

Attributes and Entrepreneurial Intention in University Students of Electrical Engineering and Computing Sciences

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Abstract—Contribution: This article analyzes the elements that determine entrepreneurial intention (EI) in electrical and computer engineering students of a private university in Ecuador.

Background: There is a lack of studies examining the EIs of university students in electrical engineering and computing sciences, where EI is influenced by elements, such as personal attributes, the student's social assessment of the characteristics of entrepreneurs, and the perception of professions in society, including business activity.

Research Questions: Are personal attributes positively associated with EI? Is the EI of university students influenced by social profession valuation? Is the EI of university students influenced by perceptions of several attributes of the entrepreneur?

Methodology: A questionnaire was administered to 570 students to test the model, and a structural equation model from partial least squares (PLS) was used.

Findings: The results positively associate personal attributes, in addition to factors, such as gender and family, with EI. On the other hand, the social valuation of the entrepreneur in the profession and the social valuation of the entrepreneurs' characteristics do not have a relationship with EI. The results suggest promoting the personal attributes of students through entrepreneurship education programs, linking the presence of entrepreneurs in academic activities and the transfer of knowledge from the university to the business sector, thus strengthening the entrepreneurial profile among students and increasing the positive image of entrepreneurs.

Index Terms—Computer engineering, electrical engineering, entrepreneurship, structural equation modeling.

I. INTRODUCTION

THE FOCUS is on the entrepreneur's attributes as explanatory of the greater or lesser inclination toward entrepreneurial activity and the aspects related to the

knowledge of these attributes in the entrepreneurial environment, and the attraction toward this activity are considered antecedents of entrepreneurial intention (EI) [1]. Sampedro et al. [2] pointed out that EI among university students is related to the perceived social influence in their immediate environment and the skills and capabilities of the individual to develop the entrepreneurial project.

Therefore, the probability of undertaking an entrepreneurial activity increases when a person believes that they possess the knowledge and skills to become entrepreneurs, when entrepreneurship education can contribute to the development of vital entrepreneurial attributes in students as potential entrepreneurs [3], and when entrepreneurship programs provide strategies to develop a proactive personality [4].

Intentions and attitudes depend on the situation and the person. Consequently, models of intentions will predict behavior better than individual or situational variables, and predictive power is critical to obtain predictions of entrepreneurial behavior [5].

Drivers of EIs in university students can be identified at the personal level with their attributes [6] and contextually through the social valuation of entrepreneurs and perceptions of entrepreneurship as a career goal [1]; however, few research papers seek to link these perspectives with EI.

Therefore, this research aims to describe the EI model of students of the electrical engineering and computing sciences of a private university from the perspective of its internal attributes and the social valuation of the knowledge of the attributes of its entrepreneurial environment.

II. THEORETICAL BACKGROUND

Lheureux and Auzoult [7] pointed out, based on the Theory of Planned Behavior [8], that EI depends on the degree to which the individual positively or negatively evaluates the possibility of creating a business (attitude), the perception of social pressure to comply with a specific behavior (perceived social norm), and the degree to which the individual considers entrepreneurial creation to be something he can control and evaluate himself capable of carrying it out (perceived behavioral control).

Intentions are the best predictors of any planned behavior, including entrepreneurship, and attitudes influence behavior through their impact on intentions [5]. Fayolle and Liñán [9] noted that the studies of EIs can be based on the analysis

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This work involved human subjects or animals in its research. The authors confirm that all human/animal subject research procedures and protocols are exempt from review board approval.

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of personal-level variables and the role of context, among other perspectives.

Concerning personal attributes, the construction of EIs is influenced by attitudinal, social, and psychological aspects [10]. These attitudes are the behavioral, cognitive, and affective attitudes of individuals and their perceived environment [11].

McLlelland [12] defined these attributes and skills and mentions that the entrepreneur takes risks, is self-confident, self-disciplined, autonomous, innovative, responsible, anticipates future decisions, enthusiasm and optimism, creativity, persevering, and persevering.

Regarding the influence of these attributes on university students' EIs, there is a strong association between these attributes and their intention to create companies [13], [14], [15].

For example, an entrepreneurial attribute is self-efficacy, which comprises the personal ability perceived by the subject to be able to carry out a given behavior; it involves the attribution of competence and personal control in a given situation [16]. It is an essential factor in entrepreneurship [17]; however, this attribute does not influence EI [18].

In addition, other attributes such as entrepreneurial risk and students who possess this attitude are characterized by higher EIs [6]. In addition, creativity should be considered in EIs [19].

The literature includes studies that address different personal attributes [12] as determinants of EI [20].

Among the contextual variables that influence EI, it is crucial to determine the entrepreneur's prestige compared with other professions and the valuation of attributes related to the entrepreneur [21].

In addition to this, other attributes such as entrepreneurial risk, students who possess this attitude are characterized by higher EIs [6]. Therefore, creativity should be considered in models of EIs [19].

Ray [22] mentioned the attributes that an entrepreneur has (creative, negotiation skills, financial and management skills, innovation, professionalism, risk-taking, vision for the future, investors, creating jobs, helping the economic development of a country, making much money, have communication skills and solve problems, are moral and honest people). Casero et al. [14] mentioned that the good image of the entrepreneur should be promoted as a mechanism to reinforce values and norms favorable to entrepreneurship.

Thus, there is a greater probability of intention to start a business when entrepreneurship is positively valued among university students [21], [22], [23], [24] and when they know other entrepreneurs and successful entrepreneurs [24]. Thus, becoming an entrepreneur to engage in such behavior depends on an excellent entrepreneurial environment [25].

The intention for future employability is determined by the theory of planned behavior, which concerns the prestige of entrepreneurial activities as a profession compared to other professions [26].

Liñán [1] pointed out that students who indicate their preference for independent professionals perceive a more positive social image of the entrepreneur to a greater extent. Some professions, such as architecture and engineering, influence

students' EIs [27]. Therefore, effective entrepreneurship education is an important consideration in vocational education [28]. Veciana et al. [21] pointed out that the entrepreneur profession is not significant between two samples of university students who studied.

Liñán and Rodríguez [29] pointed out that research reveals the importance of the subject's demographic characteristics, such as age, sex, place of origin, religion, level of education, work experience, and others in EI. Therefore, age positively influences the EI of university students [30], [31], although in other studies, it is not a determinant variable of entrepreneurial intentionality [32].

Work experience is related to EI [33]. However, other studies have reported a low incidence [34], while others do not relate this variable to EI [35].

Students' social environments fully support entrepreneurship and their social interactions are mainly with family members [10]. Thus, an entrepreneurial family environment positively influences students' EI [11], [33], [36], [37]. The gender variable has no effect on the development of entrepreneurial competencies [32], [38]. Other studies have shown that gender influences the perception of intentionality in creating a business [14], [22].

Considering the works presented in the literature and based on the previous empirical works presented in Appendix A, the following hypotheses are proposed.

- H1: Perceived personal attributes are positively associated with EI.
- H2: Social professional valuation among entrepreneurs influences the EI of university students.
- H3: Perception of the image of several attributes of the entrepreneur influences university students' EIs.

Control variables referring to the demographic information of university students (gender, age, family, and previous experience) influenced EI.

III. METHODOLOGY

A. Population and Sample

The study population comprised 9044 students from a private university in Ecuador. To select the university, the Universidad Católica de Cuenca in the city of Cuenca, Ecuador, was chosen. The following aspects were considered when selecting universities: 1) size (private universities with the most significant number of enrolled students) and 2) modality (on-site). The sample consisted of 570 students, with a confidence level of 95% and an error of 3.70%.

The surveys were conducted in a third city in terms of cultural, financial, and economic importance.

The study was based on a survey conducted by Casero [13], Veciana et al. [21], and Genescà and Veciana [39] and was applied personally to students. It was a random sample made up of 45.4% women and 54.6% men, who were enrolled between the first and ninth semesters in the areas of Electrical Engineering, Computer Engineering, and Information and Communication Technologies, aged between 18 and 51 years.

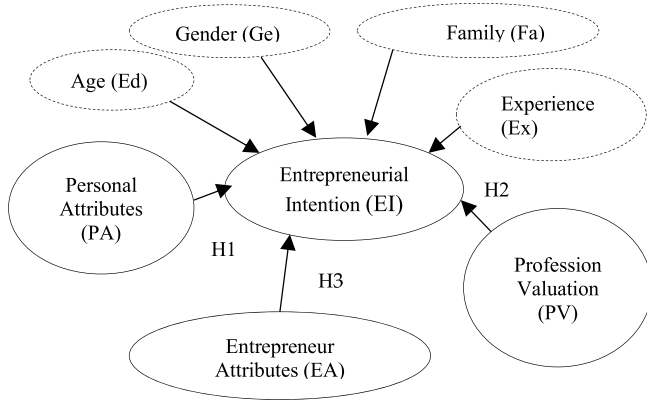


Fig. 1. Research model.

B. Model

Based on the literature review and the arguments discussed in the preceding paragraphs, the theoretical research model is schematized in Fig. 1. The data were cleaned and processed through SPSS.

C. Instrument

This research is quantitative and correlational to the cross-sectional type. A structured questionnaire was used for data collection. The “EI” is measured on a 5-point Likert scale; the “personal attributes” are measured on a 4-point Likert scale, while the “entrepreneur attributes” are measured on a 4-point Likert scale and the “profession valuation” is measured on a 7-point Likert scale. The instrument used consists of 42 questions (indicators) related to the constructs or variables of the model: 20 for “personal attributes”; 14 for “entrepreneurial attributes”; 1 for “EI”; and 7 for “profession valuation.”

From the cited references, it is determined that the diversity of indicators that point to the personal attribute construct can be grouped into 20 [13], with the intention of not generating greater granularity of constructs.

D. Statistical Method

Regression-based partial least-squares structural equation modeling (PLS-SEM) using Smart PLS 3.3.3 was used to test the hypotheses.

A variance-based approach was considered appropriate because it was designed to validate the theoretical and empirical aspects of both social and behavioral sciences in cases where theories are not strong enough and there is little available information [40]. On the other hand, PLS-SEM can explain more variance in the dependent variable [41]. The variance explained in the dependent variables was substantially higher in PLS-SEM.

IV. RESULTS

A. Analysis of the Measurement Model

This section validates whether the theory is supported by observed variables [42]. For the measurement model, the individual reliability of each indicator was first estimated.

TABLE I
CONSTRUCTS AND MEASURES

Variable	Cronbach Alpha	AVE	Compound Reliability
EA	0.917	0.377	0.890
PA	0.931	0.415	0.934
Ed	1.000	1.000	1.000
Ex	1.000	1.000	1.000
Fa	1.000	1.000	1.000
Ge	1.000	1.000	1.000
EI	1.000	1.000	1.000
PV	0.924	0.317	0.870

TABLE II
DISCRIMINANT VALIDITY

	EA	PA	Ed	Ex	Fa	Ge	EI	PV
EA	0.614							
PA	0.336	0.644						
Ed	-0.002	0.101	1.000					
Ex	0.038	0.205	0.325	1.000				
Fa	0.105	0.103	-0.022	0.120	1.000			
Ge	-0.084	-0.189	-0.172	-0.127	0.001	1.000		
EI	0.150	0.192	0.102	0.143	0.194	0.197	1.000	
PV	0.131	0.207	-0.078	0.048	0.042	0.087	-0.21	0.563

Appendix B shows that the loadings are around the accepted value of 0.7, that is, the shared variance between the construct and its indicators is greater than the error variance [43], and the indicators that did not comply with this aspect, as in the case of indicators PV1, PV2, and PV3 that correspond to the descriptions of Teacher, High School Teacher, and Professor, explain that it is not the intention of the students to undertake teaching activities.

Table I details the parameters associated with the evaluation of the measurement model: “Reliability of each construct,” which implies Cronbach’s alpha, convergent validity (AVE), and composite reliability. The measures reached satisfactory levels for the Cronbach’s alpha of the constructs, exceeding 0.7, which validated the constructs.

As for the composite reliability analysis, all the constructs present values higher than 0.6, confirming their internal consistency, while the average variance extracted (AVE) values were below the minimum recommended.

As for discriminant validity, a PLS model implies that a construct should share more variance with its measures or indicators than with other constructs [44]. This determines the degree to which a given construct differs from the other constructs. To ensure discriminant validity, the AVE value of each latent variable should be greater than the squared correlations between constructs and the others that make up the Fornell and Larcker model [45], as indicated in Table II.

B. Structural Model Analysis

Once the measurement model was validated, the structural model was evaluated (Fig. 2). For this purpose, the indices

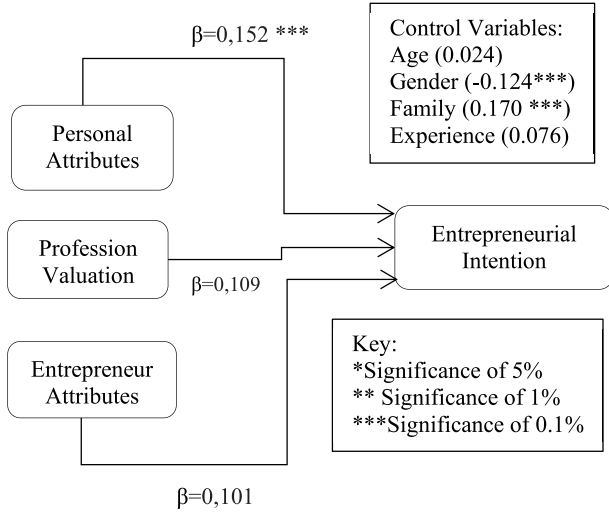


Fig. 2. Structural model.

R^2 , f^2 , and standardized path coefficients β were taken as the basis. The R^2 index, known as the coefficient of determination, is the measure of the predictive power of the model for the latent dependent variables; the value obtained is 0.17, which is below 0.19 in the weak range, according to Chin [46], who identified the values of 0.67, 0.33, and 0.19, denoted substantial, moderate, and weak, respectively. Despite this, the value detected is more significant than 0.1, so the relationships formulated as hypotheses with the latent variable do have predictive power. From the value obtained, it was determined that 17% of the students had a positive attitude toward undertaking.

The normalized fit f^2 index, which measures the impact of the latent variables on EI, reaches a value of 0.011 for EA, 0.022 for PA, and 0.074 for PV. Values of $f^2 > 0.35$ for a big effect size, $0.15 < f^2 \leq 0.35$ for a medium effect size, and $0.02 < f^2 \leq 0.15$ for a small effect size are permissible [46], and represent the strong, medium, or weak effect of a latent variable at a structural level. In this study, the values of 0.074 and 0.022 are higher than 0.02, which reflects that among the factors that influence EI, personal attributes, and professional valuation have a small effect.

Despite this, it is worth noting that PLS-SEM focuses primarily on prediction rather than fit. Therefore, there are recommendations to focus more on the predictive relevance of R^2 than f^2 fit values [47].

Concerning the standardized path β , the study found a significant relationship between “personal attributes” and “EI,” and EI ($\beta=0.152$), confirming hypothesis H1. It is validated that neither the “valuation of the entrepreneur among professions,” $\beta = 0.101$, nor the image “attributes of the entrepreneur,” $\beta = 0.109$, influences EI. Thus, these hypotheses were rejected. Of the four control variables, two affect EIs in a statistically significant way: 1) gender and 2) the background of entrepreneurial families. The age and work experience of the students did not influence their EI (Table III).

The range of responses on the Likert scale was from one to five for “EI,” from one to four for both “personal attributes”

TABLE III
RELATION BETWEEN CONSTRUCTS

	β	σ	t-student	p Values	Level	Acceptance or rejection
H1: PA \rightarrow EI	0.152	0.046	3.272	0.001	***	Accepted
H2: PV \rightarrow EI	0.109	0.160	1.607	0.109		Rejected
H3: EA \rightarrow EI	0.101	0.105	0.969	0.333		Rejected
Ed \rightarrow EI	0.024	0.041	0.596	0.551		Rejected
Ge \rightarrow EI	-0.124	0.036	3.488	0.001	***	Accepted
Fa \rightarrow EI	0.170	0.035	4.876	0.000	***	Accepted
Ex \rightarrow EI	0.076	0.040	1.894	0.059		Rejected

Significance: *** $p \leq 0.001$; ** $p < 0.01$; * $p < 0.05$

and “entrepreneur attributes,” and from one to seven for “profession valuation.”

V. DISCUSSION

It was found that the sample of university students possess a perception of their attributes that are positively associated with EI. These findings are corroborated by [5], [6], [13], [19], [48], and [49]. The findings reveal that personal attributes should be strengthened through entrepreneurial education, similar to [3] and [4].

A contribution of the study is that the valuation of the attributes of entrepreneurs is not related to the intention of entrepreneurship in the university students under study. Instead, for [23] and [24], there are more probabilities of having intentions to start a business when entrepreneurship is positively valued by university students.

Another relevant aspect is that the valuation of professions, among them the entrepreneur, is not associated with the intention of entrepreneurship. This approach coincides with [21], who points out that the entrepreneur profession is not significant for university students. In turn, the studies by Liñán [1] and Morales-Alonso et al. [27] suggest a positive image of the entrepreneur among professions.

Concerning demographic characteristics has been complemented in this research, gender influences EI, findings consistent with Casero et al. [14]; likewise, entrepreneurial relatives influence EI [11], [33], [36], [37]. Age does not influence EI, as stated by Ferreras-García [32], contrary to a previous study where age positively influences EI [30], [31]. Similarly, work experience is not related to EI, an approach that agrees with Vélez et al. [34] and Olmos [35]; however, there is a relationship for Garrido [33], Tarapuez et al. [31], and López-Nuñez et al. [28].

Consistent with recent studies, this finding is also consistent with the positive influence of attributes on company creation. This research describes important aspects of study design for different types of universities, and the aim of the study is to probe university students’ attitudes toward the creation of a new firm. This study focuses on one private university, whereas other authors have focused on several private universities [15]. In line with this study, the researchers used a sample of more than 300 undergraduate students [24]. Data were used to test EI using structural equation techniques, following [8], and

other studies of the framework used bivariate analysis [13], [14], [21]. Entrepreneurial education should strengthen personal attributes. Villasana et al. [3], Neneh [4], and Liñan and Chen [15] promoted the personal attributes of students through entrepreneurship undergraduate programs and events that promote entrepreneurial culture, such as participation in forums and fairs, which promotes their spirit toward the creation of companies. Therefore, entrepreneurship educators should improve their students' entrepreneurship knowledge.

The variables and scales were validated in [1], [13], and [39]. In this sense, the authors believe that the questionnaire used in the sample is a good instrument to analyze EIs, such as questions regarding the entrepreneur's image and perception of the profession. Recent research has been replicated several times by other colleagues with adapted questions; however, these cover most of the factors that must be addressed in the study of EI.

When collecting information from informants, a delay in the delivery of answers was evident due to the lack of knowledge of the subject. Another limitation is the selected research methodology, which did not allow triangulation with qualitative pairs. On the other hand, the existence of lines of research on student entrepreneurship in the environment is almost nil; this does not allow for reinforcing the criteria, gaining experience, or receiving feedback.

VI. CONCLUSION

The objective of this study was to examine the association between personal attributes, the social valuation of the entrepreneur among professions, and the image of the entrepreneur's attributes with EI.

The study's limitations are that the sample data do not generalize the personal and contextual determinants of EI in higher education institutions in Ecuador; nevertheless, this study contributes to the empirical literature on the determinants of EI in university students.

These results show that entrepreneurial skills should be strengthened in university students' education programs. In addition, entrepreneurship programs should be developed to strengthen the image of the entrepreneur and have a presence in the different careers of the university to affect their attitude toward the creation of companies.

For future research, it is necessary to develop the same line of research with other types of universities, such as public universities, to compare data. This will allow observing whether the contextual and personal variables of EI present differences between higher education institutions.

APPENDIX A

Proposal / Methodology	University / Country / Sample	Findings	Ref
Attitudes toward entrepreneurship / Descriptive analysis	Universities of Levante, Balears, and Canarias / Spain / 1531	The interest of students in liberal professions is bigger than an entrepreneur	[39]

(Continued)

Attitudes towards entrepreneurship / Correlation / Descriptive Analysis / Chi2 Pearson	University of Extremadura / Spain / 514	Personal attributes were positively associated with positive perceptions of a company's feasibility. The valuation of the different professions in society, including that of the entrepreneur. There is a difference in the study of entrepreneurs' image, with emphasis on the attributes	[13]
Attitudes towards entrepreneurship: A two-country comparison / T student	Puerto Rico Universities / 435 Catalan Universities, Spain / 837	Raking entrepreneur's prestige compared to other professions in both countries, showed no significant differences between the means. Differences between Puerto Rico and Catalan mean attributes related to the entrepreneur's image	[21]
Relationship between social capital and entrepreneurial intention using the theory of planned behavior (TPB) / Regression Analysis	University in the Limpopo province / South Africa / 365	Social capital is significantly correlated with entrepreneurial intention and its antecedents (attitude towards becoming an entrepreneur and perceived behavioral control)	[24]
Students' attitudes towards the creation of companies at the two universities / Chi 2 de Pearson	University of Extremadura, Spain / 516 University of Beira, Puerto Rico / 527	The image of the entrepreneur with an emphasis on attributes is different between the two universities	[14]
Ajzen's theory of planned behavior to build an entrepreneurial intention questionnaire (EIQ) and analyze its psychometric properties / Structural equation techniques	University of Sevilla, Spain / 323	Personal attitude positively influences entrepreneurial intention	[15]

APPENDIX B

Id	Items y variables	Average	Σ	Loads
Entrepreneur Attributes (EA)				
EA1	Are creative people	2.946	0.937	0.724
EA2	Have great negotiation skills	3.118	0.948	0.447
EA3	Have great financial and management skills	2.974	0.934	0.563
EA4	Have an innovative mentality	3.098	1.007	0.757
EA5	Are very professionally prepared	2.898	0.987	0.716
EA6	Are able to take risks in their company	3.020	0.975	0.744
EA7	Have a great vision of the future	3.163	0.990	0.674
EA8	Invest money	3.093	0.979	0.706
EA9	Create jobs	3.148	0.966	0.792
EA10	Help with the economic development of the country	3.052	0.980	0.759

(Continued)

EA11	Earn a lot of money	2.879	0.967	0.733
EA12	Have good communication skills	2.964	0.958	0.720
EA13	Are moral and honest people	2.801	0.972	0.624
EA14	Are good at solving problems	2.885	0.986	0.738
Personal Attributes (PA)				
PA1	Do I consider myself adapting well to change?	3.205	0.850	0.623
PA2	Am I confident about my personal and professional capabilities and possibilities?	3.211	0.921	0.755
PA3	Do I have the self-discipline to complete a task?	3.111	0.896	0.741
PA4	Do I consider it important to have autonomy at work?	3.208	0.879	0.769
PA5	Do I like to foresee or anticipate events?	3.083	0.909	0.682
PA6	Do I have good communication skills?	2.977	0.915	0.574
PA7	Do I consider myself a creative problem-solver?	2.990	0.915	0.799
PA8	Am I interested in new topics or different ways of doing things?	3.213	0.907	0.734
PA9	Do I dedicate the hours necessary to complete a task or carry out a project?	3.038	0.857	0.720
PA10	Do I face difficulties in a lively and optimistic manner?	2.952	0.864	0.750
PA11	Do I consider myself emotionally stable?	3.007	0.910	0.594
PA12	Do I consider myself a persevering person?	3.175	0.833	0.711
PA13	Do I consider myself enthusiastic when starting new projects?	3.183	0.867	0.793
PA14	Do I tolerate failures well and use them to learn about experiences?	2.943	0.872	0.560
PA15	Do I like to take the initiative in complex or delicate situations?	3.023	0.898	0.708
PA16	Do I like to imagine the evolution and outcomes of the projects I start?	3.246	0.864	0.729
PA17	Do I like to feel independent?	3.454	0.824	0.726
PA18	Do I like to face new challenges?	3.261	0.879	0.740
PA19	Do I take responsibility for my decision?	3.323	0.826	0.564
PA20	Am I willing to take moderate risk?	3.106	0.835	0.762
Entrepreneurial Intention (EI)				
EI1	Entrepreneurial Intention	3.493	1.141	1.000
Profession Valuation (PV)				
PV1	Teacher	4.721	1.814	0.302
PV2	High school teacher	4.834	1.817	0.312
PV3	Professor	5.696	1.586	0.319
PV4	Engineer	5.870	1.575	0.744
PV5	Entrepreneur	4.684	2.505	0.708
PV6	CEO	5.291	1.614	0.775
PV7	Politician	4.642	2.347	0.719
Control				
	Age	22.355	3.659	1.000
	Experience	1.355	0.479	1.000
	Family	1.416	0.493	1.000
	Gender	1.434	0.497	1.000

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