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Impact of education on innovation performance: evidence from Azerbaijan construction industry

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Abstract: *We have attempted to check the relationship between education diversity between employees and innovation performance of the firm. Also, we have tried to find an answer to the question will firms be more innovative if the level of education degree be higher. We have collected the data through surveying 50 firms in Azerbaijan construction industry and used correlation-regression analyzes and found that there is no evidence of the relationship between diverse education degrees of employees of the firm and innovation performance. In addition, we found that higher education level might have some effect on being firms more innovative, particularly master degree holders.*

Keywords: *innovation, education, diversity, degree, patents*

I. Introduction

Economic growth is one of main goals for any participants of free market, weather it is a country or a firm. According to Hasan and Tucci [1], countries rely on innovative products for economic growth. Therefore, it is important to know how to boost innovation in an effective way. One important factor is education [2]. So far, the literature mainly concentrates on the relation between education and the probability of becoming an entrepreneur or between education and performance. During writing this paper we have looked through the related literature and found that only few empirical papers have tried to explain innovation with the type of education as main determinant. Toivanen and Väänänen [3] investigate whether an engineering degree has an influence on the registration of patents. Individuals with an engineering background have a positive effect on invention (measured as number of patents). However, the authors do not distinguish between different types of firms.

Here in our paper we investigate two aspects of impact of education on innovation performance in firms. The central research question is whether firms with diverse educational background staff will be more innovative than firms with more homogenous content of employees. Beside of it we want to find the answer to the question whether innovation can be explained by personal attributes of the entrepreneur, where the main explanatory variable is the higher degree of education. To analyze these question, we have used correlation-regression analyzes technique with a sample from Azerbaijan Construct industry. Azerbaijan construction industry is chosen as a sample due to eligibility of data access and due to comparatively high level of innovativeness of firms in this industry in Azerbaijan. Also recent construction boom in Azerbaijan had made its contribution in choosing this industry as a sample. We have used negative binomial regression as our dependent variable is in form of count data and consists of the sum of all types of innovation.

II. Literature review

The development of innovation abilities is of great importance for scientific progress and industrial and social development. The influence of education on the propensity for innovation has been the subject of several studies.

According to Gendron [4] the most American schools already have entrepreneurship courses. In his research, the question was about the level of education, which must individuals have for enhancing the entrepreneurial education and how this training affects innovation behavior. There is some evidence in literature where the importance of entrepreneurship education is mentioned [5], and the emphasis is placed in the contents that should be or not transmitted and how it stimulate the entrepreneurial process of the students.

The analysis of the main axes of research around the concept of entrepreneurship and entrepreneurship education at university-level studies seem to have the best results. However, most of them study the relationship between earnings and education, and it is hard to say if earnings is proxy to innovation.

There is a small literature on the impact of college quality [6, 7, 8]. Hoestra [7] is the most convincing study since it exploits a sharp discontinuity in admissions criteria to show that attending a "flagship" state university in the US increases earnings by about 20%.

Lindley and Machin [9] use LFS data and estimate that the premium for a Masters (PhD) degree relative to a Bachelor's degree rises from 8% (14%) in 1996 to 11% (24%) in 2009. LE also provides estimates their average figures are approximately 9% for Master and 15% for PhD.

Toivanen and Väänänen [3] investigate whether an engineering degree has an influence on the registration of patents. They conclude that persons with engineering background have a positive effect on invention. The above-mentioned paper concentrates on the distinction between non-high-tech and high-tech startups. In their opinion, persons with technical education could have a comparative advantage in the high-tech industry because they have more knowledge in their field.

de Mel et al. [10] in his work propose a model of innovation where the probability of being innovative depends on the manager's ability. They examine whether the traits of the firm characteristics are able to explain different types of innovation. The authors use the Sri Lanka Longitudinal Survey of Enterprises between January and May 2008. They distinguish between four different types of innovation: product, process, marketing and organizational innovation.

Two independent regressions are conducted: one for the traits of the entrepreneur and one for firm characteristics. The authors find that beside firm size the owner characteristics also play an important role for explaining innovation. Thus, the greater the years of schooling and IQ, the more probability of the firm to be innovative. However, the authors do not include the type of education in their analysis. Sauermann and Cohen [11] also have a different focus compared to this study. They look at how employees' incentives influence innovation in companies. Thus, they do not analyze start-ups and concentrate on employees with a doctoral degree.

Based on some logical conclusions and on conducted literature review we propose the following hypothesis:
Hypothesis 1. Higher the level of education degree the more innovative is the firm.

Dutta et al. [12] analyze whether and how specialized and diversified education influence the entry decision into entrepreneurship and future wealth prospects (in the sense of performance). A similar contribution is provided by Lazear [13], who defines diversified and specialized skills, which are strongly related to education.

From a theoretical point of view, it is an unresolved question whether diversity in formal education levels should foster innovativeness and increase the innovation output of a firm. Like other types of knowledge diversity [14], educational diversity has two opposite effects on innovation ability referring to the cost and benefits of the collaboration process.

On the one hand, vertical educational diversity might increase innovation performance. Different types of education might provide alternative bodies of knowledge [15, 16, 17] which can be combined on the firm level and improve decision-making. Collaboration of employees with different educational backgrounds along with different experiences, insights, or interests might cause different interpretations of problems, enhance problem awareness, and increase the spectrum of problem solutions. This is not least because diversity is likely to improve the absorptive capacity of a firm [19, 20, 21]. These two opposing forces might explain the mixed empirical results provided by the literature concerning the impact of educational diversity on the innovation performance of firms. Østergaard et al. [22] match data from the Danish innovation survey to employee data and find that horizontal educational diversity of employees with tertiary education— diversity in terms of thematic background at the same education level—improves the probability of introducing an innovation. However, they claim that this positive relationship might decrease for higher levels of horizontal diversity. Also based on Danish employer- employee data but merged this time with patent data, Markus and Kongsted [23] find that hiring R&D workers distant from one another in the educational space [24], improves exploratory patent applications. Their focus on R&D workers suggests that their measure of diversity is mainly driven by horizontal diversity. Furthermore, the benefit of hiring distant workers decreases with rising diversity in the existing workforce. Parrotta et al. [25] use the same dataset as Parrotta et al. [26] to analyze the effect of horizontal educational diversity on innovation performance. In addition to instrumenting educational diversity by exploiting regional variation, they use pre- sample information to account for unobserved firm characteristics. They also include measures of knowledge spillovers based on geographic and technological distances to account for external knowledge. They find little evidence that horizontal educational diversity affects patenting propensity, patenting intensity, or patenting diversity.

The different meta- analyses of the literature on the relationship between team- member diversity and innovation performance provide mixed results as Williams and O'Reilly [27], Horwitz [28], Horwitz and Horwitz [28] and Hülsheger et al. [29] suggest a positive relationship, while the more recent paper by van Dijk et al. [30] finds no relationship.

There are only a few papers that focus on vertical educational diversity across education levels. McGuirk and Jordan [31] use Irish firm data to estimate the impact of educational diversity in Irish counties on the propensity to introduce product and process innovation. Calculating a Blau Diversity index for each Irish county based on six categories (primary school, lower secondary school, upper secondary school, third- level non- degree, and third- level degree or higher), they find that educational diversity improves product innovation but not process innovation. They further find that educational diversity on the labor market acts as a substitute

for absorptive capacity, measured as internal tertiary education share. Subramanian et al. [32] base their educational diversity analysis on data from the national R&D survey in Singapore and use patents as a measure of innovation performance. They analyze vertical educational diversity, measured by one minus the Herfindahl concentration index, but focus on education levels within tertiary- educated employees only. They show mixed results. In their baseline estimation they do not detect any significant differences in innovation between similar and diverse educational level populations in the workforce of research scientists and engineers.

Similarly, Faems and Subramanian [33] could not find any significant relationship between diversity in terms of different types of educational degrees (PhD, master, bachelor, postgrad, or no academic degree) among R&D manpower and their technological performance. Hence, they analyze vertical educational diversity but focus on tertiary degrees. On the innovation system level, Meuer et al. [34] applied a vertical educational diversity measure in order to characterize different types of innovation systems. They found that specialization is the key characteristic of the "autarkic" innovation system, which shows an equal propensity to generate radical, technological, and organizational innovations. However, the paper doesn't address potential endogeneity of vertical educational diversity.

Hypothesis 2. High education diversity is positively associated with innovation performance.

III. Methodology

Data collection for this study was carried out by using a research survey design. A research survey design is a method of collecting information by administering questionnaires to a sample of individuals, in our case individuals means firms, where each firm's HR department is providing the statistical information about their employees. Therefore, our questions do not intend to collect opinions or any subjective data. The research was performed through a survey using a mixture of semi-structured questionnaires. The population of the study were Azerbaijan construction firms. The method of selection of sample was random sampling in order to find 50 firms, by using the sample frame taken from Azerbaijan Ministry of Economic Development. Efforts were focused to select a range of firms with different characteristics such as markets, sizes, a history and duration of their operation, cultural characteristics of employees and employers, innovation activity indicators, so the sample has heterogeneous characteristic. These sample respondents answered to survey questions to make our quantitative analyses database. There were made attempts to make the respond rate higher through multiple approaches to firms.

Azerbaijan construction industry is considered as an object for our research and used as a sample. Beside of primary data which were collected through survey we also used eligible secondary data sources such as database obtained from Azerbaijan's Ministry of Economic Development. These database provided us some amount of data regarding innovation performance. We have collected the patent data regarding to our sample firms. We have used correlation-regression analyses to testify the proposed hypotheses. For inferential statistical methods, we used software program as Gretl.

Dependent variable in our analyzes is innovation which measured as the sum of all types of innovation and include number of new products, number of patents, number of new processes implemented. Independent variables are such variables as education diversity and types of education degree (basic education, high school, special education, bachelor's degree, master's degree, PhD and other types of education). We have to note here that when we consider special education we count special short-term courses, which usually are organized by firms where employees are employed. Other types of education include some types of advanced education, as post-doc or scientific activity or foreign degrees, which do not match to Azerbaijan standards of education. Education diversity was estimated with a Blau's index calculated as 1 -$\sum P_i^2$, where P is the proportion of individuals in a category and i is the number of categories. This measure can thus theoretically range from 0 to .80. Low index will mean less diversity.

IV. Results and discussion

Descriptive statistics of all variables is given in Table 1.The lowest value for three variables was equal to zero, while the lowest mean was for other types of education. We do not take into account diversity of education as it is in the form of index and can range only between zero and one, but we included square of diversity of education in order to check if there is non-linear relationship. In case if square of education diversity and diversity of education itself will have different signs it will mean that there is likely that relationship has U shape or inverse U shape.

Our data is in cross-sectional form, with 10 variables. Descriptive statistical results show that standard deviation for some variables is very high, for example, special education has 731 for its standard deviation, which means the data's spread range is quite high.

Table 1: Descriptive statistics*

		Mean	Median	Min	Max	Std.Dev.	C.V.	Skewness	Ex. kurtosis
1	Innovation	21.8	19	8	66	12.86	0.58	1.3	1.45
2	Diversity of education degree	0.43	0.41	0.2	0.81	0.17	0.40	0.65	-0.47
3	Diversity of education degree square	0.21	0.17	0.04	0.66	0.17	0.79	1.22	0.56
4	Basic education	42.26	22	0	250	45.9	1.08	2.05	6.26
5	High school	248.08	95	15	4200	641.6	2.58	5.01	27.3
6	Special education	473.52	220	35	3600	731.93	1.54	2.79	7.34
7	Bachelor's	60.42	43	15	250	54.21	0.89	1.76	3.19
8	Master's	18.64	14	2	80	16.31	0.87	1.55	2.58
9	PhD	4	2.5	0	20	4.35	1.09	1.53	2.47
10	Other	2.6	2	0	10	2.59	0.99	1.37	1.57

*Using the observations 1 - 50

Correlation is given in Table 2. Most of data for variables was in form of factual numbers taken from the source, usually it is common to convert all variables into logarithms but in our case as relationship between variables is not important and where only important is the relationship with dependent variable we have decided to leave it in original form. Correlation coefficients show that such variables as Master's degree and PhD have stronger correlation, which can be explained with the aim and market segment of firms of the sample. Firms, which are focused on project development and focused more on research are tend to hire employees with higher degree of education such as Master or PhD degree holders. In general, the correlation levels among variables is not high, and this fact is not important in our case, as we have mentioned the main relationship, which in our focus is the relationship between level of education and innovation. We can see that lower levels of education has negative relationship with innovation and higher levels of education is positively correlated with innovation performance of the firm. With these low levels of correlation, we can say that there is no suspect for any multicorrelation problem.

Table 2: Correlation*

		1	2	3	4	5	6	7	8	9
1	Innovation	1								
2	Diversity of education degree	-0.17	1							
3	Diversity of education degree square	-0.17	0.98	1						
4	Basic education	-0.22	-0.12	-0.15	1					
5	High school	-0.16	0.05	-0.00	0.1064	1				
6	Special education	-0.17	0.36	0.32	0.3651	0.7128	1			
7	Bachelor's	-0.04	0.01	-0.02	0.54	0.36	0.65	1		
8	Master's	0.09	-0.05	-0.07	0.5	0.24	0.53	0.61	1	
9	PhD	0.07	0.02	0.01	0.38	0.08	0.42	0.48	0.82	1
10	Other	0.008	-0.12	-0.13	0.44	0.12	0.26	0.4	0.28	0.3

*Correlation Coefficients, using the observations 1 – 50, 5% critical value (two-tailed) = 0.2787 for n = 50

For regression models we used Negative binomial regression method to find the relationship between variables, we generated several regression results in order to see effect of variables on dependent variable simultaneously and separately.

Table 3: Negative binomial regression.
Dependent variable: Innovation performance

	Diversity only		All variables	
	Coefficient	Standard error	Coefficient	Standard error
constant	3.21	0.51***	2.96	0.5***
Diversity of education degree	-0.02	2.33	1.26	2.25
Diversity of education degree square	-0.60	2.37	-1.96	2.32
Basic education			-0.00641599	0.002***
High school			-0.00027	0.00021
Special education			2.955	0.00024
Bachelor's			0.0002	0.0021
Master's			0.014	0.0082*
PhD			-0.019	0.027
Other			0.034	0.03
alpha	0.236	0.054***	0.176	0.043***
Log-likelihood	-188.4554		-182.0607	
Akaike criterion	384.9108		386.1214	

Hannan-Quinn	387.8233	394.1306
Schwarz criterion	392.5589	407.1536

Using observations 1-50, Standard errors based on Hessian.
***P<.01, **P<.05, *P<.10

First model was to check only the effect of variables of innovation and education diversity. It showed the insignificant results which can be considered that our hypothesis could not find its evidence from our sample. Another regression model was aimed to check the relationship of all variables with innovation performance. These variables are degrees of education of the staff in firms. We found no that there is only two variables have some shown the significant relationship with innovation, which in general partially supports our second hypothesis, we found that basic education, which means low level of special education makes the innovativeness of firms lower and that higher levels of education degrees as Master degree has positive effect on innovation performance of firms. But the problem with our statistical results is that not all of variables has shown the satisfactory p-values, which gives us some doubt about our results.

V. Conclusions

Here in our research we have proposed two hypotheses, the first claimed that education diversity of employees in the firm has a positive association with the innovation performance. It was based on assumption that it makes easier to identify valuable knowledge surging from the research activities of other firms and institutions due to diverse employees with different educational background. In addition, as a result it is less likely that promising new ideas or technologies will pass by unnoticed by the firm. Decisions are improved if different perspectives are involved in the decision making process [35]. There a was a possibility that it can have negative relationship based on logic that vertical educational diversity might decrease innovation performance, since vertical educational diversity can increase the level of conflicts, mistrust, and misunderstandings due to high cognitive distances. As a consequence, vertical educational diversity is likely to increase the communication and coordination costs of integrating available knowledge or coordinating the innovation process [36, 37, 38]. According to social identity theory, such coordination and communication costs might arise because individuals value members of their own social identity more highly. This indicates a potential for competitive behavior and conflict due to vertical educational diversity [39]. Consequently, the risk of failure might increase. An additional opportunity cost of vertical educational diversity stems from economies of scale in the knowledge production process. These arise in cases where a concentration of workers with similar education level and similar knowledge base are necessary for an efficient production process, such as when a sufficient number of academics is required to run a laboratory.

After analyzing through statistical techniques, we found that there is neither significant linear nor non-linear relationship between diverse education level of employees and firm's innovation performance. However, correlation results show negative relationship; statistically they are far not significant. In our opinion there should be conducted more research based on other types of sample industries, even using combination of several industries and countries.

Another hypothesis, which had been proposed, was about the level of education and had idea behind of it, which was based on logic that higher level of advanced education will promote more innovation in the firm. Here we found some statistical support, but still it was not clear as it was stated in our hypothesis. Having more employees with Master degrees was making our innovation performance better and having more employees with basic education was decreasing the innovativeness of the firm. We can conclude that it is not wrong to say that higher levels of education will enhance the innovation performance, but need to emphasize which degree holders impact more in this process.

Results of this paper give us a field for future researches and leave even more questions, thus pushing us to investigate more in detail relationship of education and training on innovation performance. Future researches need to make research on other samples with more heterogeneous nature and with more focus on exact types of degrees and may be also with consideration of majors, specialties and courses studied.

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