Teaching credentials and academic performance: a panel data study in a Latin American School of Economics

PATRICIA HERNANDEZ MEDINA[I]
GABRIEL RAMIREZ TORRES[II]
DIEGO PINILLA RODRIGUEZ[III]
http://dx.doi.org/10.22347/2175-2753v16i51.4259

Abstract
The present research studied the relationship between the credentials of teachers and the academic performance of students who, in the 2014–2015 period, joined the bachelor's degree program in Economics at the Universidad Católica Andrés Bello, Caracas, Venezuela. The hypothesis of a direct relationship between teaching quality and student performance was evaluated using a panel data methodology, in which the students were considered as "individuals," and the semesters of the degree course were the time period under study. For the fixed and random effects estimations without instrumental variables, the following were found to be significant: the teacher's marital status, place of study, pedagogical training, student evaluation, and the teacher's professional commitments outside the academic sphere. The results do not allow us to accept the null hypothesis since academic teaching credentials do not promote significant increases in academic performance.
Keywords: Student performance; Teacher characteristics; Teacher evaluation; Higher education; Panel data.

Submetido em: 03/04/2023
Aprovado em: 14/06/2024

[I] Universidad Nacional de Chimborazo (UNACH), Riobamba, Equador; http://orcid.org/0000-0001-8527-5158; e-mail: patricia.hernandez@unach.edu.ec.
[II] Universidad Nacional de Chimborazo (UNACH), Riobamba, Equador; http://orcid.org/0000-0003-1844-4278; e-mail: gabrielg.ramirez@unach.edu.ec.
[III] Universidad Nacional de Chimborazo (UNACH), Riobamba, Equador; http://orcid.org/0000-0002-6663-9478; e-mail: dpinilla@unach.edu.ec.

Credenciais de ensino e desempenho acadêmico: um estudo de dados de painel em uma escola de economia da América Latina

Resumo

A presente pesquisa estudou a relação entre as credenciais dos professores e o desempenho acadêmico de estudantes que, no período 2014-2015, ingressaram na graduação em Economia na Universidade Católica Andrés Bello, Caracas, Venezuela. A hipótese de relação direta entre a qualidade do ensino e o desempenho dos alunos foi contrastada, utilizando-se uma metodologia de dados em painel, na qual os alunos foram considerados como "indivíduos" e, como tempo, os semestres de duração da carreira. Para as estimativas de efeitos fixos e aleatórios sem variáveis instrumentais, foram significativos: o estado civil do professor, o local de estudo, a formação recebida para fortalecer o componente pedagógico, a avaliação dos alunos e os compromissos profissionais do professor fora do campo acadêmico. Os resultados não nos permitem aceitar a hipótese nula, uma vez que as credenciais acadêmicas dos professores não promovem aumentos significativos no desempenho acadêmico.

Palavras-chave: Desempenho do aluno; Características do professor; Avaliação do professor; Ensino superior; Dados de painel.

Credenciales docentes y rendimiento académico: un estudio de datos de panel en una carrera de Economía en América Latina

Resumen

La presente investigación estudió la relación entre las credenciales de los docentes y el rendimiento académico de los estudiantes que, en el período 2014-2015, ingresaron a la carrera de Economía de la Universidad Católica Andrés Bello, Caracas, Venezuela. Se probó la hipótesis de una relación directa entre la calidad docente y el rendimiento de los estudiantes, utilizando una metodología de datos de panel, en la que se consideró a los estudiantes como "individuos" y como período, los semestres de la carrera. Para las estimaciones de efectos fijos y aleatorios sin variables instrumentales, resultaron significativos: el estado civil del profesor, el lugar de estudio, la formación recibida para reforzar el componente pedagógico, la evaluación de los alumnos y el desarrollo profesional del profesor fuera del ámbito académico. Los resultados no permiten aceptar la hipótesis nula, ya que las credenciales académicas de los docentes no promueven incrementos significativos en el rendimiento académico.

Palabras clave: Rendimiento estudiantil; Características del docente; Evaluación del docente; Educación superior; Datos de panel.

Introduction

At every level of the educational system – from kindergarten to university – academic performance is one of the variables of greatest interest, not only from the student's point of view but also from that of the institution, teachers, and the state. That is why, undoubtedly, the concern for obtaining better academic results and how to achieve them is fundamental for decision-makers.

To approach the problem of academic achievement, the great challenges are in its study, definition, and measurement. If starting from the economic perspective of education, academic achievement could be considered the output of a productive process, whose inputs are individual factors, family or socioeconomic variables, and the companion and institutional effect (Hanushek, 1979). Of these process inputs, family and individual factors are non-academic, while the academic inputs are the physical conditions of the academic institution, human resources, teachers, the student experience, pedagogical training, and available support, among others (Salas Velasco, 2008).

In terms of the other challenge of measuring academic performance as a dependent variable, the literature presents various forms, some associated with subjects' grade point average, the number of subjects retaken or failed, the retention rate, the time taken to graduate, and standardized tests.

Regardless of the measurement used, various authors agree on the multiplicity of factors that explain achievement. From the pioneering work of Hanushek (1971) to the most recent, empirical evidence has shown that academic results can be explained by demand-side variables, such as those associated with the individual and his or her family, or those linked to the provider or institution. The first group of individual variables is related to the student's own characteristics, such as his or her skills, years of study, institution of origin, gender, race, grades in previous studies, and so on. This group also includes family variables, which are generally represented by the socioeconomic level, the parents' levels of education, and the type of housing or its characteristics.

However, contrary to Hanushek (1989), who concludes that there is no significant relationship between the economic resources allocated to education and students' performance, there are studies such as those by Hedges, Laine and Greenwald (1994) that, using the meta-analysis methodology, demonstrate the

opposite, *i.e.*, they establish a direct relationship between inputs (monetary resources in this case) and outputs (student results in the educational process).

On the supply side, elements such as the quality of the institution, class size, existing resources, and teacher characteristics or credentials are included. These teaching credentials are expressed according to Dee (2001), Rockoff (2004), Clotfelter, Ladd and Vigdor (2007), and Andersson and Waldenstrom (2007) in terms of academic training, years of teaching experience, research work, publications, and professional development in institutions associated with research and teaching, certification or pedagogical training courses, and class attendance.

Specifically in relation to the role of the teacher in the educational process, the most recent literature has been exposed in studies such as those by Dee (2001), Rockoff (2004), Clotfelter, Ladd and Vigdor (2007), Andersson and Waldenstrom (2007) and Azam and Kingdon (2015), who propose that there is a positive effect between teacher quality and academic performance, being one of the most important determinants from the institutional point of view. These works incorporate different variables associated with the teacher, some related to quality and others to the personal characteristics of the teacher. The former include the studies completed, the institution from which the teacher graduated, years of teaching experience, publications or research, place of work, teaching certification or pedagogical training courses, and class attendance. The latter include the teacher's gender, marital status, race, housing near the institution, and family burden.

Harris and Sass (2011) suggest a positive relationship with performance using the teacher's educational training and the requirements demanded by the country's legislation, while for Clotfelter, Ladd and Vigdor (2007), the variables related to teaching credentials are linked to teaching experience, test results, and obtaining a degree as an educator.

Authors such as Cordero Ferrera, Crespo Cebada and Pedraja Chaparro (2013) and Singh and Sarkar (2015) identify that the relationship between variables on the side of the institution has little influence on academic performance. First, they analyzed the results achieved in the PISA (Programme for International Student Assessment) in Spain, which was explained primarily by personal and socioeconomic variables. Second, they performed a study in India where they were unable to determine a significant relationship between performance and experience, gender, and the teacher's proficiency in the contents. Chu, Loyalka, Chu, Qu, Shi, and Li (2015)

worked in China and indicated that the influence will depend on the measurement of teaching credentials, finding a positive and significant relationship when credentials were analyzed in terms of teacher evaluation results but not so when the awards received or the continuation of their university training were incorporated.

Thus, depending on the variable or set of variables used for the study, it is possible to identify a relationship or not, as established by Savage (2019). This author used the teacher's university education to conclude that depending on the specialty which the individual teaches, this education has an influence or not on the students' performance.

The review of the literature for Latin America reveals a scarcity of studies that relate to institutional variables and, in particular, the effect of teachers' credentials on academic performance, as corroborated by Canales and Maldonado (2018), who conducted a study using the fixed effects panel data methodology for Chile, identifying a direct relationship with performance, specifically performance in mathematics with teaching experience. In the case of Ecuador, Acosta Gonzáles, Hermida Bermeo and Macheno Karolys (2017) also corroborate a relationship between performance in a private university's Faculty of Economics and the teachers' gender, dedication, and evaluation results.

For Venezuela, limited research on the subject is also evident, so it is relevant to consider the study of academic performance in higher education students given the number of resources needed to hire highly credentialed teachers in an environment with strong budgetary restrictions. It is especially important for higher education managers to have more input in order to make decisions related to raising the performance of their students. This is particularly the case if, knowing the existence of such budgetary restrictions, it is believed that the learning process improves upon strengthening institutional variables, such as having sections with a small number of students, professors with PhDs, and modern facilities with the best technology.

Regarding the School of Economics at the Universidad Católica Andrés Bello (UCAB), a private educational institution entrusted to the Society of Jesus and located in Caracas, the main strength for more than 20 years has been that the faculty staff are highly qualified. 80% of them have a Master's or doctoral degree, of which more than 50% obtained their degrees in a foreign university.

As the literature suggests, if the UCAB School of Economics has well-trained teachers, this could contribute toward explaining to some degree the academic performance of the students.

In this context, this research studied the possible relationship between faculty credentials and academic performance. The latter is understood as the final average grade obtained by each student in each of the required subjects of the course or as the average productivity (subjects passed with respect to subjects taken). Teaching credentials are represented by educational level, higher education institution, years of teaching experience at the time of hiring, number of research papers completed, number of publications, teaching certification understood as a pedagogical training course, experience in public or private research institutions, percentage of class attendance, location in the hierarchy (teacher's category), and students' evaluation of the teacher.

Although the phenomenon of academic performance is multifactorial, this research approached its explanation from the point of view of institutional variables. This analysis represents a contribution in terms of efficient budget allocation in higher education institutions. In Latin America, in particular, there are important financial restrictions that demand the optimal use of scarce resources.

The hiring of teachers with better academic credentials requires a budgetary input that could generate positive effects on student performance. If so, the incorporation of better-trained teachers would not only result in higher institutional quality but also in better student academic performance.

Methodology

The study considered two groups of individuals: the graduates and the faculty. The first group comprised 41 graduates accepted onto the UCAB School of Economics program for the 2014–2015 intake out of a total population of 146 enrolled in the degree program. The second group was made up of 64 professors.

These data provide sample observations for a group of students (graduates) and a considerable number of explanatory variables, with a total of 1,353 observations. This allowed us to estimate a general model for academic performance that is expressed as a function of two groups of variables: those associated with the students and those associated with the teacher (Table 1).

Table 1 - Variables used in the estimation

Variable	Relationship to academic performance	Authors who proposed its use
Individual variables		
Gender	There is no consensus on the relationship; it depends on the program.	Hanushek (1971), Stinebrickner and Stinebrickner (2003), Wilder (2014), Quadlin (2018).
Job	There is usually an inverse relationship.	
Place of residence / Change of location	Living in rural areas or moving to continue studies lowers performance.	
Economic dependence	Reliance on parents or relatives and not working raises achievement.	
Aid/Scholarship	Educational funding may raise academic achievement.	
Housing conditions	Better home conditions raise achievement.	
Mother's studies / Father's studies	Higher levels of parental education raise achievement, especially that of the mother.	
Verbal admission test score / Numerical admission test score	Better admission test scores may predict higher performance.	
Institutional variables		
Class size	Smaller class sizes increase performance.	Dee (2001), Rockoff (2004), Clotfelter, Ladd and Vigdor (2007), and Andersson and Waldenstrom (2007), Harris and Sass (2011) Cordero Ferrera, Crespo Cebada and Pedraja Chaparro (2013), Singh and Sarkar (2015) Chu, Loyalka, Chu, Qu, Shi, and Li (2015), Acosta Gonzáles, Hermida Bermeo and Macheno Karolys (2017), Canales and Maldonado (2018), Savage (2019).
Teacher's academic degree	The higher the teacher's level of education, the higher the performance in theory.	
Teacher's pedagogical training / Experience	Having teaching experience or training should increase performance.	
Teacher's evaluation results	Better evaluations should indicate increased performance.	
Teacher's number of absences	More attendance should tend to improve performance.	
Type of teaching job	Working full-time as a teacher should raise performance.	

Source: The authors (2023).

Therefore, econometric theory suggests the establishment of regression models in the form of panel data, estimated with STATA 15 (Statacorp, 2019). This estimation can be performed because observations are available for the same individuals at different points in time, as suggested by authors such as Greene (2000), Wooldridge (2002), and Montero (2011).

Other alternatives for the methodological approach could be associated with multiple regression estimations or efficiency or frontier models, but in these cases cross-sectional data were used (Cordero Ferrera; Crespo Cebada; Pedraja Chaparro, 2013).

As for performance, there are unobserved variables such as skills, motivation, intelligence, and effort, which generate problems in the estimation, thus indicating the need to perform this type of estimation through panel data. As proposed by Wooldridge (2002), the main motivation for using this technique is to solve the problem of omitted variables.

One can start from a regression model such as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + u \quad (1)$$

For the ordinary least squares estimators to be consistent, it is necessary to assume that (Montero, 2011):

$$E(u) = 0, \quad Cov(x_j, u) = 0 \text{ and } E(u|x_1, x_2, ..., x_k) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k \quad (2)$$

However, if one is not satisfied that the covariance between the variables and the residuals is zero, the estimators are not consistent and $\boldsymbol{x_1, x_2}$ ... $\boldsymbol{x_k}$ would be an endogenous variable. The existence of endogenous variables is mainly due to omitted variables, measurement errors, and simultaneity. One option to solve this problem is to use panel data models that allow us to obtain consistent estimators despite the presence of omitted variables (Wooldridge, 2002).

If starting from a linear model such as:

$$E(u|\mathbf{x}, c) = \beta_0 + \mathbf{x}\beta + c \quad (3)$$

where *c* is the unobserved variable and if $Cov(x_j, c) = 0$, then the estimator will be consistent and $\boldsymbol{x_1, x_2}$ ... $\boldsymbol{x_k}$ will not be an endogenous variable, whereby it is necessary that *c* is constant over time. Thus, it is essential to know the behavior of *c*, which could be a random variable or another parameter to be estimated (Wooldridge, 2002).

Assuming, therefore, a model such as:

$$y_{it} = \mathbf{x}_{it}\beta + c_i + u_{it}, \quad t = 1,2,...t \quad (4)$$

there is the possibility of estimating random effects if c_i is a random variable whose expected value is zero and whose variance indicates the heterogeneity of the

individuals or the estimation of fixed effects in which c_i is considered a constant for each individual and thus a parameter to be estimated (Montero, 2011).

The use of fixed or random effects is a function of the correlation that exists between x_{it} and c_i (equation 4). The final selection of the method, as indicated in the literature, will depend on the exogeneity assumption of the unobservable variable, so if the covariance between x_{it} and c_i is not zero (equation 4), then one should use fixed effects, while if it is zero, one should use random effects (Montero, 2011).

For the estimation, one must formalize the strict exogeneity assumption for the explanatory variables as:

$$E(y_{it}|x_{i1},x_{i2},...x_{iT},c_i)=E(y_{it}|x_{it},c_i)=x_{it}\beta+c_i \quad (5)$$

Therefore, the conditional expected value of the idiosyncratic error (u_{it} equation 4) is given by:

$$E(u_{it}|x_{i1},x_{i2},...x_{iT},c_i)=0 \quad (6)$$

In this case, the random effects model can be represented as $y_{it}=\mathbf{x}_{it}\beta+v_{it}$, where v_{it} is the composite error and is given by $v_{it}=c_i+u_{it}$. The presence of c_i generates a serial correlation in the composite errors, which requires estimation using the robust variance matrix (Wooldridge, 2002).

To obtain consistent estimators from this estimation, two assumptions are needed (Wooldridge, 2002), which will be called random effects 1 (RE.1) and random effects 2 (RE.2):

RE.1: $E(u_{it}|x_i,c_i)=0,t=1,...T$ and $E(c_t|x_i)=E(c_i)=0$ (7)

RE.2: range $E(X_i^{'}\Omega^{-1}X_i)=K$ where the unconditional variance matrix is given by $\Omega\equiv E(v_i v_i^{'})$. (8)

This matrix will have a random effects structure to the extent that it can be represented as:

$$\Omega=\begin{pmatrix}\sigma_c^2+\sigma_u^2 & \sigma_c^2 & \cdots & \sigma_c^2\\ \sigma_c^2 & \sigma_c^2+\sigma_u^2 & \cdots & \vdots\\ \vdots & & \ddots & \sigma_c^2\\ \sigma_c^2 & \cdots & \sigma_c^2 & \sigma_c^2+\sigma_u^2\end{pmatrix} \quad (9)$$

where the elements above and below the diagonal line represent the sum of the variance of the idiosyncratic error □□□□□ and the variance of the omitted variable □□□□□□ being the partial correlation in the idiosyncratic error (zero): $E(u_{ti}u_{is}^{'}) = 0$.

Given the form of the variances and covariances matrix, assumption 3 (RE.3) states:

RE.3 $E(u_i u_i' | x_i, c_i) = \sigma_u^2 \mathbf{I}_T$ and $E(c_i^2 | x_i) = \sigma_c^2$ (10)

This assumption ensures that the estimator is efficient in the sense that it will be the one with the minimum variance among all the consistent ones. If assumption 3 on the homoscedasticity of the idiosyncratic residuals is violated, then it will be necessary to use generalized least squares estimation (GLS), as proposed by Montero (2011).

Now, it is essential to test whether there is a random effect or not, which is equivalent to saying whether the variance of the random variable c_i is zero (Ho: □□□□0), a hypothesis that will be tested by means of a test for serial correlation AR (1) through the estimation of $v_{it} = \rho v_{it-1}$.

Accepting the null hypothesis in the above test does not guarantee that there are no fixed effects but only that there is no serial correlation, *i.e.*, that the elements above and below the variance matrix are zero (Wooldridge, 2002).

Thus, if in addition to accepting the above hypothesis, it is known that the covariance between variables x_{it} and c_i is not zero, then should be working with fixed-effects models. The assumptions, based on which the fixed effects model generates unbiased estimator's conditional on variables x_{it} are twofold:

FE.1: $E(u_{it} | x_i, c_i) = 0, t = 1,...T$ (strict exogeneity assumption) (11)

FE.2: range $E(\ddot{X}_i^{'} \ddot{X}_i) = K$ (12)

The rank condition is expressed in terms of a matrix of x_{it} variables that have been modified by subtracting the mean from each value, which is called within transformation. The consequence of subtracting the mean generates the limitation that variables constant over time for an individual are eliminated, and, with them, their contribution toward explaining the behavior of the variable of interest is lost (Wooldridge, 2002).

This transformation would imply that if c_i is a constant, it disappears, thus:

$y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)\beta + u_{it} - \bar{u}_i$ or $y_{it} = \ddot{x}_{it}\beta + \ddot{u}_{it}$ (13)

Under the assumption of strict exogeneity, ordinary least squares estimation produces consistent estimators because $E(x'_{it}\, u_{it}) = 0$, which eliminates the problem generated by the omitted variables.

Additionally, a third assumption is required to guarantee the existence of efficient estimators, associated with the homoscedasticity of the idiosyncratic residuals:

RE.3: $E(u_i u_i^{'} | x_i, c_i) = \sigma_u^2 \mathbf{I}_T$ (14)

If assumption 3 fails, it is necessary to perform a fixed effects generalized least squares estimation (FEGLS), whose estimator is asymptotically as efficient as the fixed effects least squares estimator if the variances and covariances matrix is positive definite (Wooldridge, 2002).

In addition to determining the correlation between the omitted variable c_i and the variable x_{it}, the Hausman test can also be used, whose null hypothesis states that the estimation of fixed effects is equivalent to the estimation of random effects. If this hypothesis is rejected, the consistency of the fixed effect is proposed (Montero, 2011).

Results

Characteristics of the sample

The sample considered, related to students and teachers of the 2014–2015 cohort, was made up of 146 enrolled students and 64 teachers. With respect to average academic performance, only in the first semester a value below the minimum 10 points required to pass the subjects (scale from 0 to 20) was recorded, as shown in Table 2.

Table 2 - Academic performance and class size

	Semester							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Academic performance								
Average	5.21	11.13	11.57	12.76	12.81	14.74	14.69	14.81
Minimum	3.90	7.10	1.35	7.55	8.1	10.2	10.35	10.85
Maximum	13	16.1	16.4	16.6	16.7	17.2	16.9	17.3
Class size	146	88	72	64	62	56	56	51

Source: The authors (2023).

The low performance of the first semester generates significant dropout problems, which are evidenced in the class size, decreasing from 146 students to 88.

This reduction intensified until the end of the entire course with 1/3 of the initial enrollment remaining, of which 41 students were able to graduate.

78% of the professors considered in the sample were male, mostly single (80%), and 63% carried out research, although only 3 of these professors are full-time personnel at the institution.

With respect to academic training, 53% have completed Master's and/or doctoral studies abroad; only 17% have some pedagogical training, such as a course on teaching. Professionals who are not educators need to be able to perform as such with knowledge of learning techniques, teaching tools, and evaluation mechanisms. Seventy percent of the professors had teaching experience before being hired at UCAB.

In Venezuela, according to the University Law, the classification of professors in ascending order is as follows: instructor, assistant, associate, attaché, and tenured professor. Most professors are assistants (44%), followed by a significant group of instructors (28%) and attachés (19%). The number of associate and tenured professors is barely 6.

The students' evaluation of the professors is the result of the survey applied to the students at the end of the year or semester, with a minimum score of 1 and maximum of 6. On average, the professors of the cohort had a score of 4.83, with a minimum of 2.03 and maximum of 6.

Pooled data, fixed effects, and random effects

The estimations of the academic performance model as a function of the variables associated with students and teachers were established for three modalities: pooled data, random effects, and fixed effects. The results obtained are shown in Table 3.

Table 3 - Estimation of academic performance by pooled data and random effects

	Pooled			**Random Effects**		
	Coefficient		**Standard error**	**Coefficient**		**Standard error**
Student variable						
Gender	-0.1203		0.198	-0.1236		0.494
Job	-0.0933		0.488	-0.0897		0.121
Place of residence	3.2345	*	0.650	3.2422	**	0.160

Continua

Conclusão

	Pooled			Random Effects		
	Coefficient		Standard error	Coefficient		Standard error
Student variable						
Economic dependence	-1.9433	*	0.250	-1.942	*	0.625
Aid/Scholarship	3.5365	*	0.389	3.5411	*	0.969
Type of housing	0.6391	*	0.121	0.6392	**	0.303
No. of family members	-0.2646	*	0.073	-0.2665		0.182
Housing conditions	-0.3661	***	0.221	-0.3693		0.552
Mother's studies	-0.1421	**	0.066	-0.1418		0.164
Father's studies	-0.0982		0.082	-0.0972		0.205
Parents' jobs	0.0442		0.048	0.0454		0.119
Source of income	0.0855		0.093	0.0823		0.231
Age	-0.1784	***	0.103	-0.179		0.256
Type of admission	-0.0468		0.058	-0.0462		0.144
Verbal admission test score	-0.0028		0.002	-0.0028		0.006
Numerical admission test score	0.0189	*	0.002	0.0189	*	0.005
Change of location	-2.6015	*	0.777	-2.6016		0.193
Average score at high school	0.0894	**	0.043	0.0891		0.108
Teacher / institutional variable						
Class size	0.0061		0.005	000015		0.005
Teacher's academic degree	0.4254		0.284	0.4206		0.271
Teacher's nationality	-0.7124	***	0.419	-0.8298	**	0.400
Teacher's marital status	1.0739	*	0.232	1.0454	*	0.222
Teacher's gender	0.1871		0.236	0.1773		0.225
Teacher's family burden	-0.6289		0.084	-0.6143		0.802
Age	-0.0203	*	0.008	-0.0207	*	0.008
Teacher's place of study	0.7784	*	0.223	0.76	*	0.213
Teacher's pedagogical training	0.5307	**	0.219	0.5389		0.209
Experience	0.0156		0.178	-0.1878		0.170
Teacher's evaluation results	0.2715	**	0.136	0.2717	**	0.131
Teacher's number of absences	-2.7794		0.211	-3.5123	***	0.203
Type of teaching job	-0.6168	*	0.190	-0.6249	*	0.182
Constant	0.2638		0.256	0.3875		0.606
LM Breusch-Pagan – Radom effects	799.01***					
F- fixed effects	44.83***					
Hausman	2.10					

Note: Significant at 1% (***), 5% (**), 10% (*).
Source: The authors (2023).

Based on these results, first, the appropriate model was determined by applying the Breusch and Pagan Lagrange multiplier (LM) test for random effects, where the null hypothesis is that the variance of u_i is zero, so there would be no relevant difference between the two models; if the null hypothesis is rejected, it would be preferable to use the random effects model. The results in this case do not allow us to accept the null hypothesis; the random effects model seems to be preferable to the pooled model.

Secondly, to choose between pooled data and fixed effects estimation, the F test was used, based on the null hypothesis in which the omitted variables are equal to zero so that if it is rejected, these variables exist and therefore the fixed effects model should be employed. Indeed, in the estimation, the value of the F statistic does not allow the null hypothesis to be accepted, and it would therefore be convenient to use fixed effects and not pooled data.

Hence, the approach focuses on deciding between random effects and fixed effects, even more so when it is believed that there are omitted variables. Our results allow us to accept the null hypothesis and consider that there are no significant differences between the estimators, and the covariance between the explanatory variables and the omitted variables is zero, so it is convenient to use the random effects model, thus avoiding losing the information provided by the variables associated with the student.

Upon analyzing the random effects estimation, the significant variables in the explanation of performance for the students and/or family were residence, dependence, financial aid, type of housing, and results in the numerical test. The significant explanatory variables on the teacher's side were nationality, marital status, age, place of study, evaluation, absences, and type of teaching job.

With regard to the signs in most of the relationships, they seem to be as expected; indeed, a direct relationship is shown between residence (with whom the student lives) and performance, which suggests that living with parents promotes higher grades in students, probably because of the parents' vigilance and the effort they make so that their children can complete their studies.

Additionally, a direct relationship was observed between performance and economic support, type of housing, numerical ability test results, and weighted high school average. In the first case, it could be said that students value the aid received and desire to improve their performance in addition to devoting a greater portion of

their time to study, given that they would not need to look for a job to cover the cost of tuition. In relation to the type of housing, the better the infrastructure of the building in which they live, the higher their performance; this is mainly associated with the comfort they have when studying and conditions that facilitate concentration and motivation.

The results of the numerical test and high school performance weighted by the institution of origin (public or private) seem to be variables that could allow one to predict university performance. Given that Economics is a course that requires mathematical skills, the results of the test in this area could indicate what the future outcome would be in terms of performance, as could the average baccalaureate grades. Meanwhile, there is an inverse relationship between dependence and performance, since the more students depend on their own income, the worse the performance, given that they need to dedicate time to supporting themselves.

As for the institutional variables, there is evidence of a direct relationship between performance and marital status, place of study, and evaluation, while the nationality of the teacher, age, class absences, and type of teaching job reduce the results in terms of performance.

Unmarried teachers tend to increase the grade point average as they may have more time to dedicate to the students, assessments, and follow-ups, which is evidenced by the inverse relationship with the teacher's familial responsibilities, as a greater burden (spouse and children) reduces performance. In addition, student evaluation also shows a direct relationship with performance since the higher the grades obtained, the more positive the students are in their evaluation of the teacher.

Evaluation is considered by authors such as Stanca (2004) as a proxy variable for student motivation, in the sense that the more motivated the students are, the more highly they will evaluate the teacher. This assumption about student motivation seems to be adequate if the relationship found is direct, in the sense that higher motivation is associated with higher grades and better evaluation of the teacher.

Variables such as the teacher's nationality, type of teaching job, age, and absences, as mentioned above, show an inverse relationship with performance; in the first two cases, the relationship does not seem to be so clear. If analyzing the behavior of the academic degree of the teachers, it can be observed that although it is not significant in the explanation of the performance of the teachers, it is not significant in the explanation of the performance of the teachers, the sign is adequate, because

the higher the academic degrees of the teachers, the more knowledge they have, which tends to increase their ability to explain content, master topics, and transfer knowledge, which in turn motivates students to decide to take the subject and maintain their grades.

It is also vital to determine whether the variance of the residuals is homoscedastic or not, for which a comparison was made between a model with heteroscedasticity and one that included a robust estimate of random effects. Thus, the test (LR) with the null hypothesis that assumes homoscedasticity in the variance of the residuals resulted in a value that means the null hypothesis must be rejected, and it is necessary to correct the heteroscedasticity through robust estimation (FEGLS).

The results of the robust estimation for random effects and fixed effects, shown in Table 4, are akin to the previous ones in terms of significant variables found without correction for heteroscedasticity but with the advantage of the estimators being efficient.

Table 4 - Estimation of academic performance by random effects (FEGLS) and instrumental variables

	Random Effects (FEGLS)			**Fixed Effects (Robust)**	
	Coefficient		**Standard error**	**Coefficient**	**Standard error**
Student variable					
Gender	-0.1203		0.196	(dropped)	
Job	-0.0933		0.482	(dropped)	
Place of residence	3.2435	*	0.642	(dropped)	
Economic dependence	-1.9433	*	0.247	(dropped)	
Aid/Scholarship	3.5365	*	0.384	(dropped)	
Type of housing	0.6391	*	0.120	(dropped)	
No. of family members	-0.2646	*	0.072	(dropped)	
Housing conditions	-0.3661	***	0.219	(dropped)	
Mother's studies	-0.1421	**	0.065	(dropped)	
Father's studies	0.0982		0.814	(dropped)	
Parents' jobs	0.0442		0.005	(dropped)	
Source of income	0.0855		0.092	(dropped)	
Age	-0.1784	***	0.101	(dropped)	
Type of admission	-0.0468		0.057	(dropped)	
Verbal admission test score	-0.0028		0.002	(dropped)	
Numerical admission test score	0.0189	*	0.002	(dropped)	
Change of location	-2.6015	*	0.768	(dropped)	
Average score at high school	0.0894	**	0.043	(dropped)	
Teacher / institutional variable					
Class size	0.0006		0.005	0.0017	0.005
Teacher's academic degree	0.4254		0.280	0.4198	0.271

Continua

Conclusão

Teacher's nationality	-0.7124	***	0.414	-0.8497	0.401
Teacher's marital status	1.0379	*	0.230	1.0405	0.222
Teacher's gender	0.1871		0.233	0.1758	0.225
Teacher's family burden	-0.0628		0.083	-0.0611	0.080
Age	-0.0203	*	0.008	-0.0208	0.008
Teacher's place of study	0.7784	*	0.221	0.757	0.214
Teacher's pedagogical training	0.5307	**	0.216	0.5404	0.209
Experience	0.0156		0.176	0.0193	0.170
Teacher's evaluation results	0.2715	**	0.134	0.2716	0.131
Teacher's number of absences	-2.7794		0.209	-3.6404	0.204
Type of teaching job	-0.6168	*	0.188	-0.6262	0.182
Constant	0.2638		0.253	1.3159	0.798

Note: Significant at 1% (***), 5% (**), 10% (*).
Source: The authors (2023).

Concerning the variables associated with the characteristics of the students and/or their family, five additional variables are significant: housing conditions, number of people living in the home, mother's level of education, student's age, change of city, and academic performance weighted by the institution of origin. In the first four, the relationship with the student's grade point average is inverse, so it could be expected that the lower the number of family members, the higher the performance since a small family provides a more favorable environment for study and thus a higher level of concentration.

Furthermore, younger students had higher grade point averages, as did those whose mothers had a lower level of education. The literature suggests that parental education has a positive effect on academic performance, but in our case, the inverse relationship (only with the mother's educational level) can be explained by the that she is especially keen to support a child who has opportunities that she never had and can enjoy the child's success vicariously. She understands that it is not to be squandered.

Finally, the high school grade point average becomes significant, and, therefore, we could consider that in good part, the results allow us to predict the student's future performance in college.

On the teaching credentials side, performance is affected by nationality, marital status, age, place of study, teacher training, evaluation, and type of teaching job.

Instrumental variables

Indeed, there is a possibility that the teachers' educational level (academic degree) and class size are endogenous variables, in that the student's decision to choose a certain subject during the enrollment process is an omitted variable, which explains academic performance and could be correlated with educational level and class size.

The student will choose a subject based on two variables: one associated with the individual's position in the group that will ultimately determine where he or she will be enrolled, and the other with the historical knowledge he or she has about the performance of the students who studied with each teacher.

To determine whether the teacher's educational level and the class size are endogenous or not, that is, whether they are correlated with the residual and require an instrument to be able to eliminate the correlation while avoiding the presence of inconsistent estimators, these variables were estimated in terms of the rest of the exogenous variables and the instruments. For this, two instrumental variables were used: the student's position in class and class average in each subject so that these variables should not be correlated with the residual.

The residuals of each estimate, one for the teacher's educational level and the other for class size, were included in the estimate of academic performance. Since there are two instruments, an F test was required for joint significance, with the result that both are significant. For that reason, we reject the null hypothesis of consistency, both in the ordinary least squares estimation and in the two-stage least squares estimation with the instrumental variable. Thus, the teacher's educational level and class size variables are endogenous and the estimation with instrumental variables is the one that would allow us to obtain consistent estimators.

For this purpose, a two-stage least squares estimation was used, in which it was observed that the teacher's academic degree, class size, nationality, gender, age, place of study, familial responsibilities, experience, and job type are significant variables in the explanation of academic performance, both in fixed effects and random effects, as shown in Table 5. This estimate shows a direct relationship between performance and nationality, gender, familial responsibilities, place of study, experience, and job type.

Table 5 - Estimation of academic performance with instrumental variables by random effects and fixed effects

	Random Effects			Fixed Effects		
	Coefficient		Standard error	Coefficient		Standard error
Student Variables						
Gender	0.4766		1.570	(dropped)		
Job	0.4071		3.805	(dropped)		
Place of residence	0.5489		0.5191	(dropped)		
Economic dependence	-1.025		1.996	(dropped)		
Aid/Scholarship	1.3149		0.3153	(dropped)		
Type of housing	0.278		0.958	(dropped)		
No. of family members	-0.35		0.569	(dropped)		
Housing condition	-11,.44		1.7556	(dropped)		
Mother's studies	-0.106		0.512	(dropped)		
Father's studies	0.0859		0.644	(dropped)		
Parent job	0.2111		0,376	(dropped)		
Source of income	-0.2283		0.732	(dropped)		
Age	0.1715		0.814	(dropped)		
Type of admission	-0.272		0.461	(dropped)		
Verbal admission test score	0.007		0.019	(dropped)		
Numerical admission test score	0.0138		0.017	(dropped)		
Change of location	0.9035		0.620	(dropped)		
High school average score	-0.2144		0.358	(dropped)		
Teacher / institutional variable						
Class size	0.3763	**	0.187	0.2461	** *	0.134
Teacher's academic degree	-0.4522	**	0.184	-0.4154	**	0.164
Teacher's nationality	1.169	***	6.570	1.2750	**	0.592
Teacher's marital status	-1.1957		0.185	-2.230		0.168
Teacher's gender	0.1542	**	0.622	0.1410	**	0.553
Teacher's family burden	1.1819	***	0.678	1.1994	** *	00617
Age	-0.2893	*	0.113	-0.2556	*	0.098
Teacher's place of study	0.2186	**	0.860	0.2027	*	0.768
Teacher's pedagogical training	-0.2271		0.163	-0.2366		0.149
Experience	0.5024	**	0.222	0.4770	**	0.200
Teacher's evaluation results	-1.647		0.111	-1.018		0.886
Teacher's number of absences	-2.750		0.103	-1.2247		0.932
Type of teaching job	0.4811	**	0.2448	0.4633	**	0.111
Constant	0.9474		0.1953	1.8107		00000

Note: Significant at 1% (***), 5% (**), 10% (*).
Source: The authors (2023).

Thus, the endogeneity correction results in the change of sign of some coefficients of variables such as the teacher's nationality, family burden, and workload. In this case, the relationship seems to indicate that performance is higher with Venezuelan teachers, who are probably considered more flexible. Something

similar occurs with the teacher's family burden, in the sense that the greater the number of family members, the higher the teacher's performance to the point that it increases the students' performance.

In the case of the teacher's job, the evidence seems to show that professors who work as teachers and researchers generate better grades, which could be explained by their ability, proficiency, and management of the topics and content, thereby facilitating student learning and improving grades.

Regarding the rest of the variables that show a direct relationship, such as gender, place of study, and experience, it would seem logical to think that teachers with more experience and who have studied abroad have a positive impact on the results. However, it is gender that has an impact: female teachers achieve higher grades in their students.

Class size also shows a direct relationship – as the number of students increases, the average grade also increases; this could be because of the rest of the class, *i.e.*, peer motivation, or the flexibility of the evaluation by the teacher.

On the other hand, the teacher's age and academic degree show an inverse relationship that seems to indicate that the older the teacher is, the worse the students' performance is, probably because of a higher level of difficulty and demand. Something similar occurs with respect to academic degree, in the sense that the higher the teacher's educational level, the higher the level of demand, and, therefore, performance tends to fall.

Discussion

The literature on academic achievement and its determinants is very varied, from the pioneering works by Hanushek (1971) and Hedges, Laine and Greenwald (1994) to the most recent, in which it is possible to visualize the evolution of research in the area, the variables that have been incorporated as determinants, and the econometric problems that translate into biases, mainly generated by the omission and endogeneity of variables.

Different authors establish different definitions and measurements for each of the variables, trying in most cases to solve the methodological problems that arise, especially through the estimation of panel data with fixed effects.

In the study of performance, there are challenges associated with definition, measurement, explanatory variables, and econometric estimation. In this research,

the first and the second were addressed using the measurement proposed by Porto and Di Gresia (2004), which is no more than the average grade point average of the subjects taken. Regarding the third, the model proposed by Clotfelter, Ladd, and Vigdor (2007) was considered. Here, performance is explained through five groups of variables: the vector of the teacher's permanent characteristics, including gender and marital status at the time of entry; the vector of the teacher's variable characteristics, including years of experience, academic degree, institution of origin, current institution, pedagogical training, hierarchy, absences, and student evaluation; the vector of the student's permanent characteristics, such as race, gender, date of entry to the university, marital status, family educational levels, family income, and school of origin; the vector of the student's variable characteristics, for instance number of subjects retaken and number of subjects passed in remedial exams; and finally, the vector of the characteristics of the student's classmates.

The fourth challenge, associated with the econometric model, allowed us to evaluate the hypothesis on the positive impact of faculty credentials on students' academic performance using pooled data estimations, random effects, and fixed effects. These results allowed us to demonstrate that the pooled data modality is not the most adequate because it rejects the null hypothesis of the Breusch and Pagan test, and there are theoretical differences between students in their abilities, skills, intelligence, motivation, and effort that should be considered in random effects or fixed effects estimations.

In the estimations, the results of the Hausman test coincide in indicating that the coefficients are equally consistent, so the random effects model should be selected. Moreover, due to the existence of heteroscedasticity, random effects models were estimated by FEGLS and fixed effects by robust variance to ensure consistent estimators.

Given that the teacher's academic degree teacher and class size were suspected to be endogenous variables, in that the student's decision on which subject to select during the enrollment process is an omitted variable that explains academic performance and could be correlated with academic grade and class size, instrumental variables estimation was introduced, both for fixed and random effects.

Thus, the instruments for class size and teacher's academic degree were the student's position in his or her subject and the historical average of grades for each subject. The class size and teacher's academic degree were additionally evaluated

for endogeneity through an F test of joint significance of the residuals in the estimation of performance. These residuals come from the estimation of each endogenous variable with respect to the rest of the explanatory variables and the instruments.

The analysis of all these results with instrumental variables indicates that class size and academic degree are significant in both measurements (random effects and fixed effects), in addition to teacher variables such as gender, family burden, marital status, age, place of study, experience, and type of work.

Conclusion

Thus, the empirical evidence does not allow us to accept the null hypothesis proposed at the beginning of this research: that the teacher's academic credentials encourage increases in academic performance, as corroborated by studies such as those by Cordero Ferrera, Crespo Cebada and Pedraja Chaparro (2013) and Singh and Sarkar (2015).

The empirical evidence only allows us to indicate that teachers who have studied abroad contribute with their knowledge, proficiency in subjects, and experience to the teaching process and to obtaining better results.

It could also be inferred that, given the limitations of the data and existing criticisms of the measures of academic performance used, grades appear to be a "dirty" variable that also depends on the level of difficulty the teacher employs for exams and so forth. Furthermore, in the Economics program at UCAB, there is an additional factor that should be considered, associated with the absence of pedagogical training among teachers, which could guide their work in the classroom and strengthen the teaching-learning process.

Therefore, further research should employ another form of performance measurement that does not come from the grade point average but, for example, from the labor market, as proposed by Borghans and Heijke (2005) or Card and Krueger (1996). In addition, standardized tests could be implemented, which would allow researchers to measure the added value generated by higher education (Cordero Ferrera; Crespo Cebada; Pedraja Chaparro, 2013).

Moreover, for each academic period in which students enroll, it is necessary to update the data related to their personal, familial, socioeconomic, and even labor characteristics, which change over time, minimizing the loss of information in the estimation of fixed effects.

It is important to note that the conclusions obtained cannot be extended to other higher education programs or institutions since the characteristics of their students, teachers, and institutions may lead to other results.

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