

Outside Board Members in High Tech Start-ups

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ABSTRACT. Board composition in large organizations has been subject to much empirical research, however, little attention has been focused on board composition in start-ups, and more specifically high tech start-ups. This lack of research is surprising given that many high tech start-ups have multiple equity stakeholders such as venture capitalists or public research organizations, such as universities. Given that high tech start-ups are commonly resource-poor these external stakeholders may play an important role in accessing critical external resources. Drawing on agency theory, resource dependence theory and social network theory we examine the tensions that exist between the founding team and external equity stakeholders in determining the presence of outside board members. In particular we focus on whether or not the outside board members have either complementary or substitute human capital to the founding team. We test our model on a sample of 140 high tech start-ups in Flanders. Our results indicate that high tech start-ups with a public research organization as an external equity stakeholder are more likely to develop boards with outside board members with complementary skills to the founding team.

KEY WORDS: agency theory, board, board composition, corporate governance, founding teams, high tech start-up, resource dependency, university spin-off, venture capital

JEL CLASSIFICATION: L2

1. Introduction

The literature on board composition has almost exclusively focused on large publicly held

companies (Daily et al., 1998; Lynall et al., 2003). Only recently, research has explored the role and contribution of outside directors in small and medium sized enterprises (SMEs) (Huse, 2000, 2005). The study of board composition in SMEs is different from the study of board composition in large firms as SMEs are characterized by a lack of internal resources (Daily et al., 2002; Huse, 2000). Therefore, it is argued that boards in SMEs engage less in monitoring activities but rather act more as advisors to the managers (Ward, 1989). Only recently, however, has research on the presence and evolution of boards in start-ups begun to emerge (Filatotchev and Wright, 2005; Wasserman and Boeker, 2005). To date, one subgroup of SMEs that has remained largely unstudied with respect to board activity is high tech start-ups. We find this dearth of research surprising given that high tech start-ups are typically resource-poor and frequently have important external equity stakeholders such as providers of risk capital (e.g. venture capital firms) or providers of external technology (e.g. universities or public research organizations). We argue that these external equity stakeholders will influence the presence of outside board members, which in turn may play an important role in providing access to external resources.

Agency theory suggests that outside board members may play an important monitoring function at the moment external stakeholders, such as venture capital (VC) firms and PROs (public research organizations – which include universities), get involved in the start-up. The external stakeholders will require outside board members to monitor financial disclosures and insider transactions with a sufficient level of external scrutiny and according to a prescribed set of expectations (Lynall et al., 2003).

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In addition to a monitoring function, outside board members are considered to have an important value-adding role to play in the development of high tech start-ups. High tech start-ups face the liability of smallness and the liability of newness (Henderson, 1999). The liability of smallness arises because small firms are unable to buffer themselves from market contractions due to the lack of financial resources and managerial weaknesses (Aldrich and Auster, 1986; Kale and Ardit, 1998). The liability of newness arises as the new firm needs to establish stable exchange relationships with clients, creditors, suppliers and other organizations. At the same time, new firms are able to adapt and to compete in new and dynamic environments, and thus obtain “learning advantages of newness” (Autio et al., 2000). These learning advantages however do not remove the liabilities of newness that are caused by lack of reputation, social capital and tangible resources (Aldrich, 1999; Hannan and Freeman, 1977). The human capital and networks (or relational capital) of outside board members may therefore be important resources in helping firms overcome the liability of newness and smallness (Deutsch and Ross, 2003; Hillman and Dalziel, 2003; Rosenstein, 1988) and may enhance the credibility and performance of the firm they serve (Certo et al., 2001).

The presence of outside board members, however, is a necessary but not sufficient condition for the board to add value to the start-up. Outside board members can either bring human capital that is a complement to, or a substitute for, the human capital of the founding team. We define human capital, following Becker (1975), as a function of experience, education, expertise and reputation.

Where outside board members have human capital that is complementary to the founding team, the value added in terms of networks, experience and access to external resources may be substantial. Conversely, where outside board members have human capital that is substitute of the founding team the value added in terms of networks, experience and access to external resources may be limited. In this paper we analyze the conditions under which firms install outside board members with complementary or

substitute human capital to the founding team. Drawing on agency theory, resource dependence theory and social network theory we build a model to examine the tensions that exist between the different equity stakeholders in determining outside board members. We test our model on a sample of high tech start-ups located in the Flanders region of Belgium. The advantage of using this high tech region is that it provides us with a sample that is homogenous in terms of context. The situation of this economic region is comparable to most emerging and developing high tech regions in Europe (Heirman, 2004). The venture capital industry is however quite distinct, with a large number of small and regional VCs covering the market.

The remainder of the paper is structured as follows. First, we provide an overview of the literature on board creation and composition. Second, we develop a model, with an accompanying set of hypotheses. Third, we present the sample frame, the sample itself and the data collection techniques employed in the study. Fourth, we present the results. Finally, we conclude and outline recommendations for future research and implications for practice.

2. Theoretical background

Agency theory suggests that boards of directors are formed to monitor managers on behalf of their shareholders (Eisenhardt, 1989; Jensen and Meckling, 1976). Powerful external stakeholders, therefore, may insist on the presence of outside board members (Fama and Jensen, 1983; Jensen and Meckling, 1976). In high tech start-ups, external stakeholders commonly are linked to the firm by either the provision of finance or technology. Equity providers may be a venture capitalist that invested alongside management due to the firm’s potential for significant economic returns (Gabrielsson and Huse, 2005). Alternatively, an equity provider may be an academic institution or a public research organization (PRO) that provided the technological resources for starting up the new venture (Clarysse and Moray, 2004). The fact that external equity stakeholders will demand the presence of outside board members to monitor their interests is a well established finding in the literature (see

for example: Fiegner et al., 2000; Gompers and Lerner, 2001; Gorman and Sahlman, 1989; Huse, 1998; Mitchell et al., 1997; Pruthi et al., 2003; Rosenstein, 1988).

External stakeholders may insist on outside board members but the question remains who do they select as outside board members? We argue that there are two conflicting perspectives which might explain the selection of outside board members. First, a resource dependency perspective suggests that new board members will be attracted using rational criteria to increase the diversity in the board (Hillman and Dalziel, 2003). In order for the board to monitor a venture effectively, the board should be comprised of individuals with a range of different human and social capital that complement one another. Second, a social networks perspective suggests that board members will be attracted from the social network of the stakeholders in power, be it the founding team or the external stakeholder such as the VC or PRO (for which the Technology Transfer Officer [TTO] of the organization would act in their interest). This perspective, arguably, may not result in the board diversity but in the attraction of new members that belong to the same network, regardless the diversity they might introduce in the board. Below we outline the two theoretical perspectives and their implications for board composition.

First, resource dependency theory views the firm as an open system, which is dependent on external organizations for the supply of key resources (Pfeffer and Salancik, 1978). The survival and success of a firm is dependent on the managers' abilities to manage the dependency of the firm on external resource providers (Pfeffer and Salancik, 1978). Blau (1964) argues that firm strategy under resource dependency is to gain independence from one's environment. In the case of high tech start-ups, and other entrepreneurial ventures, the mentoring role of the board may be more important than the monitoring role (Fiegner et al., 2000; Wasserman and Boeker, 2005). Existing research has focused on the roles played by board members which include: advice and counseling, provision of legitimacy, acting as a communication channel, and provision of

access to resources (e.g. Deakins et al., 2000; Rosenstein et al., 1993). The provision of resources and access to resources highlights the dependence that new ventures have on their environment. Consequently the management of start-ups will try to acquire, access or develop resources that are strategic or scarce. Given the limited resource-base of a start-up, an outside board has the potential to be an excellent vehicle to obtain access to such scarce and/or strategic resources (Lynall et al., 2003). Employing a resource-dependency logic, outside board members will be chosen to maximize the provision of strategic and/or scarce resources to the firm. Consequently, firms will attract outside board members in order to initiate and maintain control over relationships, assets and contacts in the external environment of the firm (Gabrielson and Huse, 2005). Hence, resource-dependency logic leads to the selection of outside board members that bring complementary resources to the company.

Second, social network theory provides an alternative insight into outside board composition. Social network theory examines how existing relationships influence behavior. In particular, the social networks of individuals, and more specifically their embedded relationships, will both facilitate and constrain behavior (Granovetter, 1985). Employing social network theory we argue that rather than attracting board members based on the complementarity of human capital and social capital, board members may be recruited from their existing social network. These individuals are likely to have embedded relationships with the firm stakeholder because of the need for a good working relationship when acting in the stakeholder's interests (see Uzzi, 1997). Consequently, the composition of the board may reflect the social networks of the principal stakeholders, such as the CEO and external financiers (Lynall et al., 2003). The attraction of individuals from existing social networks may also reflect a desire by external stakeholders to attract individuals similar to themselves (Forbes et al., 2006). The social network perspective thus leads us to suggest that founding teams or external capital or technology providers will recruit board members from their own social networks. Consequently,

given that the attraction and generation of human capital is highly determined by social capital (Serageldin and Dasguptan, 2001), external stakeholders will attract individuals with similar human capital to themselves.

In the next section we examine how the presence of external equity stakeholders, and more specifically venture capitalists (VCs) or public research organizations (PROs), may influence presence of outside board members. In particular, we examine the conditions under which the human capital of the outside board members may be complementary to, or a substitute for, the human capital of the founding team.

3. Model development

In this section we build on the theoretical perspectives outlined above to develop a model of the impact of external stakeholders on the presence of outside board members. The range and nature of different organizational stakeholders has been subject to debate (see Dimovski and Brooks, 2004). Our focus in this paper is on primary equity stakeholders, namely those stakeholders that are, following Clarkson (1995), shareholders, investors, employees, customers, suppliers, government or communities, and that have an equity stake in the company. Employing this definition, equity stakeholders can be internal to the company, meaning that they are part of the founding team, or external, meaning that they own an equity stake in the company but are not part of the founding team. In constructing our arguments we focus on the extent to which outside board members have complementary or substitute human capital to the founding team. Outside board members are defined as complementary if their skills and experience are not present within the founding team, and substitutes if they have similar skills and experience to the founding team. We begin by examining the case where the high tech start-up has no external equity stakeholder and then continue to examine the cases where the PRO and the VC are external equity stakeholders.

As outlined above, outside board members may be an important resource for the founding

team of a high tech start-up. In the absence of external equity stakeholders – such as VCs or PROs – the founding team may still form an outside board. Members of the founding team may look to attract outside board members with complementary human capital in order to reduce their resource dependency. The problem facing founding teams is that due to their limited social networks the attraction of complementary outside board members may not always be possible. The presence of complementary outside board members may therefore be limited in the absence of external equity stakeholders. Although it may be in the best interests of the venture commercially to attract board members with complementary human capital, the impact of the founding team's social networks will have the overriding effect. Therefore, in the absence of external equity stakeholders outside board members will reflect the founding team's social networks and human capital of the outside board members will be a substitute for the human capital of the founding team. Hence:

H1 In high tech start-ups with no external equity stakeholders the human capital of outside board members will be a substitute for the founding team's human capital.

The power of the external equity stakeholders (VCs and PROs) to influence the presence of outside board members reflects the fact that they have provided resources that are important to the development of the venture such as the finance or technology. Building on the arguments above we contend that where external equity stakeholders are present outside board members will reflect their own social networks rather than those of the founding team. In effect, the social capital of the external stakeholders will influence their ability to attract outside board members with complementary human capital to the founding team. This is because if the external stakeholders look within their own networks in order to attract outside board members the nature of their social capital means that they are likely to attract individuals with similar human capital to themselves.

First, we examine the role of the PRO as a potential equity stakeholder in high tech start-

up firms. High tech start-ups that originate from PROs (henceforth academic high tech start-ups) are a vehicle for the direct commercialization of intellectual property developed and as such are a source of economic growth and can provide significantly higher revenues to PROs than licensing (Bray and Lee, 2000). The number of academic high tech start-ups has increased significantly in recent years (Nicolaou and Birley, 2003). The PRO will be an external equity stakeholder if the high tech start-up originated from a PRO, and is dependent on the PRO for the formal transfer of the intellectual property (IP).¹ As the PRO controls a strategically important resource, the PRO has power over the founding team. Hence the PRO will be able to influence the composition of the board.

Academic high tech start-ups are interesting because of the historic non-commercial environment of many PROs. Schmoch (1999) indicates that PROs have become increasingly involved in Industry-Science Relations, however, this does not mean that the PROs have become akin to corporate venturing companies. He argues that the nature of these relations are however technological, and defines "technology transfer" as equivalent to "exchange of technology-related knowledge" (Schmoch, 1999). Furthermore, Allen and Taylor (2005) indicate that many PROs have either no mechanisms or only ineffective mechanisms in place to prepare researchers for dealing with strategic partners, money sources or potential customers. These findings suggest that PROs will draw outside board members from their own networks which are predominantly scientific in nature. Given that the attraction and generation of human capital is highly determined by social capital (Serageldin and Dasgupta, 2001), we anticipate that the backgrounds of these outside board members will be scientific in nature. Evidence of this practice is provided by Clarysse and Moray (2004) who describe how PRO management tends to install their own professors or members of the technology transfer office as outside board members.

Building on the arguments above, in the case of founding teams with mainly scientific R&D experience, and which rely on the PRO for critical technological resources, the outside board

members will have human capital that is a substitute for that of the founding team. The problem is that the outside board members will be drawn from the predominantly scientific networks of the PRO. Conversely, in teams that mainly consist of people with commercial and/or financial skills, the outside board members will have human capital that is complementary to that of the founding team, given that this human capital is expected to be mainly built on R&D experience. This leads us to the following hypotheses:

H2a In high tech start-ups with founding teams characterized by high levels of R&D human capital, where the PRO is an external equity stakeholder, the human capital of the outside board members will be a substitute for the human capital of the founding team.

H2b In high tech start-ups with founding teams characterized by high levels of commercial or financial human capital, where the PRO is an external equity stakeholder, the human capital of the outside board members will be a complement to the human capital of the founding team.

Finally, we examine the case where a VC firm is an external equity stakeholder in a venture. The presence of a VC firm shifts decision making power over the presence of outside board members from the founding team, which is in need of financial capital, to the VC firm. Employing social network theory we argue that where a VC firm is an external stakeholder the human capital of outside board members will reflect the social networks of the VC firm rather than the need for complementary human capital.

In the venture capital literature there has been an extensive discussion about the potential value adding role which venture capitalists may play through the introduction of outside board members (Sapienza, 1992). Research suggests that VC firms add little or no value added in terms of commercial support (Rosenstein et al., 1993). Rather, VC firms tend to support managerial strategy initiatives rather than developing strategies themselves (Fried et al., 1998). This finding is not surprising given that the VC firm's human capital tends to be highly related to

experience in financial management as opposed to actual business experience or experience of a high tech sector (Knockaert, 2005). Therefore, where the VC firm is an external equity stakeholder the human capital of outside board members will be in the area of financial management.

Building on the above arguments we argue that when the VC firm is an external stakeholder and the founding team has mainly R&D or commercial experience the human capital of outside board members will be complementary to the founding team's human capital. Conversely, where the VC firm is an external stakeholder and the founding team mainly has financial experience, the human capital of outside board members will be a substitute for the human capital of the founding team. This discussion leads to the following hypotheses:

H3a In high tech start-ups with founding teams characterized by high levels of R&D or commercial human capital, where the VC firm is an external equity stakeholder, the human capital of outside board members will be a complement to the human capital of the founding team.

H3b In high tech start-ups with founding teams characterized by high levels of financial experience, where the VC firm is an external equity stakeholder, the human capital of outside board members will be a substitute for the human capital of the founding team.

The research model developed in this section is summarized in Figure 1. Hypothesis 1 considers human capital of the board where no external equity stakeholders are present. In the absence of an external equity stakeholder, the human capital of outside board members will reflect the social networks of the founding team. Hypotheses 2a and b and 3a and b suggest that the composition of the board, in terms of the degree to which the human capital of the outside board members is a complement or a substitute to the human capital of the founding team, will be dependent on the social networks of the external equity stakeholder.

4. Methods and data

4.1. The sample

The high tech start-ups in this research are defined as new ventures, which have their own R&D activities and develop and commercialize new products or services based upon a proprietary technology or skill. Our sample of high tech start-ups is drawn from the Flanders region of Belgium. Flanders is a small, export-intensive economy, located in the northern part of Belgium. We selected Flanders because it is considered to be an emerging high tech region (Cantwell and Iammarino, 2001). The advantage of using this region is that it provides us with a sample that is homogenous in terms of context, without losing the generalizability of

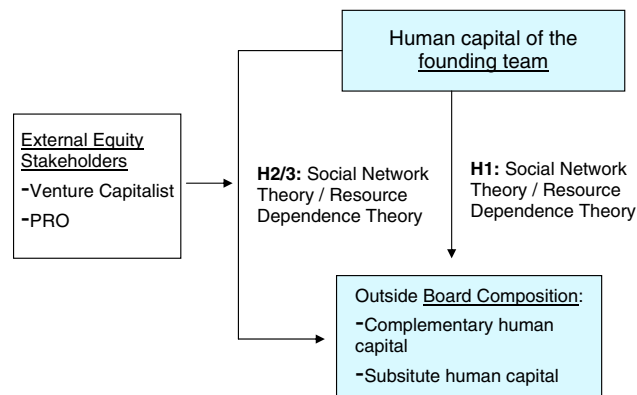


Figure 1. Research model.

the research results. The region has a relatively high R&D intensity, and has venture capital funds on the market that invest in the early phase of a high tech start-up. The R&D intensity of the region is comparable to that of Denmark and France, with only a few European countries having a higher R&D intensity (Sweden, Germany and Finland). If we consider the number of early stage investments as percentage of GDP, it is at a similar level of France, the Netherlands and Germany, but below Finland, Sweden and the UK.

To construct the sample frame, first we identified all the high tech start-ups at PROs, venture capital backed firms, and start-ups that received R&D subsidies. Second, we complemented our sample with a random selection drawn from the entire population of companies that are active in high-tech and medium high-tech industries. In total, our sample comprises 225 firms founded in Flanders (Belgium) since 1991 till 2000.

For this study, data on the board of directors was collected for 140 companies. To judge whether the sample of 140 companies could be used to make inferences about the whole sample (225 companies), *t* tests and chi-square tests were performed on all relevant variables, including sector, company size and age, institutional origin, founding team characteristics and VC financing. Differences were significant for academic origin, the sector and the size of the founding team. The sub sample contained a higher proportion of high tech start ups from academic PROs, a lower proportion of IT companies and had larger founding teams compared to the total sample. We account for these differences when commenting on our findings.

The 140 firms in our sample cover a wide range of technologies, including software (35%), micro-electronics (13%), medical-related technologies (16%), and others (36%). Thirty two per cent of the companies originated from a PRO. Twelve per cent of the companies had received VC financing at time of start-up or within the first 18 years after founding, while another 38% have received external capital from other sources such as business angels, the university fund or informal investors. The

companies in the sample had on average received 0.46 million Euro of external start-up financing.

The average size of the founding team is 2.36 people, with the smallest founding team having only 1 member and the largest 7 members. The background and experience of these founders is quite diverse, however, reflecting their technological origin. At founding 76% of the teams had R&D experience, 33% had commercial experience and 6% had financial experience. Finally, 35% had previous experience in another function, ranging from production to legal, consulting and engineering experience.

4.2. Data collection

The primary data source is a structured questionnaire, which enables the reconstruction of the firm's history and particularly focuses on the firm's resources, products, market characteristics, corporate governance and employees. The questionnaire was developed based on the existing literature on initial resources and organization and underwent pre-tests with entrepreneurs and sector experts. The questionnaire was conducted during personal interviews with the founder or CEO by a team of two researchers during the period 2001–2005. The founder or CEO was targeted because they typically possess the most comprehensive knowledge on the organization's history, the firm's strategy, its processes and performance (Carter et al., 1994). The information obtained during the interviews was cross-checked with secondary data sources such as Belfirst where possible.

4.3. Measurement of dependent variables

To test H1, H2a/b, H3a/b, we employed two concepts in our model, which we labeled human capital complementarity and human capital substitution of outside board members. To measure human capital complementarity of outside board members we counted the number of outside board members that had complementary experience to the founding team. We distinguish between three categories of experience: R&D, commercial and financial experience. An outside board member is defined as

being complementary to the founding team when he or she has experience in a category where none of the founding team members has experience. We measure human capital complementarity of outside board members as the number of outside board members that have complementary experience to the founding team. Conversely, human capital substitution by the board is measured as the number of outside board members that had substitute experience to at least one of the founding team members. As with the human capital complementarity of outside board members we use three categories of experience to measure substitutability of human capital.

The firms in our sample on average had 1.32 board members that were complementary to the founding team (standard deviation of 1.30), with a minimum of 0 and a maximum of 5. They had on average 0.89 board members that were substitute to the founding team (standard deviation of 1.13), with a minimum of 0 and a maximum of 5.

4.4. *Measurement of independent variables*

4.4.1. *Academic origin*

The academic or non-academic origin of a high tech start-up was captured using a binary variable that took the value of 1 if the company had originated from a PRO and 0 otherwise.

4.4.2. *Venture capital financing*

We constructed a binary variable that took the value of 1 if the company had received venture capital within the first 18 months after start-up and 0 otherwise. The venture capital situation in Flanders is quite specific, with only one VC managing substantial funds (GIMV) and a high number of funds managing relatively small sums of money. Few foreign VCs are active in Belgium at an early investment stage (EVCA, 2004). Foreign investments are mainly made at the buy-out stage. Foreign early stage funds are not very active on the market due to a lack of credible Belgian syndication partners (such as GIMV, Capricorn Partners).

4.4.3. *Human capital of the founding team*

We employ three different categories of human capital experience – R&D, commercial and financial experience. Commercial experience was defined as management or commercial experience within a company, ranging from sales management to business development. Financial experience is experience in audit, accounting, banking or other financial sectors. R&D experience is defined as experience in an R&D function within a corporate environment or in research in a research institution. The degree of experience in a particular category (e.g. R&D, commercial or financial) is defined as the cumulative number of years experience in a particular category divided by the total experience of all team members measured in number of years.

To measure outside board member complementarity or substitutability, we construct a new variable which is the interaction between the presence of a stakeholder such as a VC or a PRO and the degree of R&D, commercial or financial experience. The interaction term between the external stakeholder dummy and the experience in the founding team indicates the extent to which the external stakeholder has an impact on the composition of the board. For instance, if the interaction term between the presence of a VC stakeholder and the degree of financial experience in the founding team is positive and significant in the regression model (which explains the availability of substitute outside board members) VC firms will attract outside board members with financial experience regardless the available human capital in the founding team.

In the regression analysis we employ interaction terms for the three categories of experience (R&D, commercial and finance) and two external stakeholders (VC firms and PROs).

4.5. *Control variables*

4.5.1. *Founding year*

We control for the age of the company by taking into account the year of founding of the firms in the sample. All the sample firms were founded between 1988 and 2002.

4.5.2. Industry sector

To control for industry effects we differentiate IT based companies and non-IT based companies. We define the dummy variable as 1 if the company is operating in the IT sector and 0 if the company is operating in another sector such as biotech and microelectronics. We employed this variable to capture institutional characteristics which lead to mimetic isomorphism (Dimaggio and Powell, 1983).

4.5.3. Sector experience founding team

We control for the number of founders that have experience in the sector the company operates in. The sector is defined as IT or non-IT. The variable ranges between 1 and 3, and takes into account the cumulative sector experience of the founding team members in the same sector as the start-up. The variable takes value 1 if the founding team has cumulative sector experience of less than 3 years, 2 if the cumulative sector experience is between 3 and 6 years and 3 if the cumulative sector experience is higher than 6 years.

4.5.4. Degree of team heterogeneity

Following Ucbasaran et al. (2003) we employ Teachman's (1980) scale to measure the heterogeneity of the team: $(H) = -TP_i (\ln P_i)$. This measure takes into account how team members are distributed among the different categories of a variable. The total number of categories of a variable equals 3, namely R&D experience, commercial experience and financial experience. P_i is defined as the number of years experience in function over the total team experience (measured as the number of years).

4.6. Statistical method and model specification

In order to model the effects of the influence of the external equity stakeholders and the nature of the founding team on outside board member complementarity or substitutability we first had to address a potential selection bias problem. The selection bias problem may arise because ventures without outside board members will receive a figure of zero for board complementarity and substitution. It is well known that

simply omitting such observations from the analysis can lead to biased estimates. One approach would be to estimate both decisions together using a Tobit model. This approach, however, involves the restrictive assumption that variables that explain the propensity decision are exactly the same as those that affect export intensity. In our view there is little *a priori* evidence that this should be the case, hence we employ the Heckman two-stage selection model (see, for example, Greene, 2000, 926–937). Stage 1 involves estimating the existence of outside board members using a probit model. Stage two involves estimating board complementarity and substitution with the coefficients adjusted according to the results of the first stage. To do this we include the standard residual of the auxiliary regression (selection model) in our regression models.

4.6.1. Selection model

In a first stage where we measured the presence of outside board members in a high tech start-up, we employed a binary logistic regression where 0 = no outside board members and 1 = outside board members. The model took the form (Equation 1):

$$\text{Outside board members} = F(\text{academic origin, VC finance, controls}). \quad (1)$$

The control variables took the form of a vector of firm/industry variables including founding year, IT sector, sector experience of founding team and degree of team heterogeneity as outlined above. We used the founding year as control for the age of the company. All firms in the sample were founded between 1988 and 2002. Controlling for industry effects, we differentiate IT based companies and non-IT based companies. We define the dummy variable as 1 if the company is operating in the IT sector and 0 if the company is operating in another sector such as biotech and microelectronics. In order to control for sector experience of the founding team, we control for the number of founders that have experience in the sector the company operates in. The variable ranges between 1 and 3, and takes into account the

cumulative sector experience of the founding team members in the same sector as the start-up. The variable takes value 1 if the founding team has cumulative sector experience of less than 3 years, 2 if the cumulative sector experience is between 3 and 6 years and 3 if the cumulative sector experience is higher than 6 years.

4.6.2. Regression model

A regression model was developed in a second stage in order to understand the determinants of board complementarity and substitutability. By including the standardized residual of the auxiliary regression in this model, we anticipated potential selection bias, as outlined above.

The final model took the form (Equation 2):

$$\begin{aligned} &\text{Board complementarity/substitution} \\ &= F(\text{degree of R\& D experience, degree of} \\ &\text{commercial experience, R\& D*VC funding,} \\ &\text{Commercial*VC funding, Financial*} \\ &\text{VC funding, R\& D*academic, Commercial*} \\ &\text{academic, controls}). \end{aligned} \quad (2)$$

The controls took the form of a vector which included the degree of heterogeneity of the team and the standardized residual of the auxiliary regression (Equation 1). The dependent variables are the number of outside board members that are complementary and substitute to the founding team. The independent variables are the degree of R&D experience and commercial

experience. Interaction variables between these variables and VC funding (dummy) and academic high tech start-up (dummy) were used in order to assess the impact of human capital and external equity stakeholders on outside board member complementarity and substitutability.

5. Results

We are able to categorize our sample of high tech start-ups into three groups according to the nature of external party involvement. The first group is high tech start-ups which originate from a PRO (academic high tech start-ups) of which 70% make use of a university pre-seed capital fund and 30% have no external capital at all. The second group is high tech start-ups which have attracted VC firm investment within 18 months after formal company formation (VC backed). In our sample there are no examples of academic high tech start-ups which have substituted university seed capital for VC money. The final group is high tech start-ups that do not belong to the former two categories and have no external equity stakeholder. We call them “other”. The descriptive statistics for the three groups are presented in Table I. The groups differ significantly from one another across a number of variables.

The results in Table I indicate that academic high tech start-ups have a significantly higher degree of R&D experience within the founding team than the remaining firms. In addition, academic high tech start-ups raised a signifi-

TABLE I
Descriptive statistics for human capital and board configuration

	Academic origin	VC-backed	Other
Founding team heterogeneity	0.14 (0.25)	0.19 (0.34)	0.21 (0.29)
Degree of R&D experience founders****	0.87 (0.25)	0.53 (0.46)	0.48 (0.42)
Degree of commercial experience founders	0.050 (0.10)	0.11 (0.23)	0.78 (0.13)
External capital at founding****	404,290 (931,132)	2,086,032 (1,873,385)	75,355 (469,407)
IT sector	0.33 (0.47)	0.44 (0.51)	0.35 (0.48)
Size founding team***	2.84 (1.41)	2.50 (1.31)	2.05 (1.24)
Size board****	4.75 (1.41)	5.63 (1.96)	3.07 (1.36)
Number of outside board members****	1.82 (1.45)	3.44 (1.46)	0.88 (1.18)

Note: VC-backed companies are high tech start-ups that do not have an academic origin and that received venture capital financing within the first 18 months after start-up.

Kruskal Wallis test levels of significance: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; **** $p < 0.001$; $n = 140$.

cantly lower amount of external financing compared to the VC backed companies, but a higher amount compared to the other companies in the sample that were neither VC backed nor academic. The size of the founding teams of academic start-ups and VC backed companies is significantly larger than the size of the other founding teams in our sample.

VC backed companies have significantly larger boards compared to academic high tech start-ups, which in turn have significantly larger boards than the other companies in the sample. Also the number of outside board members is significantly larger for the VC backed start-ups compared to the academic high tech start-ups and the other firms. Academic high tech start-ups have significantly more outside board members compared to the other firms in the sample.

Table II presents univariate statistics to describe the sample differences between high tech start-ups which have an outside board and those that do not. We find that 60% of the high tech start-ups in our sample have boards with

outside members, which highlights the prevalence in high tech start-up companies.

Finally, we present a correlation matrix for our variables in Table III. Correlations between independent variables were all below 0.6. In order to make sure that multicollinearity was not an issue, VIF factors were calculated, and were found to be below 3.0, suggesting that multicollinearity was not an issue (see Hair et al., 1998).

5.1. Complementarity and substitutability of outside board members

To test the hypotheses relating to the complementarity and substitutability of outside board members we employed a Heckman selection procedure. As outlined above, this procedure was used in order to address a potential selection bias problem. The first stage of our analysis was to construct a selection model to control for the probability of having outside board members. Table IV shows the results of the selection model.

TABLE II
Univariate statistics for outside board presence

	No outside board members	Outside board members	Overall
Sector			
IT	44.9%	55.1%	35%
Other	36.3%	63.7%	65%
External shareholders			
Academic origin**	26.7%	73.3%	32%
VC-backed****	12.5%	87.5%	12%
Overall	39.6%	60.4%	100%

Chi-Square test levels of significance: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; **** $p < 0.001$; $n = 140$.

TABLE III
Correlation matrix

	1	2	3	4	5	6
(1) Degree of R&D experience	1					
(2) Degree of commercial experience	-0.44*	1				
(3) Degree of financial experience	-0.18*	0.25*	1			
(4) Team heterogeneity	-0.19*	0.39*	0.45*	1		
(5) Number of complementary board members	-0.10	0.23	-0.13	-0.21	1	
(6) Number of substitute board members	0.10	0.15	0.48*	0.60*	-0.25	1

Pearson correlations level of significance: * $p < 0.05$.

TABLE IV
Selection model (Step 1 of the Heckman procedure)

	Dependent variable (0 = no outside board members; 1 = outside board members)
<i>Independent variables</i>	
Academic origin (0/1)	1.173*** (0.433)
Venture capital finance (0/1)	2.008** (0.804)
<i>Control variables</i>	
Founding year	0.102 (0.063)
IT-sector	-0.539 (0.405)
Sector experience founding team	-0.109 (0.221)
Degree of team heterogeneity	-0.309 (0.699)
Constant term	-203.77 (124.99)
Nagelkerke R^2	0.185
N	140

Levels of significance: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$;
**** $p < 0.001$.

Table V shows the regression models after controlling for the probability of having an outside board. Model 1 employs board complementarity as the dependent variable and model 2 employs board substitutability as the dependent variable. All variance inflation factors were below 3.0 (maximum value 2.47) suggesting that multicollinearity was not an issue (Hair et al., 1998).

With regards to hypothesis H1 we find weak support for the hypothesis that founding teams with outside board members, but without external equity stakeholders, recruit outside board members with human capital that is substitute for that of the founding team. We find that a higher degree of commercial experience in autonomous teams leads to a higher number of substitute outside board members ($p < 0.10$). This means that the higher the commercial experience within the autonomous founding team, the more often the founding team will add outside board members with similar (commercial) experience. We find no significant evidence that the proportion of R&D experience in autonomous founding teams leads to attracting either complementary or substitute outside board members, even though the signs of the

coefficients are in the expected direction. Our evidence suggests, therefore, weak support for H1.

Hypothesis H2a states that human capital of outside board members of academic high tech start-ups will be a substitute for the human capital of the founding team where the founding team is characterized by high levels of experience in R&D activities. Hypothesis H2b states that human capital of outside board members of academic high tech start-ups will be a complement for the human capital of the founding team where the founding team is characterized by high levels of involvement in commercial and financial experience. Our findings, however, do not support our hypotheses. We find that academic high tech start-ups with a founding team with a high degree of R&D experience tend to attract outside board members that are complementary, having commercial and/or financial experience. This finding suggests that the TTO officers in PROs, which are usually involved in the team composition of academic high tech start-ups, have developed social networks with non-technical persons that might be interested in a board position. In addition, academic founding teams with high degrees of commercial experience tend to attract outside board members that have complementary experience, in particular R&D experience. In summary, H2a and H2b do not receive support.

Hypothesis H3a argues that high tech start-ups with founding teams characterized by high levels of R&D or commercial human capital, where the VC firm has some power, will have external board members with human capital that complements the human capital of the founding team. Hypothesis H3b argues that high tech start-ups with founding teams characterized by high levels of financial experience, where the VC firm has some power, will have external board members with human capital that is a substitute for the human capital of the founding team. Our results reveal that external board members of VC backed firms tend to be characterized by financial experience, which is complementary to founding teams whose human capital is characterized by high levels of experience in R&D and commercial experience. Conversely, in founding teams whose human

TABLE V
Regression analysis: determinants of board complementarity/substitution (Step 2 of the Heckman procedure)

	Dependent variable = number of complementary board members MODEL 1	Dependent variable = number of substitute board members MODEL 2
<i>Independent variables</i>		
Degree of R&D experience	-0.833 (0.521)	0.730 (0.452)
Degree of commercial experience	-1.456 (1.240)	1.963* (1.077)
Degree of financial experience	—	—
R&D * VC finance	1.834** (0.706)	-0.988 (0.613)
Comm * VC finance	6.243**** (1.491)	-1.098 (1.294)
Fin * VC finance	-28.977 (24.23)	50.890** (21.034)
R&D * academic	2.491** (1.107)	-0.042 (0.961)
Comm * academic	0.868 (4.776)	6.071 (4.147)
Fin * academic	—	—
<i>Control variables</i>		
Degree of team heterogeneity	0.143 (0.879)	0.829 (0.763)
Standardized residual of auxiliary regression	0.262 (0.326)	-0.554 (0.283)*
Constant term	1.038** (0.486)	0.416 (0.422)
F-value	4.040***	4.760***
R ²	0.583	0.622
Adjusted R ²	0.439	0.492
N	39	39

Levels of significance: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; **** $p < 0.001$.

capital is characterized by high levels of experience in finance VC firms install outside board members with human capital that substitutes for that of the founding team. Our findings do not provide sufficient support for H3a, but do provide support for H3b. The results indicate that VC firms often appoint outside board members with financial experience to the boards of their portfolio companies, which confirms previous findings about the involvement of VC firms (Gorman and Sahlman, 1989; Knockaert et al., 2006).

6. Discussion and conclusions

In this paper we have sought to shed light on a relatively unstudied area of governance in high tech start-up firms, specifically, the presence of outside board members in high tech start-ups at founding. The study of outside board members in high tech start-ups is important since high tech start-ups, in comparison to non-high tech start-ups and firms that are further along the company life-cycle, are commonly resource-poor. In order

to overcome this resource impoverishment, high tech start-ups will depend on their environment for the attraction of additional resources. Outside board member capital, consisting of human, social and financial capital may help to gain access to these resources.

This research complements previous research in the domain that has analyzed board composition and the roles of boards and the impact of external equity stakeholders on board composition (Fiegenger et al., 2000; Rosenstein et al., 1993). However, little research has analyzed whether, and under which circumstances, board composition helps to gain access to resources that high tech start-ups are so often lacking. Researchers studying board composition have indeed emphasized that it is mainly board capital that will determine whether the start-up can gain access to external resources through the board (Hillman and Dalziel, 2003). Therefore, we examined the presence of outside board members and the degree of complementarity or substitutability of their human capital to the founding team. If the human capital of the

external board members is similar (i.e. a substitute) to that of the founding team members, the access to additional external resources may be limited. Conversely, where outside board members have human capital that is complementary to the founding team then this may enable the high tech start-up to access a wider range of resources.

First, we found that founding teams without external equity shareholders do not tend to attract outside board members with complementary human capital, rather they tend to attract board members with a similar human capital. This may be due to the fact that they lack the social network to attract outside board members with complementary human capital.

Second, VC firms tend to recruit outside board members that have financial human capital and so add complementary human capital to boards where the founding team does not have such financial skills. However, in the cases where the founding team was characterized by high degrees of financial human capital, the VC-firm did not add complementary human capital through the addition of outside board members, rather the human capital it added was a substitute for the founding team's human capital.

Third, contrary to our expectations academic high tech start-ups tend to attract outside board members that have complementary human capital to the founding team. Where the academic founding team is characterized by R&D experience the external board members added were more likely to have commercial and/or financial experience. Furthermore, academic founding teams with high degrees of commercial experience tend to attract outside board members that have complementary experience compared to the founding team members, i.e. have R&D experience.

Our research has implications for both theory and practice. In terms of theory we feel that the study highlights the complex relationship that may exist between human and social capital. Although it may be in the best interests of external equity stakeholders to recruit outside board members that have complementary human capital to the founding team some external stakeholders (VC firms) have a tendency to recruit outside board members in their

own image. We feel that this finding suggests that no one single theoretical perspective can fully explain board member selection. Agency theory, resource dependency and social network theory all provide partial explanations of outside board member selection behavior but have to be employed in combination to better understand the phenomenon.

Furthermore, the complex relationship between human capital and social capital raises important issues about how the social capital, and hence networks, of individuals can be expanded. Our data suggests that external stakeholders recruit outside board members from their own networks, which are a function of their social capital. Furthermore, the social capital of external stakeholders is inextricably linked to their human capital. That is, if a stakeholder comes from a VC community he/she will have not only skills (human capital) in that area but also contacts (social capital). We feel that this finding raises interesting issues for future research – e.g. to further explore the relationship between human and social capital. In addition, it raises issues as to whether or not there are individuals that are able to span more than one network effectively. Although there is a close relationship between human and social capital it is not clear to what extent human capital is required for the development of social capital. If human capital (e.g. scientific knowledge) is required to build social capital (e.g. links into a scientific community) then building social capital requires more than merely bringing individuals from different networks together. In effect, there may be a requirement for prior human capital in order that the introduction is effective.

In terms of implications for practice we feel that our research has insights for high tech entrepreneurs, who are typically resource-poor. First, in the absence of external equity stakeholders, high tech entrepreneurs do not complement their human capital with that of outside board members, but attract outside board members with similar human capital. Further research should investigate why the founding team, in the absence of external equity stakeholders, do not attract outside board members with complementary human capital. One

explanation may be their own fear of losing autonomy due to the presence of outside board members, but a second may be the fact that they lack the appropriate network for recruiting such outside board members. Second, these findings raise new questions on the value-adding role of the venture capitalist. Our findings suggest that most VC-appointed outside board members are people with financial experience. Research suggests, however, that the founding team's commercial experience is an important determinant of a company's future growth and survival (Cooper et al., 1994; Heirman and Clarysse, 2005; Roberts, 1991). The presence of a VC firm as an external stakeholder, therefore, may not add much in the way of commercial skills to the venture. Third, we find that attracting a PRO as external equity stakeholder does have an impact on the attraction of outside board members, leading to the attraction of outside board members with complementary human capital to the founding team.

There are a number of limitations of our work which will hopefully be addressed by future research. First, the study was carried out in Flanders, a region in Europe that is comparable to other emerging high tech regions. The VC context however is somewhat specific: a large number of small VC funds that often do not have a sector specialization cover the market. Second, the study focuses on board composition at the time of start-up. We do not have an insight into how boards subsequently developed and whether or not outside board members are changed over time. A longitudinal research approach would be necessary to study the evolution in board composition over the company's life-cycle. Third, even though our research indicates that under certain circumstances complementary human capital is brought to the company through the board, the impact of the involvement of these outside board members is not measured. Future research into the specific value-adding role of outside board members is necessary and would require a more qualitative approach, analyzing decisions taken by outside board members and the impact each outside

board member had on the strategy, growth and evolution of the company.

In spite of these limitations, in this study we have attempted to shed light on the under studied topic of the presence of outside board members in high tech start-ups. Our results indicate that external equity stakeholders do affect the complementarity or substitutability of outside board member human capital to that of the founding team.

Notes

¹ Under the majority of national innovation systems in the western world (including Belgium) the PRO owns the rights on the technology. The PRO can either license the technology or transfer the technology to a start-up company (Schartinger et al., 2002). In return for transferring the IP to the start-up the PRO will commonly take an equity stake.

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