Team size, diversity and performance of new ventures and SMEs in the UK: a meta-analysis

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EXECUTIVE SUMMARY

This paper describes what we know about the effect of top managerial teams (TMT) size and diversity on the performance of new ventures and SMEs. It does so by summarising the results of a thorough literature search of quantitative studies published on this topic between 1990 and 2016 and of a meta-analysis on the relationships reported in these studies.

The search revealed 47 studies and 266 measured relationships between TMT size or diversity and firm performance. These studies employed different samples, econometric techniques, geographical and industry sector focus. Almost 77% of the studies in our sample focus on new ventures, 60% on high-tech firms and 36% on SMEs.

Meta-analysis provides a systematic approach to reviewing the existing literature on a specific topic and synthesizing the prior empirical results, and estimates the effect size of the relationship, that is its strength and statistical significance across different studies. While the meta-analysis reveals many significant and positive effects of team size and diversity, the range of effects varies quite widely depending on context, generating a range of effect sizes from small to large. This inconsistency in results suggests that more replicative studies are required to add to the body of knowledge on team effects on performance.

The analysis showed the following consistent results for new ventures and established SMEs: a medium positive effect size of functional diversity on innovation, ethnic/gender diversity on internationalization, and experience diversity on other performance measures. Consistent results were also obtained for a small positive effect size of experience diversity on internationalization.

Other results differ between groups of firms:

- For new ventures, we find a very high effect size for ethnic/gender diversity on employment size, a very small effect size of team size on innovation, and a medium high effect size of ethnic/gender diversity on other performance measures.

- For high tech ventures (both new and established) we find a medium effect of education diversity on other financial measures of performance and a medium effect of functional diversity on innovation.

Our findings support a widespread view that a well-balanced management team is more likely to deliver strong performance. Some of these associations, for example an apparent link between gender/ethnicity diversity and internationalization, are particularly intriguing and warrant further research.

In policy terms our results suggest the value of considering both diversity and the size of top management teams in any form of growth or performance audit. In general terms, larger more diverse teams are associated with better performance. Context matters, however, with the evidence suggesting that the benefits of different aspects of diversity differ between firms in low-tech industries and high-tech ventures.

CONTENTS

INTRODUCTION AND SCOPE OF THE STUDY

The objective of this white paper is to provide researchers, policy makers and entrepreneurs with a clear summary of the effect of top managerial teams (TMT) size and diversity on the performance of new ventures and SMEs as demonstrated by previous empirical studies conducted on this topic. TMTs are typically composed of senior executive directors and function heads.

Studies on this topic have employed different samples, econometric techniques, geographical and industry sector focus to estimate the effects of TMT size and diversity on firms' performance. It is not surprising therefore that estimates of these effects vary widely across studies. Given this wide range of results, it is difficult to easily summarize the overall effect of TMT characteristics on the performance of firms. However, meta-analysis techniques can help to generalize from diverse samples, identify possible factors driving the heterogeneity in the results of samples of empirical studies, and present key findings that are statistically robust.

We make four main contributions in this white paper. First, we provide the results of an up-to-date literature search for studies of new ventures and SMEs that include measures of TMT size and/or diversity and firm performance published between 1990 and 2016. This search generated 47 studies and 266 point estimates, i.e. identified measured relationships between TMT size or diversity and firm performance, for the meta-analysis. Second, we examine how different definitions of TMT size and diversity affect outcomes on several measures of firms' performance, using meta-analysis techniques to conduct statistical tests on these relationships. Third, we explore why point estimates vary, including reasons such as different sample sizes, control variables, moderating effects, research focus and estimation techniques used in these studies. Finally, we conduct several robustness tests in order to check the statistical consistency of our analysis.

In the next section, we show how we searched the literature and summarise the dependent, independent and moderating variables used in the studies located. Section 3 presents the methodology used for the meta-analysis and the meta-regressions. Section 4 presents the distribution of effect sizes across the different studies, reporting the outcome of the meta-analysis and meta-regression. Section

5 discusses possible implication of these results for researchers, policy makers and entrepreneurs.

SAMPLE

As a first step, we conducted an extensive and systematic search of the academic literature to identify relevant empirical studies, i.e. documents such as peer-reviewed articles, PhD theses, working papers or conference papers, published between 1990 and 2016. We describe how we did this in Appendix 1. Our final sample includes 47 studies, with a total of 266 point estimates, i.e. measured relationships between TMT size or diversity and firm performance of new ventures or SMEs.

We employed the following categorisations to distinguish between new ventures and more established SMEs, and to identify high-tech businesses within these two groups.

1. SMEs: Small and medium-sized enterprises (SMEs) have been broadly defined by the OECD[1] as firms which employ fewer than a given number of employees. This number varies across countries. The most frequent upper limit designating an SME is 250 employees, as in the European Union. However, some countries set the limit at 200 employees, while the United States considers SMEs to include firms with fewer than 500 employees.

2. New Ventures: new ventures or start-ups are new independent business entities in the early stage of their life, varying between 0 to 5 or 10 years of business activity. Most business new ventures are usually small and medium enterprises, but not exclusively.

3. High-Tech: firms are considered to be high-tech if they operate in high-tech manufacturing and services industries characterised by high R&D, knowledge intensity and R&D investments. Following the OECD classification[2], manufacturing high-tech firms operate in the following sectors: chemicals and pharmaceuticals;

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[1] OECD (2005). OECD SME and Entrepreneurship Outlook. Paris: OECD.
[2] OECD (2003), OECD Science, Technology and Industry Scoreboard. Paris: OECD.

machinery and engines; computers and office machinery; electrical machinery; IT and communication equipment; medical, precision and optical instruments; motor vehicles and transport equipment. Knowledge-intensive services (KIS) include the following sectors: air transports; post and telecommunications; financial intermediation; insurance; auxiliary activities to financial intermediation; real estate; computer related activities; research and development; other business activities; education; health and social work; recreational, cultural and sporting activities.

Table 1 below shows that almost 77% of the studies in our sample focus on new ventures, 60% on high-tech firms and 36% on SMEs. Almost 60% of the studies are on TMT, 40% on founding teams and 11% on board members, with some overlap between these categories. More than half of the studies look at US firms, following the usual trend in this literature, with only 38% on firms based in the EU and less than 15% on firms in developing countries. The industry sector distribution is skewed towards studies on manufacturing sectors, possibly because of better access to firm-level data in these sectors, with less than 40% of studies looking at service firms.

Most of these papers investigate the effect of team size or diversity in terms of experience (more than 60% each). On the other hand, performance is mostly measured in terms of sales growth (used in 32% of studies), followed by employment growth (25%) and other financial performance measures (19%). Finally, just a quarter of studies in our sample investigated the interacting impact of several firm-level (15%), team-level (10%) or environmental characteristics, as defined in Table A3 in Appendix 1.

Table 1 Summary statistics of the studies included in the meta-analysis

	No. of Obs.	% of Obs.	No. of Studies	% of Studies		No. of Obs.	% of Obs.	No. of Studies	% of Studies
SMEs	113	42.48	17	36.17	*Independent Variable*				
New	212	79.7	36	76.6	Age	13	4.87	8	17.02
High-Tech	127	47.57	28	59.57	Diversity	20	7.49	8	17.02
Team					Education	42	15.73	17	36.17
TMT	168	62.92	28	59.57	Experience	88	32.96	29	61.7
Board	18	6.74	5	10.64	Functional	22	8.24	11	23.4
Founding	81	30.34	19	40.43	Network	21	7.87	10	21.28
Geographical Distribution					Size	60	22.47	30	63.83
All	18	6.74	1	2.13	*Dependent Variables*				
Asia	19	7.12	5	10.64	Employment	44	16.48	12	25.53
Australia	4	1.5	1	2.13	Finance	47	17.6	9	19.15
EU	77	28.84	18	38.3	Innovation	23	8.61	7	14.89
N. America	146	54.68	24	51.06	International	39	14.61	7	14.89
S. America	3	1.12	1	2.13	Performance	30	11.24	8	17.02
Interaction Effects					Profit	31	11.61	7	14.89
None	200	74.91	41	87.23	Sales	53	19.85	15	31.91
Environment	9	3.37	1	2.13	*Industrial sectors*				
Firm-level	39	14.61	7	14.89	Service	135	50.75	18	38.3
Team-level	19	7.12	5	10.64	Manufacturing	131	49.25	29	61.7

META-ANALYSIS METHODOLOGY AND EFFECT SIZE

Meta-analysis provides a systematic approach to reviewing the existing literature on a specific topic and synthesizing the prior empirical results, and estimates the effect size of the relationship, that is its strength and statistical significance across different studies.

A detailed description of the methodology used is given in Appendix 2. In summary, after selecting the studies for the meta-analysis, we coded their main characteristics and results. After coding and standardizing all the variables, we computed the average effect size for almost 30 different categories of studies, representing each combination of 7 firm performance dependent variables and 7 dimensions of team size and diversity for which an adequate number of samples were available. In generating categories, some "lumping" of performance and diversity types was inevitable; for example gender and ethnicity measures. As additional studies become available, more fine-grained analysis will be possible.

Effect sizes are measures of the strength of an association between two variables in a sample that are comparable across different studies. Effect sizes for the same relationship generated by many different studies can be averaged, taking into account the size of different samples, to provide a more general estimate of the strength of the relationship.

As a guide, effect sizes of around 0.1 are "small", effect sizes around 0.3 are considered "medium" and effect sizes around 0.5 and above are considered "large"[3]. It may help to imagine a "medium" effect size as a clear and visible effect, one that would be noticeable to a careful observer.

In addition to measuring the strength of the relationship in terms of "size", we can also estimate the "statistical significance" of the relationship, in the sense that the effect is probably real and not a random chance occurrence of an apparent relationship. This tends to be expressed as a probability of a chance occurrence of the relationship. Probabilities of less than 5% are usually accepted as evidence that the relationship is most probably not due to chance and therefore "statistically significant". Both the size and the statistical significance of an effect size should be taken into account when judging whether a relationship between two variables is meaningful or not.

RESULTS

4.1 Meta-Analysis

Figure 1 shows the calculated average effect sizes that were statistically significant for size, all types of diversity combined and different types of diversity on all types of performance combined, based on the 266 different relationships measured in the 47 studies. Figure 2 shows the calculated average effect sizes that were statistically significant for almost 30 combinations of firm performance and entrepreneurial team size and diversity. Tables A2.1 and A2.2 in Appendix 2 list the actual effect sizes and additional statistical detail for each combination.

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[3] Cohen, J (1992). "A power primer". Psychological Bulletin 112 (1): 155–159.

Figure 1 shows that team size and team diversity appear to have positive and significant effects on performance overall, but the range of effects varies from very small to large. However, combining different performance measures together may be misleading. Figure 2 provides a more nuanced picture. When analysed by performance type, team size has a medium and significant effect on employment growth, and very small but positive and significant effects on innovation and internationalization. Ethnic/gender diversity appears to be the diversity type with the highest significant effect size when all performance variables are combined, but diversity in previous experience seems to have the highest effect size when broken down by performance type, having a large and significant effect on the innovation propensity of firms and on their financial performance (other than profitability). Indeed, diversity in experience was the only team characteristic found to have a significant impact on this performance dimension. Diversity of experience within the entrepreneurial team also has very small but positive and statistically significant effects on internationalization, employment growth and sales performance.

Other noteworthy size effects include the medium-high positive effect size of the relationship between functional diversity and sales performance and the medium-small positive effect size of the relationship between functional diversity and profitability. Diversity of experience and functional diversity may be correlated, making this a potentially strong combination. We also note a medium-small positive effect size of the relationship between education diversity and sales performance and a medium positive effect size of the relationship between ethnic/gender diversity and internationalization. The only significant negative effect sizes of a diversity measure were the small negative effect sizes for of ethnic/gender diversity on profitability and the very small negative effect sizes of functional diversity on innovation.

These results are suggestive rather than definitive, because as Tables A2.1 and A2.2 show, for most of these effect sizes there is strong evidence of a wide variation in results (known as heterogeneity) for the same relationship, suggesting that other, unmeasured variables may affect each relationship. Of the significant relationships in Figure 2, only two are consistent across studies: the medium effect of functional diversity on both sales and profits. In the next section, we examine sources of heterogeneity in effect sizes in more detail.

Figure 1 Summary of the meta-analysis significant mean effects for all performance measures combined.
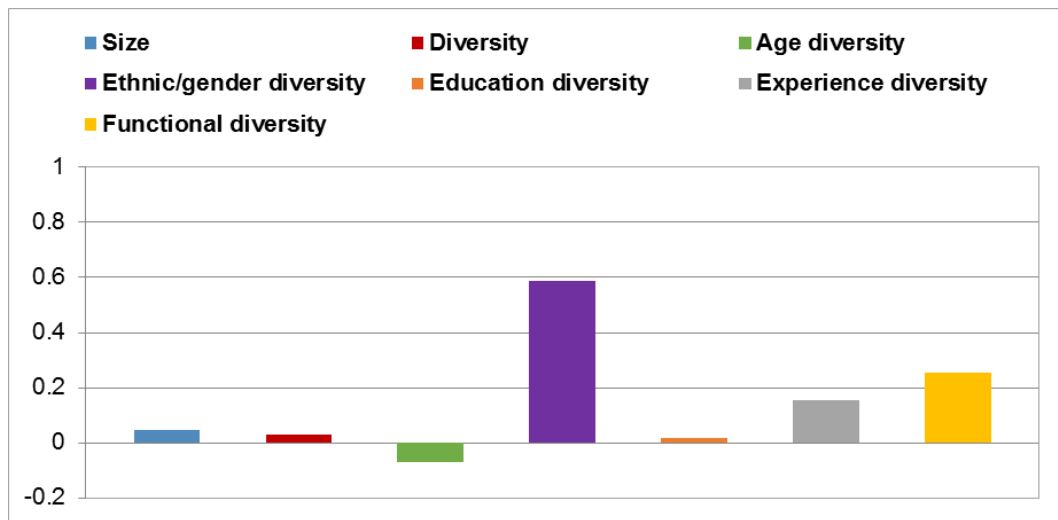
Figure 2 Summary of the meta-analysis significant mean effects by type of performance measure. Black border denotes absence of heterogeneity in effect sizes across samples.
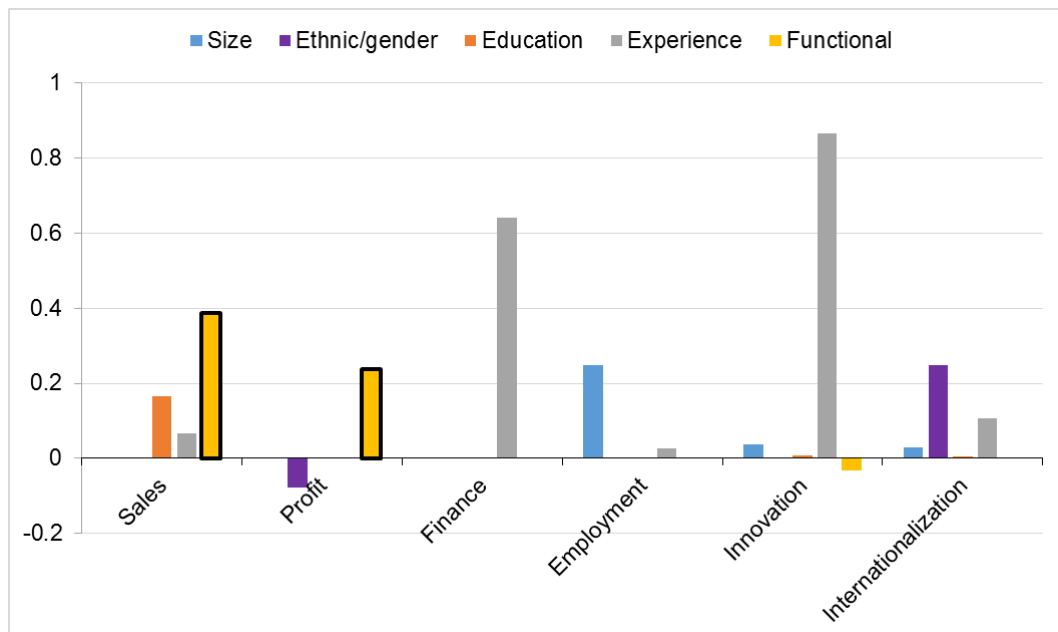
4.2 Meta-Regressions

Given the very high heterogeneity in the results of the underlying studies highlighted by the meta-analysis in some of the combination groups in Tables A2.1 and A2.2 and Figures A2.1 to 3, we conducted a meta-regression to explore the source of this heterogeneity in each combination. The objective of a meta-

regression analysis is to identify specific variables or circumstances causing excess dispersion (real variation) in the results, i.e. variation not related to the sampling error.

A relationship between two variables may be affected by a third variable in two main ways. The first way is where the strength or direction of the relationship is changed by the presence or absence, or relative strength, of a third variable. Here, the third variable is said to moderate the relationship between the variables rather than the variables themselves. Secondly, the effect of one variable on another may be partly or wholly routed through a third variable. This termed partial or complete mediation. Moderating and mediating variables can mask or exaggerate relationships between variables, and it is therefore important to test for these effects.

We tested the effect of 12 different moderating variables including geographic location, the difference between papers looking at SMEs, new ventures and high-tech firms, the effect of analysing TMT versus boards or founding groups, variation in terms of sample size, the length of the time period, the econometric technique used and the number of variables included. We also tested for variability in terms of different team size and diversity characteristics used by studies as independent variables and the several measures of performance employed as dependent variables, plus the role played by moderating variables included in some of the studies.

Table 3 summarizes the results of the meta-regressions for the full sample, for studies focusing on team size and team diversity, and for samples of SMEs, new ventures and high-tech firms. Table A2.4 in Appendix 2 shows more detailed results, including the relative strength of the effect as expressed by standardized coefficients. Many of the test variables appeared to increase the heterogeneity of point estimates in the full sample. For example, geographical location significantly changes the dispersion in the results for diversity effect sizes, although the strength of the effect is rather low. Restricting the sample of studies of diversity effects to SMEs appears to generate more precise effect sizes (negative sign) but restricting studies to high tech firms generates less precise effect sizes (positive sign). These effects are also relatively large in comparison to most other variables, suggesting that these types of studies should not be lumped together in meta-analyses.

More sophisticated statistical methods appear to reveal additional heterogeneity in the full sample and the diversity sample. Controlling for moderation seems to significantly increase precision in studies of team size but not in studies of team diversity, possibly because third variables may affect the relationship between some but not all forms of diversity and performance. As expected, the different dependent and independent variables used in the full sample of studies help to explain the high heterogeneity. Similarly, the length of the sample period affects the precision of effect sizes; the longer the panel the more variable the effect sizes. Finally, the number of control variables included in the regression models is statistically significant in explaining the variance heterogeneity in the full sample and diversity sample; the more controls, the less heterogeneity in results although this effect is not very strong.

Table 2 Results of the meta-regression models for the full sample, size and diversity samples, and for samples of SMEs, young and high-tech firms. Positive signs indicate a variable increases heterogeneity of results.

	(1) FULL SAMPLE	(2) SIZE	(3) DIVERSITY	(4) SMEs	(5) YOUNG	(6) HIGH-TECH
Geography	+*	+*	+***	+***	n.s.	+**
Sample Size	n.s.	n.s.	n.s.	+**	n.s.	+*
SME	-***	n.s.	-**		n.s.	+*
Young	-**	n.s.	-*	n.s.		n.s.
High-Tech	+***	n.s.	+***	n.s.	+*	
TMT/Board	n.s.	n.s.	n.s.	n.s.	n.s.	-**
Estimation Method	+***	n.s.	+***	n.s.	n.s.	n.s.
Moderation	n.s.	-**	n.s.	n.s.	n.s.	n.s.
Independent Variable	+**		+*	n.s.	n.s.	n.s.
Dependent Variable	+**	n.s.	n.s.	n.s.	n.s.	n.s.
Panel Period	+***	+***	+**	+***	+***	+***
No. of Control Variables	-***	n.s.	-**	n.s.	n.s.	n.s.
No. Observations	266	60	206	113	194	126

Statistical significance legend:
n.s. not significant; * marginally significant; ** significant, *** highly significant

Table 2 also enables comparison of the main sources of heterogeneity in the different sub-samples. From columns 2 and 3, note that the heterogeneity within the subsamples of size versus diversity focus studies differs widely. For size related studies, only the geographical focus and the length of the time period seem to affect the heterogeneity of the point estimates across studies, while studies including moderating effects reduce heterogeneity. The diversity sample instead follows quite closely the general sample pattern, which is not surprising since it contains studies of very different forms of diversity. The main sources of heterogeneity are whether the firms are SMEs, new ventures or high-tech firms, followed by the methodology used, panel period, geographical focus, and number of control variables included.

Finally, we split the general sample into three different sub-samples, one for each category of firms: SMEs, new ventures and high-tech firms. We found that the overall heterogeneity is drastically reduced when the sample contains a

homogeneous group of firms, such as SMEs only or new ventures only. In the point estimates of studies focused on SMEs, only the geographical focus and the size and length of the sample are significant sources of variability, and the strength of the geography effect is weak. In the sub-sample of new ventures, only the panel period length significantly affects heterogeneity. Most heterogeneity appears to be restricted to the high-tech sample, where geographical focus, whether the study is of TMT or board members, and period length are all statistically significant and relatively strong sources of heterogeneity. Specifically, studies in OECD rather than developing countries, studies of board members rather than TMT members, and longer panel studies all contribute to heterogeneity of effect sizes in high tech firm studies.

4.3 Effect sizes in studies of SMEs, new ventures and high tech firms

Since the results of the meta-regressions in section 4.2 showed that most heterogeneity is in the high tech firm samples, we re-ran meta-analyses on the three different types of firms: SMEs, new ventures and high tech firms. The full results are in Appendix 2 Tables A2.5, A2.6 and A2.7. Figures 3, 4 and 5 below show the significant effect sizes, with results that show consistency across studies, i.e. an absence of heterogeneity, bordered in black.

Figure 3 shows that for SMEs, consistent results were obtained for a medium positive effect size of functional diversity on innovation, ethnic/gender diversity on internationalization, and experience diversity on other performance measures. Consistent results were also obtained for a small positive effect size of experience diversity on internationalization. The result for innovation consisted of only two studies on high technology firms so some caution is warranted with this result.

Figure 3. Main significant effect sizes of independent variables on SMEs performance; black borders indicate consistent effect sizes, i.e. where heterogeneity is not indicated
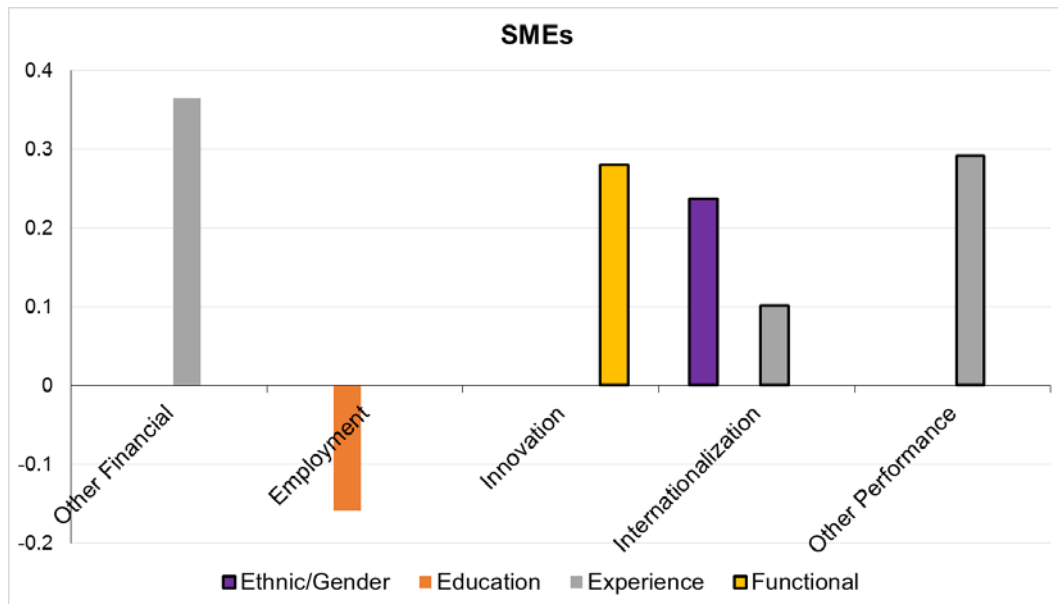
Figure 4 shows a range of significant effect sizes for the new venture sample, but relatively few of these show homogeneity in effect sizes, and none of them match the findings for SMEs. Consistent results include a very high effect size for ethnic/gender diversity on employment size, a very small effect size of team size on innovation, and a medium high effect size of ethnic/gender diversity on other performance measures. Since sample panel length significantly affects the variability in results across different new venture studies, further work could investigate if there is more consistency in results when the sample is split into above and below median panel length.

Figure 4 Main significant effect sizes of independent variables on new venture performance; black borders indicate effect sizes where heterogeneity is not indicated

Finally, only two effect sizes were both significant and consistent for high technology firms in the sample, as shown in Figure 5. These were a medium effect of education diversity on other financial measures of performance and a medium effect of function diversity on innovation. The latter result is for two studies of SMEs, and so is the same result as in Figure 3.

Figure 5 Main significant effect sizes of independent variables on high technology business performance; black borders indicate effect sizes where heterogeneity is not indicated
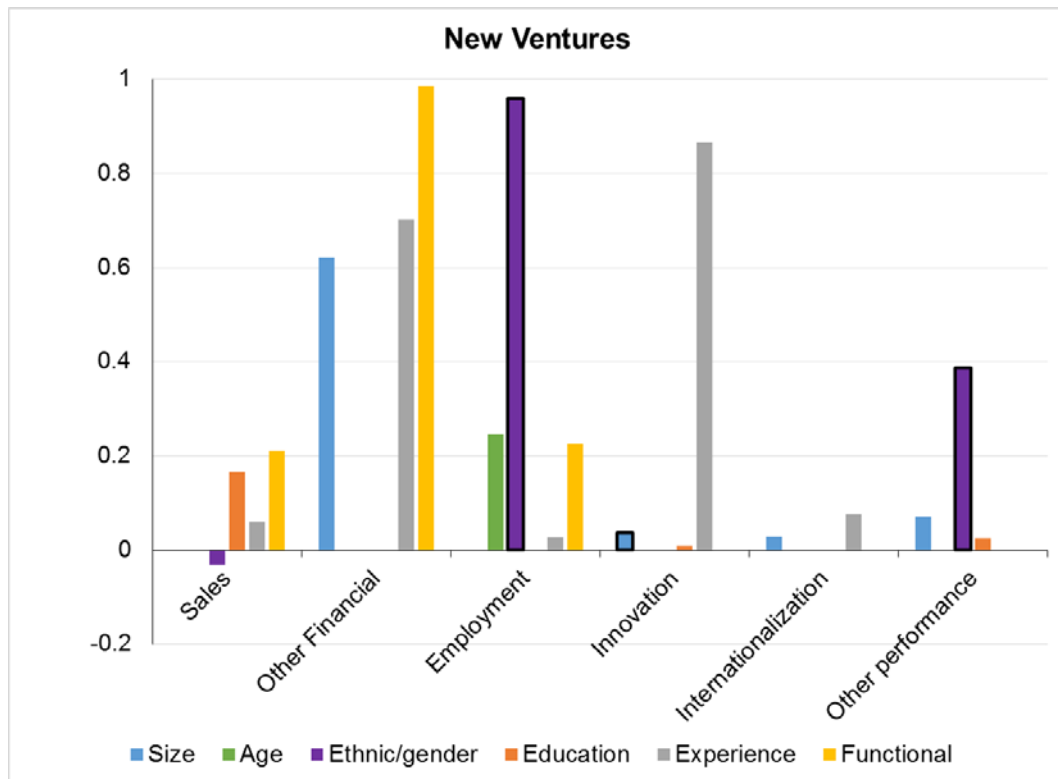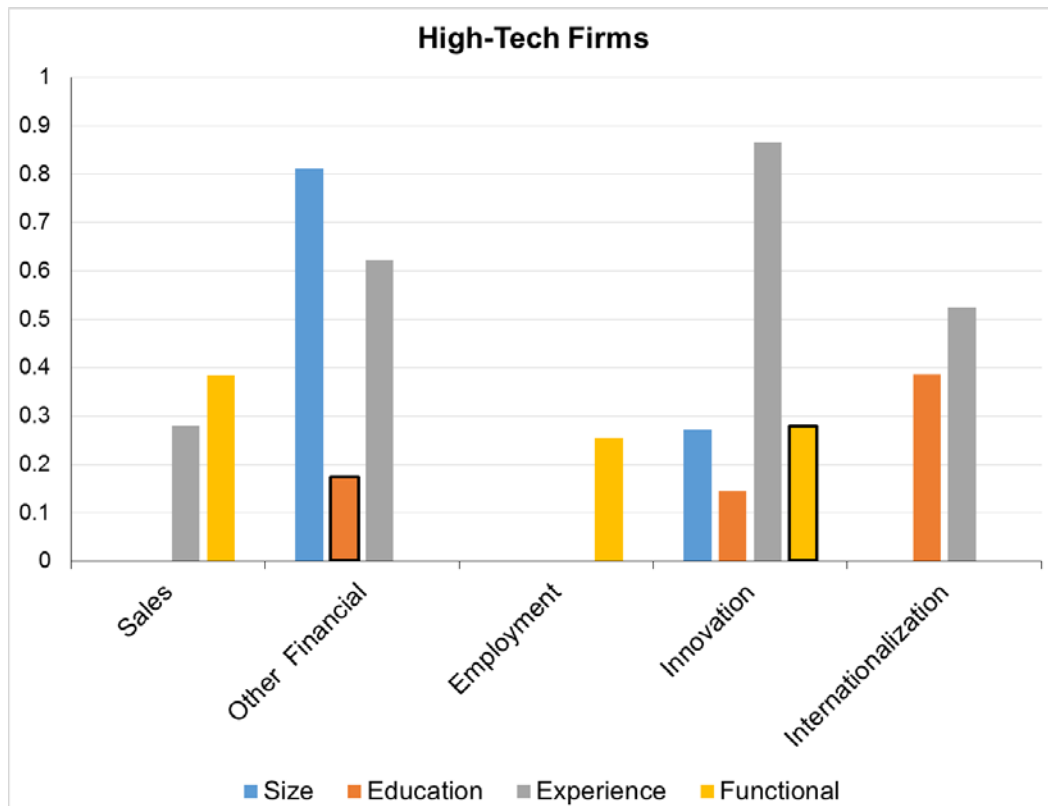
TEAM SIZE AND DIVERSITY: IMPLICATIONS FOR POLICY

We identified 47 studies and 266 separate relationships in our literature review on team size, diversity and firm performance. A general result is that functional diversity has a significant medium effect on sales and profits performance measures and that this is consistent across studies in the sample as a whole. Almost all the significant effects in the main sample and in subsamples were positive, suggesting that, overall, larger team sizes and more diverse teams lead to superior performance.

However, as we parse the data into smaller subsamples, there is less clarity with different relationships coming to the fore in different subsamples.

Team size appears to have a number of positive effects on new venture and high tech firm performance. There is a very small but consistent effect of team size on innovativeness across six studies of new ventures. There is also a significant and

large effect of team size on measures of return and valuations (the "other financial" category of performance) of new and high tech ventures, though this is not consistent across studies.

Different types of team diversity appear to have different effects on different performance measures in different types of firms:

- For new ventures, we find a very high effect size for ethnic/gender diversity on employment size, a very small effect size of team size on innovation, and a medium high effect size of ethnic/gender diversity on other performance measures.
- For high tech ventures (both new and established), we find a medium effect of education diversity on other financial measures of performance and a medium effect of functional diversity on innovation.

Our findings support a widespread view that a well-balanced management team is more likely to deliver strong performance. Some of these associations, for example an apparent link between gender/ethnicity diversity and internationalization, are particularly intriguing and warrant further research.

In policy terms, our results suggest there is value in considering both diversity and the size of top management teams for any form of growth or performance audit. In general terms, larger more diverse teams are associated with better performance. Context matters, however, with the evidence suggesting that the benefits of different aspects of diversity differ between firms in low-tech industries and high-tech ventures.

The inconsistency in results between group suggests that more replicative studies are required to add to the body of knowledge on team effects on performance. While we see many significant and positive effects of team size and diversity, the range of effects varies quite widely depending on context, generating a range of effect sizes from small to large. More replicative studies would enable us to identify effect sizes with greater precision.

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APPENDIX 1: META-ANALYSIS LITERATURE SEARCH METHODOLOGY

We conducted an extensive and systematic search of the academic literature to identify all empirical studies published between 1990 and 2016 and available in three comprehensive databases: EBSCO, Social Science Research Network, and Google Scholar. We included in our search multiple targets, including studies published in peer-reviewed journal, working paper series, PhD thesis and papers submitted to academic conferences with empirical econometric estimation of the relationship between TMT size/diversity and firms performance.

In order to capture as many relevant studies as possible we used three different categories of keywords. The first category is type of entrepreneurial team, including TMT, board of directors and team of founders. The second category is keywords related to team size and diversity to identify our independent variables as classified in Table A1 below. The third category is measures of firm performance as listed in Table A2 below. In a second step, we included studies referenced by the studies identified in the first step. This generated 177 studies. We then excluded those looking at the effect of team effectiveness rather than firm performance, leaving 123 studies. From these results, we further restricted our sample, focusing just on studies investigating SMEs, new ventures or firms operating in high-tech industries. After applying these selection criteria, our final sample includes 47 studies published between 1990 and 2016 (one of which was published in January 2017 but available to the authors), with a total of 266 point estimates (i.e., measured relationships between TMT size or diversity and firm performance).

Table A1.1 Definitions of independent variable measures

Size	Age	Ethnic/ Gender	Education	Experience	Functional	Network
Large	Age	Ethnic	Education	Government	Functional	Duality
Size		Gender	Major	IT experience		Independence
Size growth		Heterogeneity		IT knowledge		Locus
Turnover		Race diversity		Academic status		Network
				Background		Ownership
				Experience		Share of founders
				Industrial		Share of insiders
				International		Share of original TMT
				International exposure Knowledge		Share of outsiders
				Knowledge diversity Knowledge scope		
				Manufacturing		
				Prior affiliation		
				Senior		
				Skills		
				Start-up		
				Teamwork		
				Technical		
				Technological		

Table A1.2 Definitions of dependent variable measures

Sales	Profit	Other Financial	Employment	Innovation	International-ization	Other Performance
Load factor	Profit	Asset growth	Employment growth	Idea generation	FDI	Production efficiency
Revenue growth	Long term profit	Pr. IPO		Innovation	FDI intensity	Labour productivity
Sales growth	Short term profit	IPO share value		Innovation introduction	Export intensity	Performance
Sales		ROA		R&D expenditure	International alliances	Performance growth
Sales/ assets		ROA variability		Process innovation	International diversification	
Turnover		ROE		Product innovation	Internationalization	
Turnover / asset		ROI		Product to market	Joint ventures	
Market opportunity		ROS				
		Returns growth				
		Q ratio				
		Z-score				
		M&A				
		Market share				
		Market to book				
		Market value				
		Post IPO				
		VC deals				
		Cost of capital				
		Venture capital				

Table A1.3 Definitions of moderating variables measures

Team-level	Firm-level	Environment-level
Assimilation	R&D	Competition
Cohesion	Innovativeness	Credit risk
Collaboration	Internationalization	Cultural distance
Complexity	Manufacturing	Industry diversification
Consensus	Post-IPO	Region diversification
Debate	Pre-IPO	Environment
Education	Product innovation	International risk management factor
Founding experience	Risk taking	Uncertainty
Functional	Business model	
Gender	Entrepreneurial orientation	
Influence	Marketing	
Knowledge absorptive	Novelty	
Opacity	ROA	
Participative strategy		
TMT size		
Age		
TMT ownership		
Non-duality		
Spin-out founder earnings		

APPENDIX 2. META-ANALYSIS METHODOLOGY

Meta-analysis provides a systematic approach to reviewing the existing literature on a specific topic and synthesizing the prior empirical results, and estimates the effect size of the relationship, that is its strength and statistical significance across different studies.

After selecting the studies for the meta-analysis, we coded their main characteristics and results. Although all studies in the meta-sample measured the relationship between TMT size and/or diversity and firm performance, many different variables and measures were used across the sample of studies. We coded the independent, dependent and mediating variables according to the definitions in Tables A1-A3, and coded and standardized the control variables used in the meta-analysis and meta-regression such as geographical location, sample size, econometric techniques used for the estimations, length of the sample period and number of control variables included in the primary studies.

After coding and standardizing all the variables, we used the STATA command *metan* to compute the mean effect size for almost 30 different categories of studies, representing each of the seven firm performance dependent variables with respect to the seven dimensions of team size and diversity[4]. We started by weighting each study by its sample size, in order to assign more explanatory power to studies estimating the effect in a more rigorous way by using large samples[5].

For robustness checks, we also measured the main effect size using a random-effect model which controls for both the within and between-study variance. Many previous studies have argued for the use of a random effects model when combining studies from different researchers and contexts as it assumes heterogeneity between the studies due to a sampling error as well as an additional variability component that is assumed to be randomly distributed (Borenstein et al.,

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[4] For some of the combinations of dependent and independent variables the number of underlying studies was not sufficient to estimate the main effect size and these combinations have been excluded from the analysis.

[5] We investigate the influence of single studies on the overall meta-analysis estimate by making repeated calls of the meta-analysis analyses omitting one study in each turn with the STATA command *metaninf* without finding any particular outliner.

2007). As our meta-analytic database covers 47 studies encompassing a variety of industries and geographies, applying a random effects model appears appropriate.

As a first visual investigation of the heterogeneity of the results, we analysed the distribution of the estimated coefficients and their standard errors using funnel plots. These visually identify the heterogeneity of the results and the presence of possible bias through a scatter diagram of a measure of precision of effect sizes (the standard errors) versus the coefficient of the effect size. The vertical axis measures precision as the distribution of the standard error while the horizontal axis measures the magnitude of the effect size. The different shaded areas represent the several levels of statistical significance, while the points in the white area represent estimates which are not statistically significant. The plot is expected to show an inverted funnel shape, where effect sizes vary randomly and symmetrically around the true effect size, regardless of its magnitude. A visual inspection of Figures A2.1, A2.2 and A2.3 for the full sample, size sample and diversity sample suggests that the plot is slightly over-weighted on the right-hand side, with a tendency to report positive and significant impacts of TMT size and diversity on firm performance. However there appears to be no specific publication bias since many studies reported non statistically significant results, and as the precision of effect sizes increases the plot seems to centre around values which are positive but very close to zero, identifying a small but slightly positive average effect across the three sub-samples.

To analyse the sources of heterogeneity in the estimated effects across the different studies, we performed a meta-regression analysis using the STATA *metareg* command. This extends the standard meta-analysis by investigating the extent to which the statistical heterogeneity between results of multiple studies can be related to one or more characteristics common to several studies. In our meta-regression analysis we estimated the effect of a range of study characteristics on the estimated coefficient, including geographical scope, sample size and period, controlling for studies focusing on SMEs, new ventures or high-tech firms, TMT, board and founders studies, different econometric techniques, the number of control variables included and the different categories of dependent, independent and mediating variables. In addition, we split our sample between studies looking

at the effect of size or diversity, and in three subsamples for SMEs, new ventures and high-tech firms to investigate sample-specific sources of heterogeneity.

Table A2.1 Main effect sizes of all independent variables on aggregated measure of firm performance

| Independent Variable | Dep. Var. | No. Studies | Sample Size | Point. Est. | 95% Conf. Interval | | Heterogeneity | | |
					Lower Limit	Upper Limit	Chi^2	p-value	i^2
Size	all	60	895,658	0.044	0.029	0.059	230000.00	0	100.00%
Diversity	all	206	927,665	0.029	0.022	0.036	7824.34	0	97.40%
Age	all	13	6,994	-0.07	-0.03	-0.11	27.51	0.007	56.40%
Education	all	42	876,170	0.015	0.009	0.02	444.17	0	90.80%
Experience	all	88	20,397	0.154	0.111	0.198	42042.71	0	99.80%
Functional	all	22	3,536	0.254	0.102	0.406	1418.53	0	98.50%
Ethnic/Gender	all	20	14,978	0.586	0.305	0.867	302.98	0	93.70%

Table A2.2 Main effect sizes of independent variables to performance categories. Significant effect sizes shown in yellow; significant effect sizes with homogeneous results are bordered in red.

Independent Variable	Dependent Variable	No. Studies	Sample Size	Point Est.	95% Conf. Interval		Heterogeneity		
					Lower Limit	Upper Limit	Chi²	p-value	i²
Size	All	60	895658	0.044	0.029	0.059	23000	0	100%
Diversity	All	206	927665	0.029	0.022	0.036	7824.4	0	97.4%
Size	Other Financial	14	18531	0.028	-0.177	0.232	34392	0	100%
	Profit	6	1260	0.071	-0.068	0.209	3.58	0.612	0%
	Sales	11	3467	-0.732	-4.157	2.693	14896	0	99.3%
	Employment	10	5945	0.247	0.14	0.354	61721	0	100%
	Innovation	6	288455	0.038	0.028	0.048	15005	0	100%
	Internationalization	9	289870	0.029	0.021	0.037	77.06	0	89.6%
Ethnic or Gender Diversity	Profit	3	641	-0.078	-0.154	-0.002	400.88	0	99.5%
	Employment	3	651	-0.052	-0.121	0.017	5.67	0.059	64.7%
	Innovation	6	1260	0.071	-0.068	0.209	3.58	0.612	0.00%
	Internationalization	10	5945	0.247	0.14	0.354	61721	0	100%
Diversity in Education	Other Financial	4	815	0.037	-0.017	0.092	177.04	0	98.3%
	Innovation	4	288043	0.009	0.001	0.018	120.07	0	97.5%
	Internationalization	6	288651	0.006	0.001	0.013	91.02	0	94.5%
	Profit	6	1223	-0.082	-0.308	0.145	5.36	0.374	6.6%
	Sales	6	751	0.166	0.023	0.31	146.35	0	96.6%
	Employment	9	5397	0.282	-0.007	0.571	3387.2	0	99.8%
Diversity in Experience	Other Financial	12	2007	0.641	0.521	0.761	1239.1	0	99.1%
	Innovation	5	1129	0.866	0.317	1.415	221.67	0	98.2%
	Internationalization	13	2099	0.106	0.059	0.153	6101	0	99.8%
	Profit	9	1547	0.077	-0.122	0.276	604.74	0	98.7%
	Sales	22	5137	0.066	0.017	0.115	333.73	0	93.7%
	Employment	14	6450	0.026	0.003	0.049	459.62	0	97.2%
Functional Diversity	Other Financial	3	578	0.181	-0.031	0.393	15.22	0	86.9%
	Innovation	2	1706	-0.031	-0.048	-0.015	24.35	0	95.9%
	Internationalization	6	1230	0.319	-0.866	1.505	42.3	0	88.2%
	Profit	4	864	0.237	0.082	0.393	7.37	0.061	59.3%
	Sales	4	6184	0.387	0.097	0.677	2.22	0.528	0.00%
	Employment	2	404	-0.405	-1.285	0.475	0.74	0.391	0.00%

Legend: i²: Proportion of variation due to heterogeneity

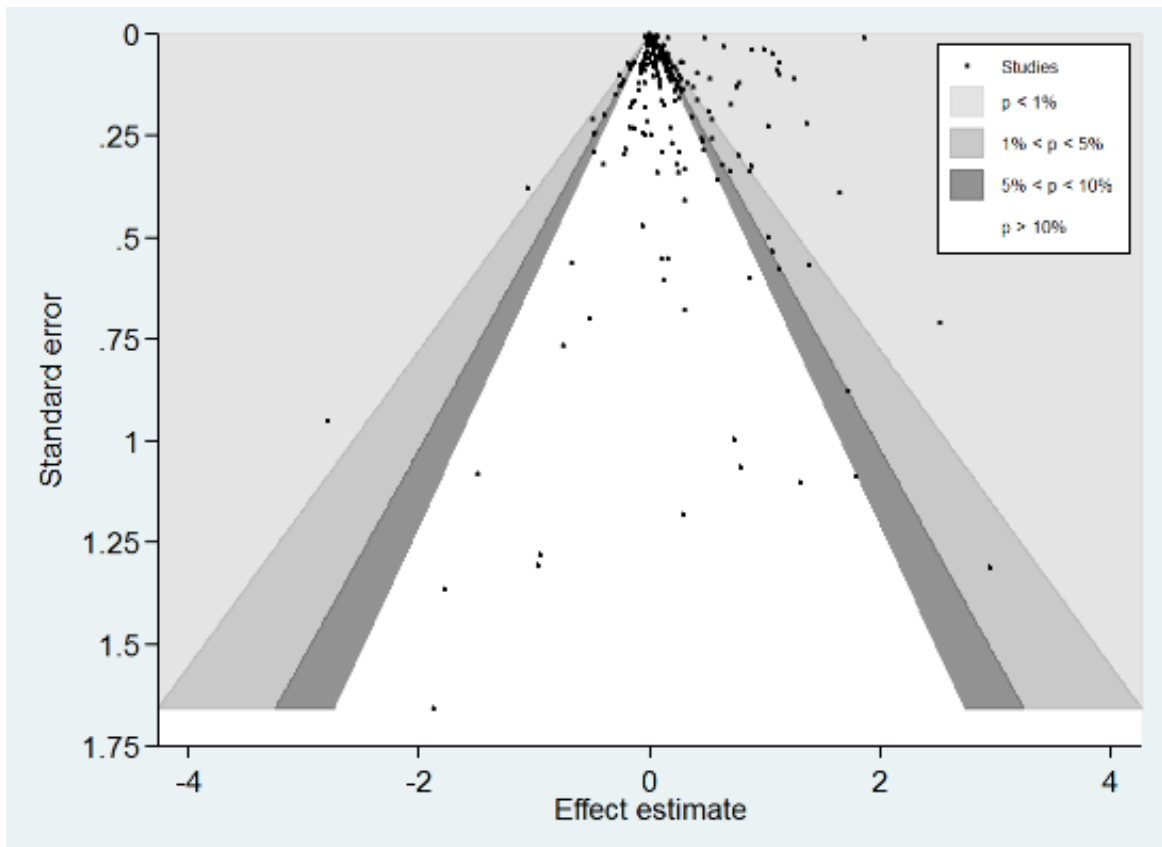Figure A2.1 Funnel plot of estimated coefficients and standard errors of studies for all samples

Figure A2.2 Funnel plot of estimated coefficients and standard errors of studies for size samples
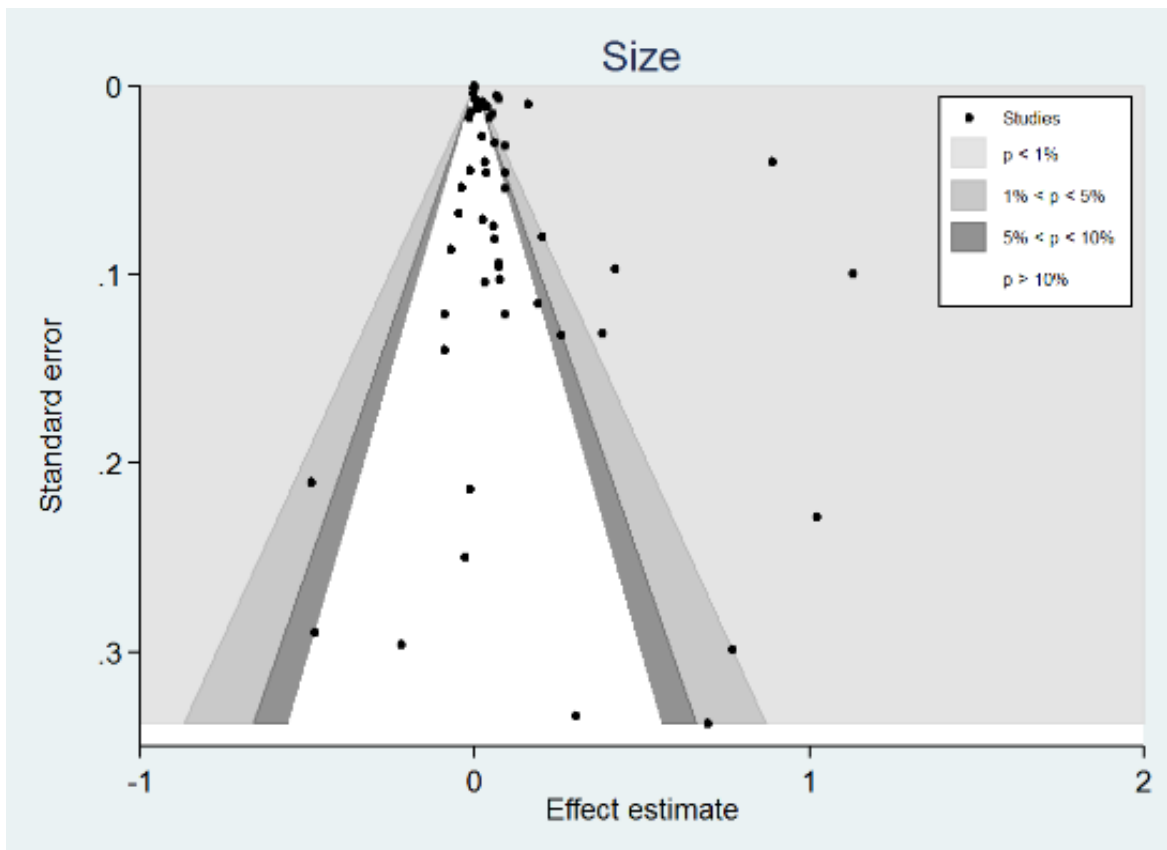
Figure A2.3 Funnel plot of estimated coefficients and standard errors of studies for size sample
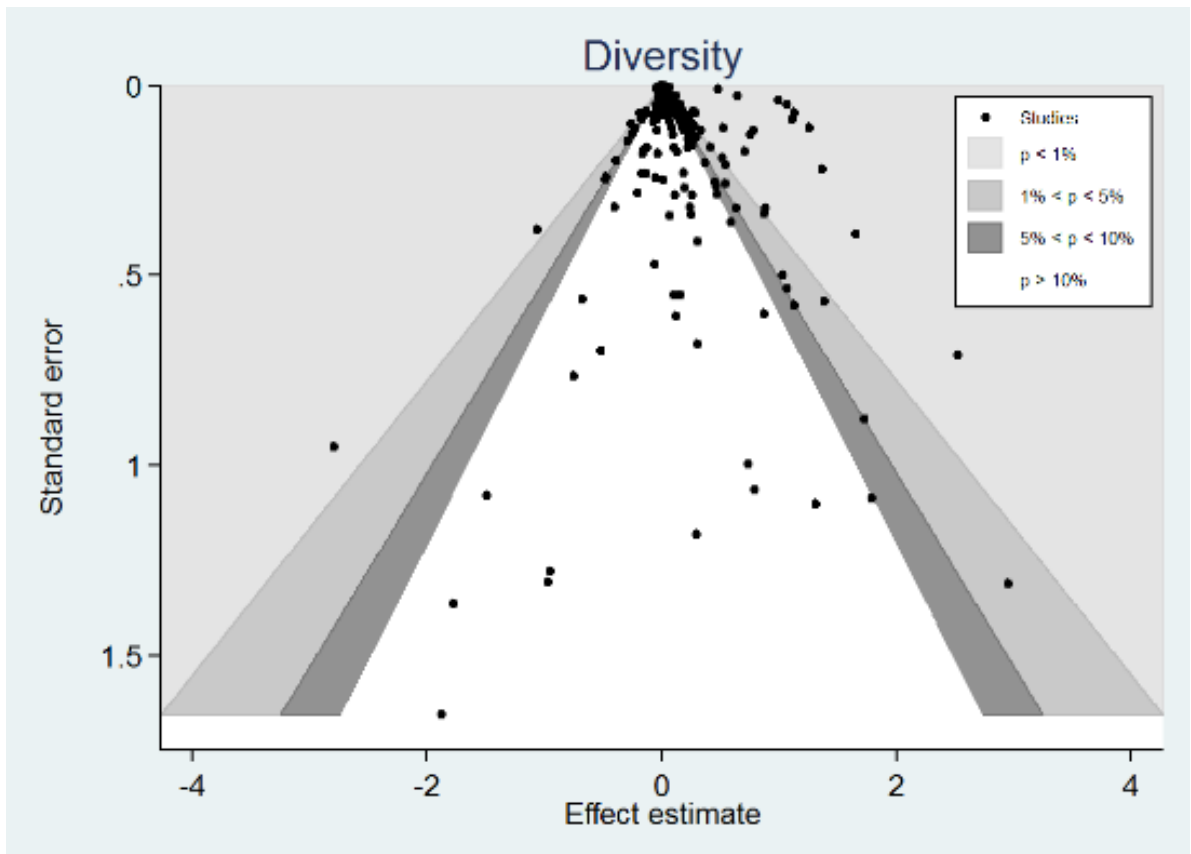
Table A2.3 Definitions of the variables used in the meta-regression models.

Variables	Definition
Geography	Dummy variable equal to 1 if the study focused on a OECD country and 0 otherwise
Sample Size	Continuous variable measuring the number of firms used in the study
SME	Dummy variable equal to 1 if the study focused on SMEs and 0 otherwise
New	Dummy variable equal to 1 if the study focused on young firms and new ventures and 0 otherwise
High-Tech	Dummy variable equal to 1 if the study focused on High-Tech firms and 0 otherwise
TMT/Board	Dummy variable equal to 1 if the study focused on TMT and 0 if focused on Board members
Estimation Method	Dummy variable equal to 1 if the study used a more advanced econometric method than simple OLS and 0 otherwise
Moderation	Dummy variable equal to one if the study included an interaction term analysis and 0 otherwise
Independent Variable	Categorical variable including different diversity measures
Dependent Variable	Categorical variable including the different performance measures
Panel Period	Continuous variable measuring the length of the panel period used in the study
No. of Controls	Continuous variable measuring the number of control variables included in the econometric analysis

Table A2.4 Results of the meta-regression models for the full sample, size and diversity samples, and for samples of SMEs, new and high-tech firms.

	ALL			SIZE			DIVERSITY		
	Coeff.	*sig.*	*S.E.*	*Coeff.*	*sig.*	*S.E.*	*Coeff.*	*sig.*	*S.E.*
Geography	0.03	*	(0.01)	0.07	*	(0.04)	0.01	**	(0.00)
Sample Size	0.00		(0.00)	0.00		(0.00)	0.00		(0.00)
SME	-0.18	***	(0.05)	-0.33		(0.21)	-0.14	**	(0.05)
New	-0.13	**	(0.07)	-0.05		(0.24)	-0.12	*	(0.07)
High-Tech	0.13	***	(0.04)	0.08		(0.11)	0.12	***	(0.04)
TMT/Board	-0.03		(0.02)	-0.10		(0.06)	-0.02		(0.02)
Estimation Method	0.06	***	(0.01)	0.02		(0.03)	0.06	**	(0.01)
Moderation	-0.03		(0.02)	-0.21	**	(0.08)	-0.013		(0.02)
Indep. Variable	0.16	**	(0.08)				0.03	*	(0.01)
Dep. Variable	0.03	**	(0.01)	-0.00		(0.02)	0.01		(0.00)
Panel Period	0.02	***	(0.00)	0.07	***	(0.02)	0.02	**	(0.00)
No. of Controls	-0.02	***	(0.00)	-0.00		(0.01)	-0.009	**	(0.00)
No. Observations	266			60			206		
	SMEs			**YOUNG**			**HIGH-TECH**		
	Coeff.	*sig.*	*S.E.*	*Coeff.*	*sig.*	*S.E.*	*Coeff.*	*sig.*	*S.E.*
Geography	0.005	***	(0.0007)	0.02		(0.02)	0.20	**	(0.09)
Sample Size	0.0004	***	(0.0001)	0.009		(0.00)	0.001	*	(0.00)
SME				-0.08		(0.13)	0.49	*	(0.29)
New	-0.07		(0.04)				0.31		(0.34)
High-Tech	0.11		(0.11)	0.21	*	(0.11)			
TMT/Board	0.00		(0.54)	-0.07		(0.05)	-0.25	**	(0.13)
Estimation Method	0.01		(0.03)	0.03		(0.02)	-0.04		(0.05)
Mediating Eff.	0.04		(0.05)	-0.06		(0.06)	-0.04		(0.07)
Indep. Variable	0.01		(0.02)	0.006		(0.02)	0.03		(0.04)
Dep. Variable	0.03		(0.02)	0.00		(0.01)	0.01		(0.03)
Panel Period	0.09	***	(0.03)	0.09	***	(0.02)	0.13	***	(0.03)
No. of Controls	-0.00		(0.01)	-0.00		(0.01)	-0.01		(0.03)
No. Observations	113			194			126		

Notes: * p<0.10; ** p<0.05; ***p<0.01.

Table A2.5 Main effect sizes of independent variables on SMEs performance. Significant effect sizes shown in yellow; significant effect sizes with homogeneous results are bordered in red.

SMEs Indep. Variable	Dependent Variable	No. Studies	Sample Size	Point Est.	95% Conf. Interval Lower Limit	Upper Limit	Heterogeneity Chi2	P-value	I2
Team Size	Sales	2	191	-0.217	-0.543	0.108	7.24	0.007	56.20%
	Other Financial	7	17731	0.001	-0.213	0.214	29.9	0.123	79.90%
	Employment	2	191	-0.171	-0.495	0.152	10.92	0.001	60.80%
	International-ization	2	432	-0.08	-0.241	0.081	0.02	0.892	0.00%
Age Diversity	International-ization	3	651	-0.052	-0.121	0.017	5.67	0.059	64.70%
Ethnic/ Gender Diversity	Innovation	6	1230	0.319	-0.866	1.505	42.3	0.213	68.20%
	International-ization	4	864	0.237	0.082	0.393	7.37	0.061	59.30%
Education Diversity	Sales	3	279	0.135	-0.183	0.454	9.88	0.007	79.70%
	Profit	3	351	-0.401	-1.123	0.32	19.19	0.563	59.60%
	Employment	4	454	-0.159	-0.315	-0.004	86.61	0.023	69.70%
	International-ization	3	651	0.008	-0.249	0.265	0.16	0.922	0.00%
	Other Performance	2	198	0.052	-0.061	0.166	1.13	0.287	11.70%
Experience Diversity	Profit	7	1143	-0.06	-0.238	0.118	46.75	0.064	68.70%
	Sales	12	1593	0.126	-0.016	0.268	35.93	0.053	69.40%
	Other Financial	4	697	0.365	0.05	0.68	88.38	0.046	66.60%
	Employment	7	872	-0.072	-0.18	0.035	46.41	0.022	77.10%
	Internationa-lization	9	1711	0.101	0.048	0.154	55.22	0.904	79.90%
	Other Performance	9	1126	0.292	0.021	0.562	43.29	0.431	68.20%
Functional Diversity	Innovation	2	410	0.28	0.183	0.377	0.05	0.823	0.00%
	International-ization	2	432	0.17	-0.501	0.841	3.19	0.074	68.60%

Table A2.6 Main effect sizes of independent variables on new ventures performance. Significant effect sizes shown in yellow; significant effect sizes with homogeneous results are bordered in red.

| New Ventures | | | | | 95% Conf. Interval | | Heterogeneity | | |
Indep. Variable	Dep. Variable	No. Studies	Sample Size	Point Est.	Lower Limit	Upper Limit	Chi2	P-value	I2
Team Size	Profit	6	1260	0.071	-0.068	0.209	3.58	0.612	0.00%
	Sales	11	3467	-0.732	-4.157	2.693	148.06	0	99.30%
	Other Financial	7	800	0.621	0.556	0.686	15825.95	0.001	82.90%
	Employment	10	5945	0.247	0.14	0.354	61.39	0	91.02%
	Innovation	6	288455	0.038	0.028	0.048	1.50E+05	0.522	74.32%
	Internationalization	7	289438	0.029	0.021	0.037	74.71	0	92.00%
	Other Performance	4	288130	0.071	0.06	0.082	129.12	0	97.70%
Age	Sales	2	1706	-0.031	-0.048	-0.015	24.35	0.002	95.90%
	Profit	3	578	0.181	-0.031	0.393	15.22	0.032	86.90%
	Other Financial	2	346	-0.028	-0.107	0.051	60.15	0	98.30%
Ethnic/ gender	Profit	2	404	-0.405	-1.285	0.475	0.74	0.391	0.00%
	Employment	2	5988	0.959	0.375	1.542	0.07	0.79	0.00%
	Other Performance	4	6184	0.387	0.097	0.677	2.22	0.528	0.00%
Education	Sales	6	751	0.166	0.023	0.31	146.35	0	96.60%
	Profit	6	1223	-0.082	-0.308	0.145	5.36	0.374	6.60%
	Other Financial	3	520	0.03	-0.011	0.071	113.4	0	98.20%
	Employment	9	5397	0.282	-0.007	0.571	3387.24	0	99.80%
	Innovation	4	288043	0.009	0.001	0.018	120.07	0	97.50%
	Internationalization	3	288000	0.006	-0.001	0.013	90.89	0	97.80%
	Other Performance	5	291092	0.024	0.014	0.033	153.93	0	97.40%
Experience	Profit	9	1547	0.077	-0.122	0.276	604.74	0	98.70%
	Sales	20	5033	0.06	0.01	0.11	279	0.001	93.20%
	Other Financial	11	1712	0.703	0.567	0.839	1413.73	0	99.30%
	Employment	14	6450	0.026	0.003	0.049	459.62	0	97.20%
	Innovation	5	1129	0.866	0.317	1.415	221.67	0	98.20%
	Internationalization	8	1180	0.076	0.006	0.146	3148.86	0	99.80%
	Other Performance	7	1304	-0.178	-0.428	0.071	24.75	0.034	75.80%
Functional	Profit	3	350	0.221	-0.325	0.767	13.77	0.001	85.50%
	Sales	5	923	0.212	0.086	0.339	206.9	0	98.10%
	Other Financial	4	668	0.985	0.553	1.416	15.51	0.012	77.29%
	Employment	5	623	0.226	0.062	0.39	79.87	0	95.00%

Table A2.7 Main effect sizes of independent variables on High-Tech Firms performance. Significant effect sizes shown in yellow; significant effect sizes with homogeneous results are bordered in red.

High-Tech Indep. Variable	Dep. Variable	No. Studies	Sample Size	Point Est.	95% Conf. Interval Lower Limit	Upper Limit	Heterogeneity Chi2	P-value	I2
Team Size	Sales	5	1000	0.039	-0.039	0.116	17.27	0.002	76.80%
	Other Financial	5	599	0.812	0.729	0.895	11247.97	0.008	77.12%
	Employment	5	1094	0.005	-0.058	0.068	31.37	0.002	87.20%
	Innovation	3	455	0.272	0.246	0.298	7.40E+00	0.021	69.67%
	Internationalization	6	950	0.691	-6.593	7.974	174.38	0	97.10%
	Other Performance	3	643	0.113	-0.04	0.267	13.08	0.001	84.70%
Age	Internationalization	3	344	0.596	-0.461	1.653	1892.01	0	99.90%
Diversity	Other Financial	2	281	-2.922	-7.022	1.179	20.33	0	95.10%
	Innovation	7	1255	0.387	-0.776	1.55	77.27	0.001	92.20%
Education	Sales	2	156	0.161	-0.226	0.548	0.53	0.466	0.00%
	Other Financial	2	225	0.174	0.068	0.28	3.46	0.063	71.10%
	Employment	2	609	0.054	-0.107	0.214	3.57	0.059	72.00%
	Innovation	4	118	1.447	0.989	1.904	1014.2	0	99.70%
	Internationalization	4	756	3.862	0.476	7.248	550.23	0	99.50%
	Other Performance	4	711	-0.007	-0.049	0.036	2.84	0.417	0.00%
Experience	Sales	23	3599	0.28	0.12	0.44	1343.25	0	98.40%
	Profit	5	818	-0.065	-0.306	0.177	5.26	0.262	23.90%
	Other Financial	13	1994	0.624	0.504	0.744	1239.39	0	99.00%
	Employment	7	1336	0.001	-0.092	0.094	24.21	0.017	75.20%
	Innovation	5	1129	0.866	0.317	1.415	221.67	0	98.20%
	Internationalization	15	2203	0.525	0.127	0.923	1.51E+01	0.013	85.24%
	Other Performance	14	2368	0.009	-0.155	0.174	2282.57	0	99.40%
Functional	Sales	3	626	0.385	0.206	0.564	67.6	0	97.00%
	Other Financial	9	1325	0.834	-2.891	4.56	297.57	0	97.30%
	Employment	3	447	0.256	0.058	0.454	65	0	96.90%
	Innovation	2	410	0.28	0.183	0.377	0.05	0.823	0.00%
	Internationalization	3	344	0.985	-0.311	2.281	29.06	0.001	93.10%

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