-225.

Bruneel, J., d'Este, P., Salter, A. (2010) Investigating the factors that diminish the barriers to university, industry collaboration, *Research Policy* 39: 858-868.

Burt, R. (1992) *Structural holes. The social structure of competition*. Cambridge, Mass: Harvard University Press.

Burt, R. (2005) *Brokerage and closure: An introduction to social capital*. Oxford and New York: Oxford University Press.

Chesbrough, H. (2003) *Open Innovation. The New Imperative for Creating and Profiting from Technology*. Cambridge: Harvard Business School.

Chowdhury, S. (2005) Demographic Diversity for Building an Effective Entrepreneurial Team: Is it Important? *Journal of Business Venturing*, 20(6), 727-746.

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., and Vohora, A. (2005) Spinning out new ventures: a typology of incubation strategies from European research institutions. *Journal of Business Venturing*, 20 (2), 183-216.

Clarysse, B., Wright, M., Lockett, A., Mustar, P. and Knockaert, M. (2007) Academic spin-offs, formal technology transfer and capital raising. *Industrial Corporate Change*, 16(4), 609-640.

Clercq D.D., Sapienza H.J., Yavuz R.I., Zhou L. (2012) Learning and knowledge in early internationalization research: Past accomplishments and future directions, *Journal of Business Venturing* 27, 143–165.

Colombo, M.G. and Grilli, L. (2005) Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy*, 34(6),795–816.

Colombo M.G. and Grilli L. (2010). On growth drivers of high-tech start-ups: exploring the role of founders' human capital and venture capital. *Journal of Business Venturing*, 26(6), 610-626.

Colombo, M.G. and Piva, E. (2011). Firms' genetic characteristics and competence-enlarging strategies: A comparison between academic and non-academic high-tech start-ups. *Research Policy*, 41 (1) 79-92.

Combes, P.P., Duranton, G. and L. Gobillon (2010) The identification of agglomeration economies, Working Paper University of Toronto.

Davis, L. (2005) Why do Small High-tech Firms Apply for Patents, and Why Not? Andersen, B. (Eds) Intellectual Property Rights: Innovation, Governance and the Institutional Environment, Edward Elgar.

Delmar, F. and Shane, S. (2006). Does experience matter: The effect of founding team experience on the survival and sales of newly founded ventures. *Strategic Organization*, 4 (3), 215–247.

D'Este, P. and Patel, P. (2007) University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy*, 36: 1295-1313.

Djokovic, D., Souitaris, V. (2008) Spinouts from academic institutions: a literature review with suggestions for further research. *Journal of Technology Transfer*, 33, 225-247.

Ebers, M. (2003) Geleitwort. In: I. Maurer: Soziales Kapital als Erfolgsfaktor junger Unternehmen. Eine Analyse der Gestaltung und Entwicklungsdynamik der Netzwerke von Biotechnologie Start-Ups. Wiesbaden: Westdeutscher Verlag.

Ensley, M. D. and Hmieleski, K. M. (2005) A comparative study of new venture top management team composition, dynamics and performance between university-based and independent start-ups. *Research Policy*, 34 (7), 1091-1105.

Ettlie, J.E., Bridges, W.P., and Okeefe, R.D. (1984). Organization Strategy and Structural Differences for Radical Versus Incremental Innovation, *Management Science* 30: 682-695.

Etzkowitz, H. (2008) *The Triple Helix: University-Industry-Government Innovation in Action*. London: *Routledge*.

Feeser, H. and Willard, G. (2006) Founding strategy and performance: A comparison of high and low growth high tech firms. *Strategic Management Journal*, 11(2), 87–98.

Feldman, M. (1999) The New Economics of Innovation, Spillovers and Agglomeration, *Economics of Innovation and New Technology*, 8, 5-25.

Fern, M.J., L. Cardinal, and O'Neill, H.M. (2012) The genesis of strategy in new ventures: Escaping the constraints of founder and team knowledge. *Strategic Management Journal*, 33, 427-447.

Fernandez-Alles, M., Camelo-Ordaz, C. and Franco-Leal, N. (2014). Key resources and actors for the evolution of academic spin-offs. *Journal of Technology Transfer*, online 21 December 2014.

Flåten, B-T, Isaksen, A, Karlsen, J. (2015) Competitive firms in thin regions in Norway: the importance of workplace-learning. *Norwegian Journal of Geography*, 69 (2), 102-111.

Freeman, J., Carroll G. R., and Hannan M. T. (1983) The liability of newness: age-dependence in organizational death rates. *American Sociological Review*, 48, 692-710.

Fried, A., Knoll, M., and Duschek, S. (2006) Networks of entrepreneurs revisited – dilemmatic settings and dysfunctional effects during company foundation processes. Institute of Innovation Research, Chemnitz University of Technology.

Furlan, A. and Grandinetti, R. (2014). Spin-off performance in the start-up phase–a conceptual framework. *Journal of Small Business and Enterprise Development*, 21(3): 528-544.

Geenhuizen, M. van, and Soetanto, D.P. (2009). Academic spin-offs at different ages: A case study in search of obstacles to growth, *Technovation*, 29 (10), 671-681.

GEM 2010: http://www gemconsortium org/docs/266/gem-2010-global-report

Geuna, A. and A. Muscio (2009) The Governance of University Knowledge Transfer: A Critical Review of the Literature, *Minerva* 47 (1), 93-114.

Gargiulo, B., and Bennassi, M. (2000). Trapped in Your Own Net? Network Cohesion, Structural Holes and Adaptation of Social Capital. *Organization Science*, 11(2), 183-196.

Gibson, C. B. and Birkinshaw, J. (2004) The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of Management Journal*, 47, 209–26.

Goddard J, Vallance P (2013) *The university and the city*, Routledge.

Gordon, I. and McCann, P. (2000) Industrial clusters' complexes, agglomeration and/or social networks? *Urban Studies*, 37(3), 513-532.

Grabher, G. (ed.) (1993) *The Embedded Firm. On the Socioeconomics of Industrial Networks*. London, Routledge.

Grandi, A. and Grimaldi, R. (2003). Exploring the Networking Characteristics of New Venture Founding Teams, *Small Business Economics*, 21 (4), 329-370.

Hambrick, D., Cho, T., Chen, M. (1996) The influence of top management team heterogeneity on firms' competitive moves, *Administrative Science Quarterly*, 41, 659-684.

Heine, K. and Rindfleisch, H. (2013). Organizational Decline - A Synthesis of Insights from Organizational Ecology, Path Dependence and the Resource-Based View. *Journal of Organizational Change Management*, 26 (1), 8-28

Henneke, D. and Lüthje, C. (2007) Interdisciplinary Heterogeneity as a Catalyst for Product Innovativeness of Entrepreneurial Teams. *Creativity and Innovation Management*, 16 (2) 121-132.

Hite and Hesterley (2001). The evolution of firm networks: from emergence to early growth of the firm. *Strategic Management Journal*, 22 (3): 275-286.

Horwitz, S. (2005) The compositional impact of team diversity on performance: Theoretical considerations. *Human Resource Development Review*, 4 (2), 219-245.

Horwitz, S. and Horwitz, I (2007) The effects of team diversity on team outcomes: A meta-analytic review of team demography, *Journal of Management* 6, 987-1015.

Huggins, R. and A. Johnston (2009) The economic and innovation contribution of universities: a regional perspective, *Environment and Planning C: Government and Policy*, 27, 1088-1106.

Hughes, A., Kitson, M., Probert, J.; Bullock, A. and Milner, J. (2011) Hidden connections – knowledge exchange between the arts and humanities and the private, public and third sectors. Cambridge University: AHRC-CBR.

Hussler, C., Picard, F., and M.F. Tang (2010) Taking the ivory from the tower to coat the economic world: Regional strategies to make science useful, *Technovation*, 30, 508-518.

Isaksen, A. (2015) Industrial development in thin regions: trapped in path extension, *Journal of Economic Geography*, 15 (3): 585-600.

Jansen, J.J.P., Tempelaar, M.P., Van den Bosch, F.A. and Volberda, H.W. (2009) Structural differentiation and ambidexterity: the mediating role of integration mechanisms. *Organization Science*, 20 (4): 797-811.

Johansson, M., Jacob, M., and Hellstrom, T. (2005) The strength of strong ties: university spin-offs and the significance of historical relations, *Journal of Technology Transfer*, 30 (3), 271-286.

Knight, G. A. and Cavusgil, S. T. (2004) Innovation, organizational capabilities, and the born-global firm. *Journal of International Business Studies*, 35 (2), 124-141.

Laursen, K. and Salter, A. (2006) Open for Innovation: The Role of Openness in Explaining Innovation Performance Among U.K. Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.

Lavie, D. (2006) The Competitive Advantage of Interconnected Firms, and Extension of the Resource-based View, *Academy of Management Review*, 31 (3): 638-658.

Leiponen, A., Helfat C.E. (2010). Innovation Opportunities, Knowledge Sources, and the Benefits of Breadth. *Strategic Management Journal* 31 (2): 224-236.

Levinthal, D. A. and March, J.G. (1993). The myopia of learning. *Strategic Management Journal*. 14, 95–112.

Lichtenthaler, U. (2012) Technological Turbulence and the Impact of Exploration and Exploitation Within and Across Organizations on Product Development Performance, *Entrepreneurship Theory and Practice*

Lindelöf, P. and Löfsten, H. (2004) Proximity as a Resource Base for competitive advantage: University–Industry links for technology transfer. *Journal of Technology Transfer*, 29(3), 311-326.

Lockett, A., Murray, G., Wright, M. (2002) Do UK venture capitalists still have a bias against high tech investments? *Research Policy*, 31, 1009-1030.

Lockett, A., Wright, M. (2005) Resources, capabilities, risk capital and the creation of university spin-off firms, *Research Policy*, 34 (7) 1043-1057.

Looy, B. van, Landoni, P., Callaert, J., Pottelsberghe, B. van, Sapsalis, E. and Debackere, K. (2011) Entrepreneurial effectiveness of European universities: an empirical assessment of antecedents and trade-offs. *Research Policy* 40: 553-564.

Lowe, R. A. 2002. *Invention, Innovation, and Entrepreneurship: The Commercialization of University Research by Inventor-Founded Firms*. Doctoral dissertation, University of California, Berkeley.

Maurer, I., Ebers, M. (2006) Dynamics of social capital and their performance implications: Lessons from biotechnology start-Ups. *Administrative Science Quarterly*, 51(2), 262-292.

McEvily, B. and Zaheer, A. (1999) Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal*, 20, 1133-1156.

McEvily, B. and Marcus, A. (2005) Embedded ties and the Acquisition of Competitive Capabilities, *Strategic Management Journal*, 26 (11): 1033-1055.

Mizruchi, M.S. and Stearns, L.B. (2001) Getting deals done: The use of social networks in bank decision-making. *American Sociological Review*, 66 (5), 647-671.

Mohr, J., Sengupta, S. and Slater, S. (2005) Marketing of High Technology Products and Innovation. Pearson/Prentice Hall (2nd edition).

Moray, N., and Clarysse, B. (2005) Institutional change and resource endowments to science-based entrepreneurial firms. *Research Policy*, 34 (7), 1010-1027.

Mowery, D., Nelson, R, Sampat, B. and A. Ziedonis (2004) *Ivory Tower and Industrial Innovation. University-Industry Technology Transfer Before and After the Bayh-Dole Act*. Stanford Business Press, Stanford, California.

Muscio, A., and Pozzali, A. (2013). The effects of cultural distance in university-industry collaborations. Some evidence from Italian universities. *Journal of Technology Transfer*, 38 (4): 486-508.

Mustar, P., Renault, M., Colombo, M.G., Piva, E., Fontes, M., Locket., A., Wright, M., Clarysse, B., Moray, and N., (2006) Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. *Research Policy*, 35 (2), 289-308.

Mustar, P., Wright, M., and Clarysse, B. (2008). University spin-off firms: Lessons from ten years of experience in Europe. *Science and Public Policy* 35(2): 67-80.

Myers, S.C. (1984) The Capital Structure Puzzle. *The Journal of Finance*, 39, 574–592.

Myers, S.C., Majluf, N.S. (1984) Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13(2), 187-221.

Niosi, J. (2006) Success Factors in Canadian Academic Spin-Offs, *The Journal of Technology Transfer*, 31 (4): 451-457.

Nooteboom, B. (2009) *A Cognitive Theory of the Firm. Learning, Governance and Dynamic Capabilities.* Cheltenham: Edward Elgar.
Onkelinx, J., Manolova, T.S., Edelman, E.F. (2016) Human capital and SME internationalization: Empirical evidence from Belgium. *International Small Business Journal* 34 (6), 818-837.
Oviatt BM and McDougall PP (1994) Toward a theory of international new ventures. *Journal of International Business Studies* 25 (1): 45-64.
Pelled, L. H. (1996) Demographic diversity, conflict and work group outcomes: An intervening process theory. *Organization Science*, 7(6) 615-631.
Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy*, 42: 423–442.
Prashantham, S. (2005) Toward a knowledge-based conceptualization of internationalization. *Journal of International Entrepreneurship* 3(1): 37-52.
Rasmussen, E. and Borch, O.J. (2010) University capabilities in facilitating entrepreneurship: A longitudinal study of spin-off ventures at mid-range universities. *Research Policy* 39 (5), 602-612.
Rasmussen, E., Mosey, S., and Wright, M. (2014) The Influence of University Departments on the Evolution of Entrepreneurial Competencies in Spin-off Ventures. *Research Policy* 43 (1): 92–106.
Reagans, R. E. and B. McEvily (2003) Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly*, 48, 240-267.
Rickne, A. (2006) Connectivity and Performance of Science-based Firms. *Small Business Economics* 26, 393-408.
Robbins, S. P. and Judge, T. A. (2011) *Essentials of Organizational Behavior* (11th ed.). Essex: Pearson.
Rodriguez-Gulias, M.J., Rodeuro-Pazos, D., and Fernández-López, S. (2017) The growth of university spin-offs: a dynamic panel data approach." *Technology Analysis & Strategic Management*, DOI:10.1080/09537325.2016.1277580.
Rothaermel, F.T., Thursby, M., 2005 Incubator firm failure or graduation?: The role of university linkages. *Research Policy*, 34 (7), 1076-1090.
Pérez, M.P. and Sánchez, A.M. (2003) The development of university spin-offs: early dynamics of technology transfer and networking. *Technovation*, 23 (10) 823-831.
Pirnay, F., Surlemont, B., Nlemvo, F. (2003) Toward a Typology of University Spin-offs. *Small Business Economics*, 21 (4), 355-369.
PRO INNO EUROPE (2011) The Innovation Union's Performance scoreboard for Research and Innovation, (online) http://ec.europa.eu/enterprise/policies/innovation/files/ius-2011_en.pdf, accessed on 01/10/2012.
Saetre, A., Atkinson, O., Ellerås, B. (2006) University Spin-offs and Technology Commercialization, A comparative study between Norway, Sweden and the United States, Trondheim: NTNU.
Semadeni, M. and Cannella, A.A. (2011) Examining the performance effects of post spin-off links to parent firms: should the apron strings be cut? *Strategic Management Journal*, 32, 1083-1098.
Shane, S. (2004) *Academic Entrepreneurship. University Spin-offs and Wealth Creation.* Northhampton (MA): Edward Elgar.
Shane, S. and Stuart, T., (2002). Organizational endowments and the performance of university start-ups. *Management Science* 48 (1), 154–171.
Shrivastava, M. and Rao, T.V.S.R.. (2015). Organisational synergies, dissonance and spinoffs. *International Journal of Economics and Business Research*, 9 (1), 54-64.
Siegel, D.S., Waldman, DA., Atwater, L.E. and Link, A.N. (2003) Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *Journal of High Technology Management Research*, 14 (1), 111-133.
Siegel, D., S. and Wright, M. (2015) Academic entrepreneurship: time for a rethink? *British Journal of Management*, 26 (4): 582-592.
Simsek, Z. (2009). Organizational ambidexterity: Towards a multilevel understanding. *Journal of Management Studies*, 46 (4), 597-624.
Sorenson, P. and Waguespack, D.M. (2005) Research on social networks and the organization of research and development: an introductory essay. *Journal of Engineering and Technology Management*, 22 (1/2), 1-7.
Stinchcombe, A.L. (1965). Social structure and organizations, in J. March (ed) *Handbook of Organizations*, Rand McNally, Chicago, 142–193.
Taheri, M. (2013) From Mind to Market at University. PhD dissertation, TPM, TU Delft.
Taheri, M., and Geenhuizen M. van. (2016) Team's boundary-spanning capacity at university: Performance of technology projects in commercialization. *Technological Forecasting and Social Change*, 111: 31-43.
Teixeira, A.A.C. and Coimbra, C. (2014) The determinants of the internationalization speed of Portuguese university spin-offs: an empirical investigation. Journal of International Entrepreneurship, 12, 270-308.

Thorgren, S., Wincent, J. and Eriksson, J. (2011) Too small or too large to trust your partners in multipartner alliances? The role of effort in initiating generalized exchanges. *Scandinavian Journal of Management*, 27 (1), 99-112.

Tidd, J., Bessant, J. (2009) *Managing Innovations. Integrating Technological, Market and Organizational Change*, 4th edition, John Wiley.

Trencher, G., Yarime, M., McCormick, K.B., Doll, C.N.H. and Kraines, S.B. (2014) Beyond the third mission: Exploring the emerging university function of co-creation for sustainability. *Science and Public Policy*, 41, 151-179.

Ulhøi, J.P. (2005) The social dimensions of entrepreneurship. *Technovation*, 25, 939-946.

Utterback, J. (1996) *Mastering the Dynamics of Innovation*. Harvard Business School Press.

Vanaelst, I., B. Clarysse, M. Wright, A. Lockett, et al. (2006). Entrepreneurial Team Development in Academic Spinouts: An Examination of Team Heterogeneity. *Entrepreneurship Theory and Practice*: 1042-2587.

Vrande, V.J.A. van der, Jong, J.P.J. De, Vanhaverbeke, W., and Rochemont, M. De (2008). Open innovation in SME's: trends, motives and management challenges. *Technovation*, 29 (6): 423-437.

Villena, V.H., Revilla, E., and Choi, T.Y. (2011) The dark side of buyer–supplier relationships: A social capital perspective. *Journal of Operations Management*, 29 (6), 561-576.

Vohora, A. Wright, M. and Lockett A. (2004) Critical junctures in the development of university high-tech spin-out companies. *Research Policy* 33 (1), 147-175.

Walter, A., Auer, M. and Ritter, T. (2006) The impact of network capabilities and entrepreneurial orientation on university spin-off performance. *Journal of Business Venturing* 21, 541–567.

Wennberg, K., Wiklund, J. and Wright, M. (2011) The effectiveness of university knowledge spillovers: Performance differences. *Research Policy* 40, 1128-1143.

Wiklund, J., Patzelt, H., Shepherd, D. (2009) Building an integrative model of small business growth. *Small Business Economics*, 32 (4), 351-374.

Williams, K. Y. and O'Reilly III, C. A. (1998) Demography and diversity in organizations: A review of 40 years of research. In B. M. Staw and L. L. Cummings (Eds), *Research in Organizational Behavior*, 20, 77–140.

Wright, M., Hmieleski, K.M., Siegel, D.S. and Ensley, M.D. (2007) The role of human capital in technological entrepreneurship. *Entrepreneurship, Theory and Practice*, 31 (6), 791-806.

Wright, M., Piva, E., Mosey, S. and Lockett, A. (2009) Academic entrepreneurship and business schools, *The Journal of Technology Transfer*, 34 (6), 560-587.

Appendix 1 Measurement of diversity in social networks

Social network diversity is calculated as the product of socio-economic background diversity and local/regional diversity, as follows:

$$Div = Hs\ (1 + \frac{EI}{2}) \quad (1)$$

and

$$Hs = 1 - \sum_{k=1}^{8}(\frac{a_k}{N})^2 \quad (2)$$

where a_k is the number of partners with a different socio-economic background, and where $k = 1\ (large\ business), 2\ (university)\ \ 3\ (small\ business), 4\ (government),$ $5\ (family\ or\ friends), 6\ (financial\ investor), 7\ (lead\ customer),\ 8\ (others)$. N is the total number of partners with whom a spin-off interacts. Note that a partner could be assigned to only one partner type (main identity). In addition, spatial orientation is calculated as:

$$EI = \frac{E_p - I_p}{E_p + I_p} \quad (3)$$

where E_p is the number of external, non-local, partners, at more than 60 minutes by car, and I_p is the number of local partners ($E_p + I_p = N$). A high value indicates a relatively strong external orientation and access to new circles. Overall, the spin-offs in our sample face an average score on openness of 0.35, however, scores close to one also occur (Table 1).

Appendix 2

We apply augmented regression test (DWH test) to test for endogeneity in the *employment growth* model, using diversity through international networks as instrument variable. Accordingly, we first perform the original regression model and then include the residuals in an augmented regression. If the coefficient of the residual is not significantly different from zero, OLS is not consistent. In this case, F(1,86)=0.00 and Prob > F=0.95, we conclude that the OLS results are consistent and there is no problem of endogeneity. Because we also assume that employment growth may influence diversity from social networks, we again check for the existence of endogeneity. Using Durbin-Wu-Hausman test, the outcome, F(1,86)=1.90, Prob > F=0.171, indicates that OLS results are consistent with absence of endogeneity problem. We also check for endogeneity in the *turnover growth* model, taking diversity through international networks into account. Because the residual is found to be different from zero at 10% level, F(1,85)=3.40, Prob>F=0.068, we conclude that the estimates are consistent at 5% test level.

Appendix 3 Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1 Employment growth	1											
2 Turnover growth	0.71 **	1										
3 Year of founding	-0.16*	-0.31 **	1									
4 Business ecosystem (metropolitan=1)	0.24 *	0.19 *	-0.23 *	1								
5 Initial EO	0.38 **	0.24 *	0.05	-0.02	1							
6 Founding team education level	-0.18 *	-0.03	0.09	-0.14	0.04	1						
7 Founding team size	0.06	0.05	0.14	-0.08	-0.01	-0.16	1					
8 Pre-start experience diversity	-0.18 *	-0.19 *	-0.10	-0.09	-0.07	0.15	-0.32 **	1				
9 Education diversity	-0.00	-0.12	-0.18 *	0.10	0.01	0.06	-0.67 **	0.34 **	1			
10 Invention experience diversity	-0.14	-0.01	-0.04	-0.34 **	-0.07	0.54 **	-0.24 *	0.45 **	0.16	1		
11 Social network diversity	0.32 **	0.25 **	-0.10	-0.21 *	0.22 *	0.12	0.03	0.14	0.11	0.18	1	
12 Internationalization reach diversity	0.12	0.21*	-0.07	-0.14	-0.05	0.29 **	-0.11	0.00	0.23 *	0.17	0.41 **	1

*P<0.05, **P<0.01,

a) Spearman correlation coefficients.