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The Effect of Educational Diversity in Top and Functional Management Teams on Search Strategy and Innovation of Firms

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Abstract

The effect of team diversity on firm innovation has been an important topic in the literature. However, there has been strong focus on the diversity among Top Management Teams (TMT) as the dominating actor. The role of other management levels, in particular Functional Management Teams (FMT), is frequently neglected. In this paper, we intend to close this gap by explicitly differentiation between TMT and FMT diversity effects. Focusing on educational diversity in TMTs and FMTs, we compile a linked employer-employee panel dataset for Sweden, biannually through 2004-2012. We find the following results. First, the predominant effect of TMT diversity is not on the actual innovation outputs (measured by commercialization of new products), rather it is on increasing the search strategy breadth (measured by whether firms perform no R&D, either internal or external R&D, or both). Second, it is FMT diversity that increases the likelihood and the radicalness of innovation outputs. Third, while TMT diversity on average has no direct impact on innovation outputs, it has a positive effects for firms with intermediate breadth of the search process, i.e. firms with either internal or external R&D. Also the positive effect of FMT educational diversity is strongest here. This suggests that firms can use TMT and FMT diversity as substitute for their relatively narrow search process. These findings prevail after controlling for the potential endogeneity that may arise from the simultaneous determination of the search strategy and innovation outcomes on the one hand, and TM and FMT diversity on the other hand.

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The effect of team diversity on firm innovation has been an important topic in the literature. However, there has been strong focus on the diversity among Top Management Teams (TMT) as the dominating actor. The role of other management levels, in particular Functional Management Teams (FMT), is frequently neglected. In this paper, we intend to close this gap by explicitly differentiation between TMT and FMT diversity effects. Focusing on educational diversity in TMTs and FMTs, we compile a linked employer-employee panel dataset for Sweden, biannually through 2004-2012. We find the following results. First, the predominant effect of TMT diversity is not on the actual innovation outputs (measured by commercialization of new products), rather it is on increasing the search strategy breadth (measured by whether firms perform no R&D, either internal or external R&D, or both). Second, it is FMT diversity that increases the likelihood and the radicalness of innovation outputs. Third, while TMT diversity on average has no direct impact on innovation outputs, it has a positive effects for firms with intermediate breadth of the search process, i.e. firms with either internal or external R&D. Also the positive effect of FMT educational diversity is strongest here. This suggests that firms can use TMT and FMT diversity as substitute for their relatively narrow search process. These findings prevail after controlling for the potential endogeneity that may arise from the simultaneous determination of the search strategy and innovation outcomes on the one hand, and TM and FMT diversity on the other hand.

Keywords: Educational diversity, Top Management Teams (TMTs), Functional Management Teams (FMTs), search strategy, innovation output, Community Innovation Survey

1. Introduction

Upper echelon theory posits that the characteristics of top management teams (TMT) impact organization performance (Beckman and Burton 2008, Hambrick 2007, Hambrick and Mason, 1984, Peffer 1983). Moreover, following a competence and learning-based approach, the role of such TMTs diversity has been prominently analyzed on the innovation activities of firms (Eesly et al. 2014). A generic argument for the beneficial effects of TMT diversity outsets from the claim that diversity grants access to wider knowledge and skill bases (e.g. Beckman 2006, Eisenhardt and Schoonhoven 1990) and therefore increases the access to broader cognitive sources allowing for greater innovative potential. On the other hand diversity creates costs because it amplifies problems in control, coordination, and knowledge integration (Simons et al. 1999, Smith et al. 1994, Grimpe and Kaiser 2010). It has therefore been argued that the resulting trade-off is governed by firm's internal processes (Ling and Kellermanns, 2010).

These claims have been made with respect to very different facets of diversity, including educational, occupational, gender, race, or cultural diversity. Nonetheless, to the degree that these arguments are knowledge-related, we assume that the most compelling case is made for the educational background because this largely determines the employees' competences, skill set, and general mind sets (see Allen 1977). We will in the following therefore focus on educational diversity.[1]

While a line of research has begun to explore how the effects of diversity unfold given the organizational processes, one feature of this literature is its strong focus on TMTs as the dominating actor. The role of other management levels, in particular functional management teams (FMTs), is frequently neglected. In fact, while it is true that the role of TMTs as broadly determining the overall corporate strategy (Finkelstein et al. 2009) is of central importance, the actual implementation of these strategies is more likely to be attributed to FMTs. For high firm performance, however, both a wisely chosen corporate strategy as well as a sensible implementation is necessary. Thus, accounts of how diversity impact on firm performance is incomplete as long as it focuses solely on TMTs.

In this paper, we intend to close this gap by explicitly differentiation between TMT and FMT diversity effects. Moreover, because the benefits of diversity are expressed in terms of access to broader knowledge bases and thus to innovation, we follow the literature that has analyzed

[1] We drop the term "educational" mostly for simplicity unless it is necessary to make a distinction to other terms of diversity explicit.

how diversity impacts on innovation performance (see Miller and del Carmen Triana 2009, Camelo et al. 2010, Talke et al. 2011, Li 2013).

We express two major expectations. First, because TMTs are responsible of setting the general innovation strategy while FMTs are much closer to the implementation of actual innovation projects (Wooldridge et al. 2008), we argue that effects of diversity on innovation differ between these levels. In particular, we argue that FMT diversity is more important for the actual success of innovation activities than TMT diversity. On the contrary, because the TMTs' main responsibility is in overall strategy setting (including decisions on the direction and quantity of resources devoted to innovation), TMT diversity is more important for increasing the breadth and/or the intensity of the search process evolving around innovation activities.

In order to test our hypotheses we compile a linked employer-employee panel dataset for Sweden for the years 2004, 2006, 2008, 2010, and 2012. We draw the firm-level data (including the innovation variables) from the biannual Swedish contribution to the Community Innovation Survey (CIS) conducted in all EU member states. To this we add employee data (including occupational data to identify TMTs and FMTs as well as data on educational background to measure diversity) from the LISA database as provided by the Swedish Statistical Office (SCB). Our results largely confirm our hypotheses by showing that the predominant effect TMT diversity is on increasing the breadth as measured by whether firms perform no R&D, either internal or external R&D or both, while FMT diversity increases the likelihood and the radicalness of innovation outcomes. Beyond that two more observations are worth noting. First, we can prove that TMT diversity has a positive indirect impact on innovation outcomes that runs through the increase in breadth and intensity of the search process. Second, while we found that TMT diversity on average has no direct impact on innovation outcomes, we can show that for firms with intermediate breadth of the search process – i.e. firms with either internal or external R&D – the effect of TMT diversity on innovation outcomes becomes positive. Also the positive effect of FMT diversity is strongest here. This suggests that firms can use TMT and FMT diversity as substitute for a relatively narrow search process. These conclusions prevail when we control for the potential endogeneity that may arise from the simultaneous determination of the search strategy, the innovation outcomes on the one hand and TMT and FMT diversity on the other hand.

2. Theory

2.1 Diversity and innovation

Several literatures have made strong cases for a positive relationship between innovation and diversity. Despite this generic claim, there are however quite substantial differences between these literatures in terms of theoretical background, organizational level of analysis, and definition of diversity.

As already indicated, Upper Echelon Theory has generally hinted at the importance of TMTs and their characteristics for the fate of companies (Beckman and Burton, 2008; Hambrick and Mason, 1984; Pfeffer, 1983). This literature has also analyzed the role of diversity. The justification for has often been with reference to broader cognitive frames that can emerge in more diverse TMTs (see Hambrick 1996). These frames allow the TMTs to perceive and make sense of a more diverse set of information that may either come from the environment or from the firm itself (Li 2013). Diversity one the one hand can help improve the informational basis because more information is simultaneously perceived and evaluated. On the other hand it can help preventing behavioral group-dynamic problems such as group-think (Janis 1982) because broader prespectives allow members to reflect on ideas from broader perspectives making constructive criticism more likely (Barsade et al. 2000). This can reduce both component ambiguity (not understanding what a certain signal means) and causal ambiguity (not knowing what knowledge the content of a signal can be used for) (c.f. Law 2014). Furthermore, increasing the accuracy of information about the future reduces the perceived variance in future outcomes (Neuhäusler et al. 2015). With risk-averse managers, this will imply a more favorable judgment of projects that might otherwise be regarded as too risky, in particular R&D. In this respect, diversity will alleviate myopia of learning (Levinthal and March 1993).

Evolutionary theories in the innovation come to a remarkably similar conclusion although starting from a quite different perspective. Here the argument is not so much about individual learning or group behavior but relates to evolutionary value of diversity. In this view, innovation results from recombinations of existing but formerly related or unrelated technological solutions (Fleming 2001, Yayavaram and Ahuja 2008; Tavassoli and Carbonara, 2014). Greater diversity then implies a greater pool of possible recombinations. The arguments have both been made with respect to diversity in technologies available to the firm (Breschi et al., 2003; Suzuki and Kodama, 2004; Garcia-Vega, 2006) and with respect to diversity in the skills of employees

(Dosi, 1982; Quintana-Garca and Benavides-Velasco, 2008, Östergaard et al. 2011, Schubert and Andersson 2014).

Despite the general agreement that diversity reduces potential costs (e.g. Auh and Menguc, 2005; Bunderson and Sutcliffe, 2002) and can foster firm level innovativeness, there considerable ambiguities in these approaches. First, it is not clear according to which variable diversity should be defined. Indeed, diversity can be defined in terms of gender diversity (Dwyer et al. 2003, Francoeur et al. 2008, Campbell et al. 2008), race diversity (Herring, 2009), functional diversity (Bunderson and Sutcliffe 2002, Cannella et al. 2008, Buyl et al. 2011) and educational diversity (Knight et al. 1999, Dalin et al. 2005). Some authors have relied on compound diversity measures that try combining various sources of diversity (e.g Erhardt et al. 2003). In fact, theory gives little guidance on this issue, having implied that some authors have implicitly declared it an empirical question by simply analyzing a broad set of different measures (see Bantel and Jackson 1989, Ostergard et al. 2011). In this paper we will focus on educational diversity because educational background is a strong predictor of skills and approaches to the solution of specific problems. Allen (1977) for example shows marked differences between engineers and scientists. Similar arguments are made in the knowledge base literature (Asheim and Gertler 2005, Laestadius 1998).

A second issue concerns the level of analysis. While upper echelon theory in principle acknowledges that both TMT and firm characteristics simultaneously affect firm performance, in practice at least the empirical design was focused almost exclusively on the role of TMT characteristics and the ways how group's internal processes, e.g. conflict resolution, moderate these effects (Eesley et al. 2013, Camelo et al. 2010). Links to other levels often remain under-researched. The innovation literature dealing with the role of diversity has tended to treat the firm as big pool of diverse skills or technologies and has usually not made any distinction between the locations of diversity. Thus in the upper echelon theory has focused on an – albeit without doubt important organizational – level not or at best implicitly dealt with different organizational levels. The innovation literature was in this respect much broader, by e.g. including all employees. However, potentially differential effects between the various organizational levels are thereby ignored.

In this paper, on the one hand we recognize the need to go beyond top management levels as the sole or at least most important locus of diversity. On the other hand we concur with the upper echelon literature that managerial levels in a company may be of prime importance for companies' innovativeness, because of their long-term of strategic influence on the innovation agenda and the implementation of the innovation activities. In this respect, we strike a middle ground between both literatures by suggesting that diversity on the level of the TMTs is not to be underestimated. Nonetheless, this should not lead to a neglect of the role of lower management levels, in particular FMTs. This is particularly important, because we will argue that the effects on innovativeness are likely to differ between both levels.

2.2 The roles of TMTs and FMTs in the company

Upper echelon theory states that organizational performance is affected by characteristics of the firm, the TMT and the CEO. From that perspective Hitt et al. (2007) note that upper echelon theory is clearly a multi-level theory. Yet, at the same time they note that research was mainly situated with only one level. In our context, authors have analyzed the role of diversity in TMTs on innovation performance ignoring other diversity at other (i.e. lower) levels. This may be problematic, because implicitly the unaddressed levels are treated as constant, which may not be true (Rothaermel and Hess 2007).

The hierarchies in most companies are based on a differentiation between strategic managers that impact their organizations' fate through their impact on the general strategic orientation. Below the TMTs, there are the levels which are often referred to as middle or functional (Wooldridge 1990, Wooldridge et al. 2008). Several authors have argued that because managers at these levels connect TMTs to operational management levels, they can be considered agents of changed (Floyd and Wooldridge 1999, Huy 2002). This is also because functional managers are more likely to understand the causal ambiguities in the problems faced by the companies (King and Zeithaml 2001). Thus, it can be assumed that the importance of middle managers can be as important as those of top managers for the economic success of companies.

In our context, this would suggest that analyzing only the impact of TMT diversity on innovation runs a risk of yielding biased results as long as FMT diversity is not appropriately accounted for.

This may be particularly problematic, if FMT and TMT diversity were to differ, which is not unlikely because the largely differing roles and responsibilities of FMTs and TMTs. If this was case, the effects actually stemming from FMT diversity may be falsely associated with TMT diversity.

2.3 The hypotheses

As argued in the previous sections, educational diversity is likely to have positive influence on innovativeness, because it gives access to a wider set of cognitive frames which improves both the quality of the information processing in the team (Li 2013) as well as it contributes to preventing behavioral biases such as group think (Barsade et al. 2000). This would suggest that diversity in both types of managerial teams can benefit the innovative performance of a company. But taking into account the different responsibilities and roles, we argued that these effects emerge at different stages of the innovation process.

In particular, we argue because TMTs tend to determine quite high level characteristics of the innovation strategies including budgets, we expect that the effects of TMT diversity on innovation strongly related to innovation inputs. There is not necessarily a direct positive effect on the success with innovation activities, because TMTs can be quite remote from the concrete allocation of these resources to concrete project as well as their efficient management.

> H1: a) TMT-diversity has a positive influence on the probability of a company to conduct R&D. b) While TMT-diversity is not expected to have a direct positive effect on being a product innovator, there is a positive indirect effect that runs through the induced increase in R&D-intensities.

FMTs on the contrary are much closer to the practicalities of the of actual innovation processes (Huy 2002) and have may have only limited influence on decisions about R&D spending to the creation of organization-wide strategic commitment to R&D as a cultural value (c.f. Smith and Tushman, 2005; Gibson and Birkinshaw, 2004). Thus, diversity in FMTs is more likely to relate to the efficient use of resources for innovation having been made available by TMTs. This is also because FMTs are due to their proximity to the actual ongoing innovation projects in a much better position to understand the causal ambiguities underlying the relationships between technology, demand, and economic performance (King and Zeithaml, 2001). Furthermore, it is likely the case that greater FMT-diversity increases the diversity of the available knowledge stock (Eesley 2013), which increases chances to find useful recombination of existing knowledge assets (Fleming, 2001) and thus increases innovation success (Colombelli et al. 2014, Neuhäusler et al. 2015).

> H2: a) FMT-diversity does not increase the probability of a company to conduct R&D. b) FMT-diversity is positively associated with the probability of being a product innovator.

H1 states that firms with greater TMT diversity are more likely to be R&D active. By the same tokn, we would expect that such firms also chose broader R&D strategies. In this context, many scholars have argued for the value of open modes of innovation because firm with more pervious boundaries are more able to perceive outside information and assess its value (Nerkar and Rosenkopf 2001, Chesbrough 2003, Laursen and Salter 2006). However, organizational boundaries can also function as useful filters to reduce the ambiguity in the information. Thus, whether open boundaries help to support companies depends on their abilities to deal with that information effectively. Following the arguments from above, firms with greater TMT diversity are more likely to be able to reduce the ambiguity of information stemming from multiple sources in and outside the organizational boundary and therefore are more likely to exploit broad information sources simultaneously (compare Classen et al. 2012). We thus argue that TMT diversity does not only increase the probability of conducting R&D. It will also make the adoption of broader R&D strategies, which we define as the combination of simultaneous internal and external R&D, more likely.

> H3: Higher TMT-diversity increases the probability of combining both external and internal R&D more than adopting just one type of R&D.

Likewise, the broader cognitive frames of FMTs associated with broader diversity in the educational backgrounds is likely to lead to a broader understanding of both technological options as well as demand preferences. Firms may therefore find it easier to accurately assess the market success of so far untried products. At the same time they are more likely to be able to implement product solutions that incorporate a higher level of technological progress.

> H4: Higher FMT-diversity increases the chances of innovations that are new to the world-market by more than innovations that are new to the firm.

Most works in the literature have highlighted that the effects of diversity depends on key contingencies. In order to deepen the understanding in this respect we highlight that the breadth of the R&D strategy is actually an important contingency for direction and size of the effects. As already argued a key source for innovation is the recombination of existing knowledge sources (Fleming 2001, Schumpeter 1943) and that diversity can increase the access to a broader set of knowledge stocks (Yayavaram and Ahuja 2008). However, diversity is not the only source of recombinative potential. Firms may choose to access at wide variety of external knowledge sources (Laursen and Salter 2006) and may thus be able to substitute knowledge breadth incorporated internal diversity by broader R&D strategies. Turned around, firms focusing on relatively narrow R&D strategies are faced with a lower recombinative potential and thus need to substitute this lack by internal diversity. We thus expect that the gains from diversity in terms of innovation output are largest for firms with narrow R&D strategies.

H5: The effects of FMT and TMT diversity on innovation outcomes are most pronounced for firms with narrow R&D strategies.

3. Data and Identification Strategy

3.1 Data

The final dataset used in this paper is the result of merging three datasets, all maintained by Statistic Sweden (SCB): (i) Community Innovation Survey (CIS), (ii) matched employer-employee dataset at individual level (LISA), and (iii) registered firm-characteristics dataset. First, the CIS dataset provides information concerning the innovation related data in this study. We append five waves of the Swedish CIS in 2004, 2006, 2008, 2010, and 2012. The CIS 2004 covers the period 2002-2004 and CIS 2006 covers the period 2004-2006 and so on, hence using the five ways, provide us with information about innovation activities of firms over a ten years period, i.e. from 2002 to 2012. In all five waves, inter alia, there is information concerning introduction of product innovations as well as whether such product innovation has been new to firm or new to market. There is also information concerning various innovation inputs (e.g. internal and external R&D investments, training of employees etc.). The survey consists of a representative sample of firms in industry and service sectors with 10 and more employees. Among them, the stratum with 10-249 employees has a stratified random sampling with optimal allocations and the stratum with 250 and more employees is fully covered. The response rates in the five waves vary between 63% and 86%, in which the later CIS waves having higher response rates compared with the earlier ones. There are 21,104 observations in total, after appending all five waves of CIS[2]. Then we construct a balanced dataset, which consists of 2,870 observations, corresponding to 572 firms who participated in all five waves of CIS. To this we merged the balanced panel of CIS dataset with the matched employer-employee dataset. This gives us a wide variety of information on the characteristics of all employees by the firm. Particularly, useful in our context is the information on the educational background, on which we base the construction of our diversity measures. Furthermore, we make use of the available occupation code based on ISCO-88COM. This classifications allows us to identify managerial

[2] This is obtained after the usual data cleaning, i.e. dropping observations with zero turnover or zero employees.

person in the firm and to assess whether they belong to the top management team (ISCO 121X) or functional management teams (ISCO 122X) (for details compare Table A1 in the appendix).

Finally, we merged the above dataset with registered firm-characteristics data (i.e. turnover, physical capital, export intensity, and sector affiliation). The description of all variables are presented in Appendix A2 and descriptive statistics in Appendix A3. The Vector Inflation Factor (VIF) among regressors has the mean value of 1.54 and each variable get a VIF score of below 2.36. This implies that multicollinearity is rather mild and may not bias the subsequent regression analyses results in Section 3.

3.2 Definition of the main variables

3.2.1 The dependent variables

Following our theoretical discussion we differentiate between inputs and outputs of the innovation process. On the input side we use two measures. The first is whether firms engage in R&D (see H1a). Thus we use a dummy variable here, which is one if a firm had internal R&D activities or zero otherwise. We also referred to the breadth of the R&D process, which we defined on the basis of whether a firm conducts no, only internal, only external or simultaneously external R&D. We thus have ordered variable that is zero if the a firm does not perform R&D, 1 if it performs either internal or external R&D but not both, and 2 otherwise (H1b, H3)

On the output side we use a variable that indicates whether a firm actually introduced any product innovations on the market (H2a). The variable is 1 if yes and zero otherwise Following the CIS nomenclature innovations need to be only new to the firm (OECD 2005). So, this definition includes also pure imitator innovations and thus captures the diffusion of innovative products. This also lays the conceptual basis for what we label radical innovation. Under this term we summarize all innovations that are truly new to the market and are thus no imitator innovations. Based on this additional information we create a second variable that is zero if the firm introduced no product innovations, 1 if it introduced imitator innovations, and 2 if it introduced new-to-market innovations (H2b, H4, H5).

3.2.2 The diversity measure

The core variables in this paper relate to diversity in TMTs and in FMTs, where the teams can be identified on the basis of the ISCO classification (see Section 3.1). Defining diversity, however, requires two types of decisions. The idea is always that attitudes, beliefs and cognitive frames vary systematically with demographic factors (Robinson and Dechant 1997, Miller and Triana 2009). While this argument is certainly true, a common agreement is that the main benefits of diversity are associated with breadth of cognitive problem solving perspectives and the breadth of available knowledge bases. This suggests that in particular educational background should intimately link to the relevant elements of diversity, because perspectives on certain problems differ fundamentally between certain educational disciplines. In that respect education strongly shapes managers experiential background and thus their attitudes to certain problems (Cyert and March 1963). [3] The same argument may be true for gender or race diversity but without knowing the specific socialization processes of each individual this argument becomes obscured. We thus focus solely on educational diversity.

The educational background j is based on one-digit field of education in ISCED97 classification and can take the following nine values: j=0 (general education), j=1 (pedagogics and teaching), j=3 (social science, law, business, and administration), j=4 (natural science, mathematics, and computer science), j=5 (technology and manufacturing), j=6 (agriculture, forestry, and animal care), j=7 (health, medical care and social care), and j=8 (services).

The second question when computing a diversity index relates to the specific technique to use. Considerably heterogeneity exists here as well where some authors have used counts (Eesley et al. 2013). Others have relied on concentration measures such as the Blau's index (Miller and Triana 2009), which gives the probability that two units in a sample are of the same type. While this measure grasps some aspects of diversity, we however propose using an entropy measure, because entropy has a very direct link to information theory (Shannon 1948, 2001). This links entropy measures very closely to our theoretical framework, which emphasized the importance of effective information processing in management teams. Thus the question is what is the average value of the information base in a team? Suppose, there are a given number of managers that who can have either of the nine previously defined educational background. Now assuming that managers with the same disciplinary background transmit the same kind of informational content (linked to their cognitive perspective on a problem), the expected value of the informational base in a management team is simply the probability of occurrence of a signal multiplied by its value summed over all potential signals:

[3] A good point could be made that functional diversity has the same effect, but the ISCO classification does not differentiate corporate managers and executives according to their field of expertise. Thus, while appropriate measures could be derived for FMTs we are unable to do so for TMTs.

$$E(InfVal) = \sum_{i=1}^{R} p_i I(p_i) \quad (1)$$

Information theorists then highlighted that the value of information increases in the probability of its occurrence but this increases becomes gradually smaller because of duplication. In other words, there value of information is subject to diminishing returns in its probability. A function that usefully captures this is the logarithm. Furthermore, in practical applications the probabilities are replaced by empirical shares. In this way it is possible to derive a measure of diversity that is underpinned by information theory. using the basic properties of the natural logarithm, it is easy to show that the measure for TMT diversity in our context can be written as follows:

$$TMT\_DIV_{i,t} = \sum_{j=1}^{J} TMTEDU_{i,t,j} \ ln \ (\frac{1}{TMTEDU_{i,t,j}}) \quad (2)$$

Where, $TMT\_DIV_{i,t}$ is the measure of TMT diversity of firm i in year t, $TMTEDU_{i,t,j}$ is the share of TMT with educational background j to total TMT managers in firm i year t, and ln is natural logarithm. Theoretically, $TMT\_DIV_{i,t}$ gets the minimum value of 0 and maximum value of $ln^{J=9} = 2.19$. The minimum value happens when all top managers in the firm i have exactly the same educational background j, hence no diversity exists at all. The maximum value happens when there is an equal distribution of top managers over all of the nine educational background j.

Similar to equation (2), we can construct the measure of FMT diversity of firm i in year t as follows:

$$FMT\_DIV_{i,t} = \sum_{j=1}^{J} FMTEDU_{i,t,j} \ ln \ (\frac{1}{FMTEDU_{i,t,j}}) \quad (3)$$

3.2.3 Other controls

We include a variable capturing firm size, measured as total turnover (TURNOVER), a variable capturing capital intensity, measured as physical capital per employee (PHYSICAL CAPITAL), and a variable capturing international linkages, measured as export intensity (EXPORT). Moreover, since our FMT_DIVERSITY measure may be simply the artifact of organizational departmentalization, we included a variable capturing such organizational departmentalization and division of labor, measured by the number of different departments (functions) in a firm divided per employee (DEPARTMENT). To account for general sector differences we use nice dummies corresponding to one-digit categories in the NACE code. We also include general year dummies to control for any unobserved time-specific effects. Exact definitions of all variables are presented in Table A2.

3.3 Identification Strategy

Based on formulation of our hypotheses, we have two types of dependent variable: binary and ordinal (ordered categorical). Therefore, we employed Probit and Ordered Probit models in order to investigate the effect of TMT and FMT diversity on search strategy as well as innovation performance of firm.

An important estimation issue results from the direction of causality in our relationship. Our hypotheses implicitly treat the diversity measures as being exogenously determined, which is obviously a very strong assumption because diversity in management teams might also arise from past decisions about the R&D process or the innovation outcomes. For instance, an organization with higher innovation performance (or broader search strategy) may attract diversified labor. Thus it is difficult to impose a unidirectional relationship. If this assumption however fails, then the diversity measures are potentially endogenous. To test the robustness of the results, an Instrumental Variable approach and Two-Stage Least Squares (2SLS) estimator is used. We experimented with various potential instruments that related to some exogenous feature of the firm. First, we used sector averages. We also used the age of the firm, which is can be assumed to be related to the diversity of management teams. We based on these measures we used both tests on overidentifying restrictions to test the validity of the instruments and we tested whether there were endogeneity issues at all. The main results suggest that only in a few cases endogeneity were problems at all. And to the degree that this was important the main results remained fairly robust. Thus we will present the 2SLS results only in the appendix and occasionally hint at them in the main body whenever results emerge that are different from those coming from the plain models.

Apart from Instrumental Variable approach, we performed two more additional robustness checks. First, we construct a restricted version of the FMT_DIV variable, which is composed of only those functions (departments) which can be assumed to be more innovation-related (R&D, sales, advertising, supply chain). Second, we tested whether results have systematic difference between larger (employment>100) and smaller firms. In both cases, the results remained stable[4].

4. Results

The results of our empirical estimations are presented in Table 1 to 4. Table 1 deals with hypotheses 1a & 1b and also 2a & 2b. Table 2 deals with hypothesis 3, Table 3 with hypothesis 4, and finally Table 4 with hypothesis 5. Table 1 estimates the effect of TMT and FM diversity on the probability of doing R&D and innovation, employing two separate Probit models.

[Table 1 about here]

Table 1 shows that the higher diversity among TMT (TMT_DIV) positively and significantly increases the probability of engagement in internal R&D investments, while it does not have a significant effect on the probability that firms introduce product innovations. On the other hand, the higher diversity among FMT (FMT_DIV) positively and significantly increases the probability of engagement in successful introduction of product innovation to the market, while it does not have a significant effect on the probability that firms engage in internal R&D investments. This implies that both hypotheses 1 and 2 are confirmed.

Table 2 goes deeper to investigate the search strategy of firms (not only internal R&D investments as in Table 1) and specifically estimates the effect of TMT and FM diversity on the breath of search strategies of firms using an Order Probit model.

[Table 2 about here]

Table 2 shows that TMT diversity significantly affects the search strategies of firms. Specifically, the higher TMT diversity, the lower chance that firms do nothing in terms of search strategy, i.e. doing neither internal nor external R&D investments (Model 3). On the other hand, the higher TMT diversity, the higher chance that firms engage in some sorts of search strategy, which can be narrow search strategy (doing either internal or external R&D), as in Model (4), or broad search strategy (doing both internal and external R&D), as in Model (5). Interestingly, the effect of TMT diversity is about five times more (0.075/0.014) on the probability that firms engage in broad search strategy in compare with narrow one. Looking at FMT diversity, it does

[4] For the sake of brevity, we did not report the result of aforementioned robustness check. They are available upon request.

not affect the probability of engagement in any type of search strategy, which is indeed in line with results in Table 1. These findings confirm the hypothesis 3.

Table 3 goes deeper to investigate the innovation performance of firms, by estimating the effect of TMT and FMT diversity on various types of innovation performance, which are: when firms introduce no product innovation at all (Model 6), succeed in introducing incremental innovation (Model 7), and succeed in introducing radical innovation (Model 8). Again, an Ordered Probit model is used.

[Table 3 about here]

Table 3 clearly shows that TMT diversity has no direct effect on any types of innovation performance of firms. On the other hand, it is FMT diversity that drives the innovation performance of firms. Specifically, the higher FMT diversity, the lower chance that firms fail to introduce product innovation (Model 6). On the other hand, the higher FMT diversity, the higher chance that firms engage in some sorts of innovation performance, which can be incremental (i.e. success in introducing a product innovation that is new to firm), as in Model (7), or radical innovation (i.e. success in a product innovation that is new to market), as in Model (8). Interestingly, the effect of FMT diversity is about twice more (0.059/0.030) on the probability that firms introduce radical innovation in compare with incremental one. These findings confirm the hypothesis 4.

Finally, Table 4 investigates the effect of TMT and FM diversity on innovation performance with respect to the breath of search strategy of firms. The table also seeks to go beyond a linear relation that we have been detecting so far.

[Table 4 about here]

Model (9) in Table 4 shows that, as expected, TMT diversity does not have a positive and significant direct (and linear) effect on innovation performance of firms (even negative effect here, although the significance level is not high). The interesting point is that the interaction between TMT diversity and search strategy turns out to be significant and positive, while the interaction with the square root of search strategy is significant and negative. This simply means, as soon as we consider the search strategy breath of firms, the relation between TMT diversity and innovation performance has the inverted u-shape form. This implies that the gains from diversity in terms of innovation performance are largest for firms with narrow R&D strategies (search strategy=1), while such gains actually go down for the firms with broader search strategies (search strategy=2). The same inverted u-shape form is found in Model (10) for the relation between FMT diversity and innovation performance, as soon as we consider the search strategy breath of firms. These finding confirm the hypothesis 5.

5. Discussion and Conclusion

Upper echelon theory has emphasized the important role of demographic characteristics of TMTs to explain firm performance and firm decision making. A particularly well developed branch of this literature deals with the role of demographic diversity. However, a central shortcoming exists in this literature: there was a great focus on the role of TMTs in isolation. We argued that this focus ignores that the role of TMTs is rather a strategic one than one of actual implementation. We have further argued that this distinction is very important for theorizing, because many of the effects that theory would have attributed to TMT diversity are actually more credible for diversity in FMTs. Based on the distinction between FMTs and TMTs we suggest that diversity in the latter will tend primarily impact on the input side (in particular by raising the probability to perform R&D and also by increasing the breadth of the R&D process). Diversity in the former group of managers instead will primarily impact on the actual innovation outcomes because these managers are much closer to the actual implementation of the innovation process. In this respect our line of argumentation shares communalities with a recent paper by Ndofor et al. (2015) who argue that TMT diversity impacts differently on resource-action link (in our case decision about R&D) and resource-performance link (outcomes of the innovation process). However, we go beyond this notion by allowing the existence of multiple management levels that might have an influence on how diversity affects inputs and performance. This has an important implication because we highlight the importance of a multilevel perspective in management (see Salvato and Rerup 2011, Lopes Costa et al. 2013). To the degree that research in TMTs has taken on multilevel perspectives at all, the research rather related to the interaction between individual-level and group and firm level characteristics (see Nielsen 2009). But the actual relationship between different organizational management levels was not in the focus (see Wooldridge and Floyd 1990, Raes et al. 2011 for notable exceptions). In our view this does not invalidate position of upper echelon theory at all. It rather draws attention to the fact that TMTs are not the only group affecting the fate of a company. Rather, if their role for firm performance and input decisions is to be understood better more research is needed how they interact with other management levels. Such a perspective would benefit the strategy research in general because it allows for a better understanding on how corporate strategies actually emerge in a multilayered setting – i.e. in setting that is not artificially narrowed down to very small number of very influential general manager and executives.

Apart from the call for a multilevel approach to strategy our results also show how diversity can be strategically employed as a resource to increase innovative performance. We demonstrated that this can happen through two different mechanisms. On the one hand, TMT diversity is associated with both a higher propensity to invest in R&D and broader R&D strategy. Both associations indirectly support innovative performance through raising the inputs into the innovation process. On the other hand, there is a direct effect on performance (both in terms of propensity to innovate as well as concerns the degree of novelty of the innovation), which stems from diversity in FMTs. Because these results remain robust after controlling for potential endogeneity issues (for a discussion see of the sources see Miller 2006, Carter et al. 2010) the results underpin that diversity can indeed be seen as a valuable resource, causally driving performance rather than just being associated with it (see Richard 2000, Tallman and Li 1996). At the same time we go beyond assumption that diversity should be related to performance by outlaying the basis of an information-theoretic underpinning of this argument. This would open a venue for future research appropriately testing the hypothesis that group diversity leads to better more appropriate decisions. While most research has focused on sociological constructs such conflict or trust (Olson et al. 2007, Simons and Peterson 2000, Curseu and Shruijer, 2010, Jen and Neale 1999, Panteli and Sockalingham 2005), the role of diversity in intrapersonal information processing has received less attention (Iselin 1988, Simons et al 1999).

Finally, we have shown that different diversity at different levels can be used as strategic substitutes. In particular, firms with relatively narrow search strategies benefit from TMT and FMT diversity the most, all else equal. That suggests that firms can substitute for breadth in the search process. This may become important when other considerations, e.g. a firm deciding against external R&D due to fear of knowledge leakage (see Schubert 2015), prevent firms from choosing broader strategies. In that respect diversity broadens the set of strategic options available to the firm. This in fact is highly related to views from biology that consider the value of diversity in its option value that derives increasing the capacity to adapt to environmental change (Jump et al. 2009).

This work also has some limitations which could open up the road for future research. First, because the theory relied on arguments about information processing the aggregation of data at the firm level did not actually allow looking into the processes occurring during information processing. An analysis of the validity of these arguments would even require going below the group level, which is most appropriate for the analysis of most sociological processes linked to diversity. Thus, direct tests of an information-based theory would require looking inside the heads of managers when they process information. This obviously implies a psychological turn in the analysis of diversity. Second, we implicitly side-stepped important sociological constructs such as trust, debate, and conflict. It could be worthwhile in a further step to bring together both psychological research on information processing with the sociological processing taking place at the same time. Such an integrated framework could potentially much more clearly explain how diversity actually plays both on the level of information processing for decision-making as well as for group behavior.

Table 1-TMT and FMT diversity and the probability of doing R&D and innovation

VARIABLES	(1) Internal R&D (D)	(2) Innovation (D)
TMT_DIV	0.081***	0.037
	(0.030)	(0.031)
FMT_DIV	0.014	0.083***
	(0.030)	(0.029)
EXPORT INTENSITY	0.337***	0.299***
	(0.040)	(0.042)
PHYSICAL CAPITAL	-0.001	-0.009**
	(0.004)	(0.004)
TURNOVER	0.062***	0.040***
	(0.011)	(0.010)
DEPARTMENT	0.520*	0.500*
	(0.305)	(0.297)
Sector Dummies	YES	YES
Time Dummies	YES	YES
Nr. of firms	572	572
Observations	2860	2860

Notes for Table 1: The table reports Average Marginal Effects (AME) with clustered standard errors over 572 firms in parentheses. ***, ** and * indicate significance on a 1%, 5% and 10% level. Probit model is used for estimating the effect of TMT and FMT diversity on the probability of engaging in internal R&D investment (Model 1) and probability of introducing product innovation (Model 2). The results are based on the balanced panel of five waves of CIS with t=2004, 2006, 2008, 2010, 2012.

Table 2-TMT and FMT diversity and the breath of search strategies of firms

VARIABLES	(3) No Search Strategy	(4) Narrow Search Strategy	(5) Broad Search Strategy
TMT_DIV	-0.089***	0.014***	0.075***
	(0.028)	(0.005)	(0.024)
FMT_DIV	0.001	-0.000	-0.001
	(0.028)	(0.004)	(0.023)
EXPORT INTENSITY	-0.310***	0.049***	0.262***
	(0.037)	(0.008)	(0.030)
PHYSICAL CAPITAL	-0.004	0.001	0.003
	(0.004)	(0.001)	(0.003)
TURNOVER	-0.072***	0.011***	0.061***
	(0.009)	(0.002)	(0.008)
DEPARTMENT	-0.610**	0.095**	0.515**
	(0.262)	(0.041)	(0.222)
Sector Dummies	YES	YES	YES
Time Dummies	YES	YES	YES
Nr. of firms	572	572	572
Observations	2860	2860	2860

Notes for Table 2: The table reports Average Marginal Effects (AME) with clustered standard errors over 572 firms in parentheses. ***, ** and * indicate significance on a 1%, 5% and 10% level. Ordered Probit model is used for estimating the effect of TMT and FMT diversity on three types of Search Strategy of firms, with “No strategy” (no internal and external R&D investments) as the base model (strategy). The results are based on the balanced panel of five waves of CIS with t=2004, 2006, 2008, 2010, 2012.

Table 3-TMT and FMT diversity and innovation performance of firms

VARIABLES	(6) No Innovation	(7) Incremental Innovation	(8) Radical Innovation
TMT_DIV	0.032	-0.119	-0.023
	(0.024)	(0.089)	(0.017)
FMT_DIV	-0.082***	0.030***	0.059***
	(0.021)	(0.079)	(0.015)
EXPORT INTENSITY	-0.025	0.095	0.018
	(0.031)	(0.115)	(0.022)
PHYSICAL CAPITAL	0.011***	-0.040***	-0.008***
	(0.003)	(0.013)	(0.002)
TURNOVER	-0.008	0.030	0.006
	(0.008)	(0.028)	(0.005)
SEARCH STRATEGY	-0.241***	0.903***	0.174***
	(0.007)	(0.039)	(0.007)
DEPARTMENT	-0.000	0.000	0.000
	(0.175)	(0.655)	(0.126)
Sector Dummies	YES	YES	YES
Time Dummies	YES	YES	YES
Nr. of firms	572	572	572
Observations	2860	2860	2860

Notes for Table 3: The table reports Average Marginal Effects (AME) with clustered standard errors over 572 firms in parentheses. ***, ** and * indicate significance on a 1%, 5% and 10% level. The result are based on Ordered Probit models. The base category is "No Innovation". The results are based on the balanced panel of five waves of CIS with t=2004, 2006, 2008, 2010, 2012. Using Multinomial Logit model, as an alternative estimator, reveals similar results.

Table 4-TMT and FMT diversity and innovation performance of firms with respect to search strategy

VARIABLES	(9) Innovation	(10) Innovation
TMT_DIV	-0.302**	-0.085
	(0.141)	(0.090)
FMT_DIV	0.305***	0.170
	(0.079)	(0.110)
SEARCH STRATEGY	0.906***	0.974***
	(0.043)	(0.062)
TMT_DIV# SEARCH STRATEGY	1.225***	
	(0.337)	
TMT_DIV# SEARCH STRATEGY ^2	-0.594***	
	(0.159)	
FMT_DIV# SEARCH STRATEGY		1.086***
		(0.153)
FMT_DIV# SEARCH STRATEGY ^2		-0.571***
		(0.065)
EXPORT INTENSITY	0.087	0.065
	(0.115)	(0.113)
PHYSICAL CAPITAL	-0.040***	-0.039***
	(0.013)	(0.013)
TURNOVER	0.034	0.040
	(0.029)	(0.028)
DEPARTMENT	0.024	-0.058
	(0.659)	(0.671)
Sector Dummies	YES	YES
Time Dummies	YES	YES
Nr. of firms	572	572
Observations	2860	2860

Notes for Table 4: The table reports estimated parameters with clustered standard errors over 572 firms in parentheses. ***, ** and * indicate significance on a 1%, 5% and 10% level. The result are based on two separate Ordered Probit models in Model (9) and (10). The base category in both cases is "No Innovation", which is not shown. The results are based on the balanced panel of five waves of CIS with t=2004, 2006, 2008, 2010, 2012. Using Multinomial Logit model, as an alternative estimator, reveals similar results.

Appendix A1-Definition of TMT and FMT, based on International Classification of Occupations ISCO-88COM

ISCO88COM Code	Corporate Managers (Code 12)	TMT or FMT
121	**Directors and chief executives**	TMT
1210	Directors and chief executives	"
122	**Production and operations managers**	FMT
1221	Production and operations managers in agriculture, hunting, forestry and fishing	"
1222	Production and operations managers in manufacturing	"
1223	Production and operations managers in construction	"
1224	Production and operations managers in wholesale and retail trade	"
1225	Production and operations managers in restaurants and hotels	"
1226	Production and operations managers in transport, storage and communications	"
1227	Production and operations managers in business services enterprises	"
1228	Production and operations managers in personal care, cleaning and related services	"
1229	Production and operations managers not elsewhere classified	"
123	Other specialist managers	
1231	**Finance and administration managers**	FMT
1232	**Personnel and industrial relations managers**	FMT
1233	**Sales and marketing managers**	FMT
1234	**Advertising and public relations managers**	FMT
1235	**Supply and distribution managers**	FMT
1236	**Computing services managers**	FMT
1237	**Research and development managers**	FMT
1239	**Other specialist managers not elsewhere classified**	FMT

Appendix A2-Variable definitions

Variables	Definitions
$SEARCH\ STRATEGY_{i,t}$	Gets value 0 if firm i in year t did not invest neither in internal R&D nor external R&D (no search strategy) Gets value 1 if firm i in year t invests in either internal R&D or external R&D (narrow search strategy) Gets value 2 if firm i in year t invests in both internal R&D and external R&D (broad search strategy)
$INNOVATION_{i,t}$	Gets value 0 if firm i in year t did not introduce any product innovation* (no innovation) Gets value 1 if firm i in year t introduces at least a product innovation new to firm (incremental innovation) Gets value 2 if firm i in year t introduces at least a product innovation new to market (radical innovation) *A product innovation is defined as the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems.
$TMT\_DIV_{i,t}$	An entropy measure that captures the diversity of TMT in firm i in year t (see Equation (1) for formula)
$FMT\_DIV_{i,t}$	An entropy measure that captures the diversity of FMT in firm i in year t (see Equation (2) for formula)
$TURNOVER_{i,t}$	The amount (value in SEK) of turnover of firm i in year t (log)
$PHYSICAL\ CAPITAL_{i,t}$	Sum of investments in Buildings and Machines at year's end for firm i in year t (log)
$EXPORT_{i,t}$	The amount (value in SEK) of export per employee in firm i in year t (log)
$DEPARTMENT_{i,t}$	The number of departments per employee in firm i in year t, measured as the maximum number of different types of FMTs in the firm
$Sector\ dummies_i$	Sector-specific component captured by seven industry dummies in 1-digit NACE code
Time Dummies	Time-specific component captured by five year dummies

Appendix A3-Descriptive Statistics

VARIABLES	Observation	Mean	Std. Dev.	Min	Max
SEARCH STRATEGY	2860	0.78	0.86	0	2
INNOVATION	2860	0.59	0.79	0	2
TMT_DIV	2860	0.18	0.35	0	1.74
FMT_DIV	2860	0.65	0.51	0	1.91
EXPORT INTENSITY	2860	0.24	0.32	0	1
PHYSICAL CAPITAL	2860	16.56	3.28	0	23.96
TURNOVER	2860	19.03	1.88	13.81	25.44
DEPARTMENT	2860	0.04	0.04	0	0.42

Appendix A4-Robustness check with instrumental variable approach (2SLS)

VARIABLES	(1') Search Strategy	(2') Search Strategy	(3') Innovation	(4') Innovation
TMT_DIV	0.429*	0.184***	1.314***	-0.047
	(0.240)	(0.056)	(0.324)	(0.048)
FMT_DIV	-0.004	-0.488*	0.100**	0.263***
	(0.052)	(0.264)	(0.053)	(0.100)
EXPORT INTENSITY	0.689***	0.674***	0.235***	0.148**
	(0.081)	(0.079)	(0.087)	(0.062)
PHYSICAL CAPITAL	0.008	0.017*	-0.018**	-0.019***
	(0.007)	(0.008)	(0.009)	(0.006)
TURNOVER	0.115***	0.221***	-0.070***	-0.013
	(0.026)	(0.049)	(0.025)	(0.022)
DEPARTMENT	1.018**	2.768***	0.084	-0.376
	(0.514)	(1.038)	(0.418)	(0.452)
SEARCH STRATEGY			0.454***	0.061***
			(0.027)	(0.003)
Sargan test	1.18	0.477	2.01	1.733
	(0.277)	(0.489)	(0.155)	(0.188)
DWH test	1.37	5.22	50.57	4.49
	(0.240)	(0.022)	(0.000)	(0.034)
Sector Dummies	YES	YES	YES	YES
Time Dummies	YES	YES	YES	YES
Nr. of firms	572	572	572	572
Observations	2860	2860	2860	2860

Notes for Appendix 4: The table reports estimated parameters with clustered standard errors over 572 firms in parentheses. ***, ** and * indicate significance on a 1%, 5% and 10% level. 2SLS estimator is used in all four models and the table reports only the result of the 2nd stage. In Model 1' and 3', TMT_DIV is considered endogenous. It is instrumented with all explanatory variables plus total number of managers and average TMT_DIV in industry level. In Model 2' and 4', FMT_DIV is considered endogenous. It is instrumented with all explanatory variables plus total number of managers and average FMT_DIV in industry level. The results are based on the balanced panel of five waves of CIS with t=2004, 2006, 2008, 2010, 2012.

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