Transforming Lives: The Positive Impact of School Retention Strategies on the Probability of Students' Dropout in Medellin

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Síntesis

Justificación	Education is an essential human capital factor that contributes to the reduction of poverty and inequalities, to the increase in business innovation, and to the acceleration of people's environmental behavior at a global scale. School dropout is an obstacle that prevents societies from achieving economic and social goals via education, and therefore represents a major challenge for governments and educational institutions. This study assesses the effect of school retention programs on the probability of school dropout in Medellin as one of the key strategies to tackle this social issue. The scobit model is estimated using micro data on enrollment consolidated by the Ministry of National Education and data on beneficiaries of school retention programs, year 2019.
Argumentos centrales	• Students with access to the School Meals Program, School Transportation Program, or Complementary School Day Program reduce the probability of dropping out by 6.62 pp, 1.64 pp, and 2.84 pp, respectively • Significant heterogeneity exists around the mean effect of school retention programs on the probability of school dropout explained by students' social class, nationality, and sex. • School retention programs not just lower the overall students' probability of dropout, but also balance dropout rates between poor and nonpoor students • The effects of school retention strategies on the reduction of school dropout probabilities favor the immigrant population over the locals and favor male over female students.
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Transforming Lives: The Positive Impact of School Retention Strategies on the Probability of Students' Dropout in Medellin

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Abstract

This study assesses the effect of school retention strategies on the probability of school dropout in Medellin, Colombia. The scobit model is estimated using micro data on enrollment consolidated by the Ministry of National Education and data on beneficiaries of school retention programs, year 2019. Results show that the students with access to the School Meals Program, School Transportation Program, and/or Complementary School Day Program reduce the probability of dropping out by 6.62 pp, 1.64 pp, and 2.84 pp, respectively. However, the study finds significant heterogeneous effects around school retention programs that favor economically vulnerable students over those with better social status, immigrant students over the locals, and male students over female students.

Keywords: School Dropout; School Meals Program; School Transportation Program; Complementary School Day; Scobit Model.

Introduction

Education is one of the most contributing social factors to the countries' social and economic growth and development (Murillo & Gallón, 2018). As a human capital factor, education improves the quality of life of citizens by providing them with access to better jobs, wages, and cultural conditions (Cardona et al., 2007). Further, education drives business innovation (Camacho-Murillo et al., 2020) and contributes to overcoming poverty and reducing inequalities (Manzano & Ramírez, 2012). Amid the frenetic race to tackle climate change, education has the power to influence on people's pro-environmental behaviors (Pérez-Arango & Camacho-Murillo, 2022). Any public and private effort resulting in an increasing access to education and low school dropout rates is crucial for the society.

School dropout, understood as the abandonment of the academic system by students (Manzano & Ramírez, 2012), can be considered as an obstacle when it comes to accessing opportunities for the development of skills to obtain better working, cultural, and quality of life conditions. Some of the consequences associated with school dropout include intergenerational continuity of poverty and social inequalities, which negatively affects social integration and democracy strengthening (Espíndola & León, 2002). School dropout has a major negative effect on the students' economic, social, educational, and psychological environment, as the possibilities for their personal and economic growth decrease (Silvera, 2020). Therefore, the reduction of school dropout rates accounts for the success of some public education policies adopted by different countries (García, 2016).

According to the Secretary of Education of Medellin (SEM), major progress has been made in Medellin regarding educational coverage over the last few years; however, challenges

persist for students who start a school year and fail to finish it (SEM, 2020). Medellin is the second largest city in Colombia in terms of municipal population, with almost 2 million inhabitants that accounted for 5% of the national population in 2023 (DANE, 2023). Before the COVID-19 pandemic, the decline in the city's dropout rate was significant, reaching the lowest level historically in 2019, with 2.74% (SEM, 2020). However, with the arrival of the pandemic and quarantine restrictions, the dropout rate increased to 3.47%, with high and middle school students being the most affected (SEM, 2020). The COVID-19 pandemic accelerated the digital gap among students in some of the country's educational institutions (Cespedes-Parra & Camacho-Murillo, 2022), which may have led to higher dropout rates in Medellin, as was the case at the national level (Morales, 2021).

School dropout can be explained by different socioeconomic and cultural variables, both internal and external to the school system (Manzano & Ramírez, 2012). Variables are classified as protective risk factors, including the education level of the household head, household income, and sex (Rodríguez, 2021); and harmful risk factors, such as pregnancy, family type (single-parent or two-parent), employment status, overage, and family history of psychoactive substance use (Rodríguez, 2021). Public policies oriented to school retention are external factors that have not been fully explored in the Latin American literature, except for Jiménez and Jiménez (2016) and Carrillo (2014). Policymakers face the challenge of improving the living conditions of students to ensure that more children and young people graduate from basic education (Jiménez & Jiménez, 2016).

Medellin has adopted three relevant public strategies to reduce school dropout in public establishments, although the results have not been quantitatively assessed yet. These strategies have served as input for sound and evidence-based decision making by policy makers under eligibility criteria of beneficiaries. The School Meals Program (PAE, as per its Spanish acronym)

provides students with balanced food (breakfast, snacks, lunch, and other supplements). Its distribution among public schools depends on the characteristics of the educational entity, such as school hours per day and the availability and conditions of the school restaurant, among others (Decree No. 1852, 2015). The School Transportation Program provides round-trip mobility alternatives for students living in the city or within its jurisdiction (SEM, 2020). Finally, the Complementary School Day offers 4 hours of extracurricular activities per week for students in the areas of environment, science and technology, bilingualism, sports and recreation, culture, and citizenship education (Alcaldía de Medellín, 2014).

Carrillo (2014) and Jiménez and Jiménez (2016) showed that school retention strategies contribute to a decrease in student dropout. However, further research should be conducted on whether this dropout decrease is homogeneous among students or if their effects are heterogeneous around students' sociodemographic characteristics, such as the students' socioeconomic level (Nita et al., 2021; Barragán & Lozano, 2022), gender (Gómez-Restrepo et al., 2016; Rodríguez, 2021), and nationality (Colombian versus students from other countries). Literature has not addressed the latter, yet.

This paper aims to assess the impact of school retention strategies on the possibilities for student dropout in Medellin, analyzing two primary hypotheses. The first one is whether the probability of dropping out is lower for those students who have access to PAE, School Transportation, and/or Complementary School Day, respectively, compared to those who do not have access to these programs. The second one evaluates whether the expected decrease in student dropout resulting from the access to the assessed school retention programs differs among students in terms of relevant sociodemographic variables, such as the students' socioeconomic level (favoring economically vulnerable students over non-vulnerable students), nationality (favoring locals over foreigners), and sex (favoring women over men).

School dropout is characterized by the fact that it is not a sporadic event; therefore, it requires prevention and treatment alternatives. According to Espinoza et al. (2014), there is a clear relationship between school dropout, poverty, and social exclusion. Consequently, identifying whether school retention programs reduce the probability of dropping out of school in Medellin is a crucial step to understand the effectiveness of public intervention on social wellbeing, as well as to guide the public policymakers in their decisions on education. This research focuses on the pre-pandemic year, 2019, as significant progress was made in terms of school dropout up to that date. Furthermore, the school transportation strategy was not implemented throughout 2020; a gap that lasted until the moment at which educational institutions were re-opened.

This study uses consolidated enrollment data from Colombia' Ministry of National Education (MEN) on the district of Medellin, year 2019, along with analyzing the information concerning the beneficiaries of the retention strategies sourced from Medellin' Secretary of Education (SEM). The scobit model is used to estimate the probability of student dropout, conditioned by different explanatory factors, including school retention strategies. A literature review on the effects of public policies on school dropout is presented in Section 2. Section 3 evaluates data and estimates the scobit model, and Section 4 discusses the results of the study. Finally, Section 5 describes the conclusions and implications.

Literature Review

Various internal and external factors under study in the literature affect school dropout. Rodríguez (2021) identified the risk factors with the greatest influence on student dropout and classify them into protective and harmful factors. Protective risk factors include the

characteristics that make student dropout less probable, such as the higher education level of household head, greater household income, doing extracurricular activities, and sex. Harmful risk factors are those that increase the probability of dropout, including pregnancy, living in a single-parent home, employment status, belonging to a family with a history of psychoactive substance use, and being overage (Rodríguez, 2021); the latter is when a student is two or three years older than the average age expected in a grade (MEN, 2023).

One of the relevant topics, although not studied extensively, is the effect of school retention-related public policies on student dropout rates. These policies tend to improve the school retention rates as the direct and indirect costs of going to school, including food and transportation, are substantially reduced (Rute & Verner, 2011). Lower costs via direct money transfers have a positive impact on the students' attendance, who no longer must work to contribute to their household and support their families financially, or caring for their siblings while their parents are working (Nita et al., 2021; Jiménez & Jiménez, 2016). The programs that help to reduce costs through the direct provision of food, school transportation (Carvalho et al., 2010), and extended day activities (Tenti, 2010) are also essential to boost school retention. The following is an analysis of empirical studies on the effects of school retention strategies in Latin American countries, including Colombia, which identifies the gaps that this research aims to fill.

Carrillo (2014) evaluated the impacts of the "Prepa Sí" program, implemented in the city of Mexico, on student dropout. This program comprises money transfer sent to students attending classes in the upper middle and high school levels during the school year. Using a binomial probit model, Carrillo (2014) found that the program reduces the probability of school dropout and improves the academic performance of Mexican students. Pedroza et al. (2021) assessed the impact of the Programa Escuelas de Tiempo Completo (Full-Time School Programs) in a Mexican institution and found that the program successfully lengthens the time students stay in

school, thereby reducing the academic lag among students, and the students' probability of dropout in those who belong to a lower socioeconomic stratum.

Jiménez and Jiménez (2016) evaluated the effects of the Universal Child Allowance program on adolescent school dropout in Argentina. Using propensity score matching with data from the National Household Expenditure Survey, the authors concluded that the program significantly reduces school dropout levels. In Ecuador, Rosales (2020) used a difference-in-difference model to assess the impact of PAE on the permanence of second- to seventh-year students, and found that the student promotion rate to the next grade increases by 10% in students with access to the program. In contrast, Espínola and Claro (2010) found that the results of the programs created to combat school dropout in Chile, called "Beca de Apoyo a la Retención Escolar" (School Retention Support Scholarship; BARE) and "Subvención Pro Retención" (Pro-Retention Subsidy; SPR), are insufficient and ineffective as the desired results were not achieved. The negative results found in Chile are due to methodological mistakes in the inclusion/exclusion of students from the program; the lack of financial resources to cover the opportunity cost of dropping out; and the omission of efficient monitorization of allocated resources to educational institutions (Espínola and Claro, 2010).

Colombia has developed several school retention programs, including the PAE, School Transportation, and Complementary School Day. Caicedo et al. (2021) evaluated the effect of the PAE on student dropout in Ciudad Bolívar (Bogotá), using data from the MEN and through student characterization. The study showed that the PAE significantly contributes to primary school students' retention rates, and its success lies in the fact that students can access food that cannot be supplied to their homes on a daily basis (Caicedo et al., 2021). In Cali, Vergara and Rodríguez (2015) found that the PAE contributes to the decrease in students' dropout and reprobation rates in the city, as well as to the increase in academic performance.

The Complementary School Day is another strategy adopted in Colombia that allows students to stay in school for additional hours to the regular school day. It does not imply that students can attend more regular classes during this time, but that they participate in formative, recreational, and sports activities that keep them away from the social risks to abandoning school. Using family fixed-effects models in panel data, statistics from the 2007–2008 System of Identification for Social Assistance Beneficiaries (SISBEN, for its Spanish acronym), and statistics from MEN, García et al. (2013) reported that all-day schooling reduces the probability of school dropout between 1 and 2 percentage points, whereas repetition decreases this possibility from 2 to 5 percentage points.

School transportation is crucial for the students' access to and retention in the educational system, mainly in rural or geographically remote areas. When the State provides school transportation through contracted service routes, it contributes to the regularity and punctuality of students' attendance to class, which tends to reduce school dropout rates (Leal and Oliveira, 2022). However, no empirical research evaluating the effect of transportation on reduced student dropout rates are found in the literature. This lack of studies may be partly due to the allocation of student quotas prioritizing the proximity of their residence to the educational entity, which leads to a low demand for transportation services.

In short, the literature shows that the retention strategies associated with direct and indirect money transfers have contributed to the decrease in student dropout in various Latin American cities and countries. No evidence exists on the impact of transportation programs on school dropout rates. There is major interest in identifying whether the impact of school retention strategies is homogeneous for all beneficiaries or if differences exist between students that may be explained by the students' sociodemographic characteristics.

Data and Method

This study focuses on the people from Medellin, Colombia, which account for 5% of Colombia's total population. The study uses the enrollment registry consolidated and validated by the MEN in the Integrated Enrollment System (SIMAT). This is a census-based dataset that considers the entire enrolled population of the city, which reached 299,071 students in 2023; therefore, the use of population expansion factors for estimations in this paper are not necessary. The figures allow us to identify students from public elementary and high schools who drop out during the school year (intra-year dropout), including students' socioeconomic and demographic characteristics. Another database sourced from the SEM is employed to identify the beneficiaries of the different retention strategies analyzed in this paper.

All public schools can receive support for the programs from the SEM at the beginning of each year. There are eligibility criteria of beneficiaries applied to each program. For PAE, the SEM initially chooses students already registered by each public school in SIMAT; then, the principal of each public school and a committee choose the beneficiaries giving priority to i) full-time students (100%), ii) early childhood students (100%), iii) ethnic population, armed conflict victims, and disabled people (progressively from early childhood to superior levels), and iv) people enrolled in SISBEN (also progressive from early childhood to superior levels) (Rendón, 2024). The School Transportation strategy applies to students who live in neighborhoods where the need for mobility is not covered by public local transport. Students must reside in Medellin farther than 12.5 blocks from their schools, be enrolled in SIMAT, live in vulnerable households

(strata 1, 2, or 3), and be between 5-13 years of age (SEM, 2024). For the Complementary School Day program, all students can participate (there is no eligibility criteria).

To assess the effects of school retention programs in Medellin on the probability of dropping out, which can occur anytime within the school year, this study uses econometric models for binary response variables (Train, 2009; Wooldridge, 2020). The linear probability model (LPM) is discarded in this study, as the predictive probabilities delivered from the regression are below 0 in about 14% of the observations; a result that is inappropriate in probabilistic analyses where the response variable must be between 0 and 1 (Stock & Watson, 2020). The goodness-of-fit of the logit model with respect to the probit model is marginally higher (measured through the Pseudo-R^2), which allows for its selection (Alamilla & Arauco, 2009; Gujarati & Porter, 2006). The result of the likelihood ratio test between the logit model and the scobit model (also known as skewed logit) indicates that the latter is more appropriate for this study and is thus chosen (the comparative results of marginal effects between binary choice models in Appendix A show slight differences between logit and scobit models, and more notorious differences between the latter and the probit model).

The scobit model eases the assumption of logit and probit models that the marginal effect of a change in an independent variable (X_k) on the probability of an event (P_i) reaches its maximum value when the predicted P_i is close to 0.5 (Nagler, 1994). Therefore, changes in the predictive probabilities of student dropout in this study, explained by discrete changes in the school retention programs analyzed, can reach their maximum values at individual predictive probabilities other than 0.5. The scobit model has the functional form of Equation (1):

$$P(y = 1|x) = \frac{1}{(1 + e^{-z})^{\alpha}} \qquad (1)$$

where $P(y = 1|x)$ is the probability that a student drops out, conditional on several explanatory factors (x). The parameter α defines the response curve of the scobit function based on the observed data (skewness parameter), instead of assuming that the sigmoidal-shaped curve of logit (and probit) defines the best fit. This modification is achieved if $\alpha > 0$ under a Burr-10 distribution, which satisfies the condition that the probability density function of the logit $f(z)$ can be maximized when the cumulative distribution function $F(z)$ have values different than 0.5 for all $-\infty < z < \infty$ (Nagler, 1994). The maximum likelihood method is used to estimate Model (1). The latent variable z considers the following explanatory factors of Equation (2):

$$z = \beta_0 + \beta_1 PAE + \beta_2 Transp + \beta_3 JEC + Controles + u \qquad (2)$$

where *PAE*, *Transp*, and *JEC* are the key dichotomous variables in this study. The treatment groups include those students who have access to any of these programs, as they fulfil the eligibility criteria mentioned earlier; the control groups include those who do not have access to any of the programs. Thus, *PAE* is equal to 1 if the student is a beneficiary of PAE, and equal to 0 otherwise; *Transp* is equal to 1 if the student has access to the School Transportation Program, and equal to 0 otherwise; and *JEC* equals 1 if the student is a beneficiary of the Complementary School Day Program, and equal to 0 otherwise.

The following variables are included as controls: *Stratum012* takes the value of 1 if the student belongs to socioeconomic strata 0, 1, or 2, and 0 if they belong to the other strata (3, 4, 5, or 6). This is a proxy variable for the socioeconomic level of students and their families. *Overage* is a variable that takes 1 if the student is overage and 0 otherwise. *Repeat* is equal to 1 if the student is a repeater and 0 otherwise. *Victim* is equal to 1 if the student is a victim of an armed

conflict (in a situation of displacement, disassociated from armed groups, son/daughter of demobilized adults, and victim of anti-personnel mines, among others), and 0 otherwise. *Ethnic* is a variable that takes the value of 1 if the student belongs to an ethnic group and 0 otherwise. *Disab* takes 1 if the student has some type of disability and 0 otherwise. *HouHead* takes the value of 1 if the student is the head of household and 0 otherwise. *Colombia* is equal to 1 if the student is Colombian and 0 otherwise. *Woman* is a dichotomous variable that takes the value of 1 if the student is female and 0 if the student is male. Finally, *Rural* takes the value of 1 if the student lives in a rural area and 0 if the student comes from an urban area.

A reduction in the probability of dropping out of school is expected if the student is a beneficiary of the different retention strategies (*PAE*, *Transp*, and *JEC*), *ceteris paribus*. Some characteristics, such as ethnic group, being overage, and being a victim of an armed conflict, among other variables included as control in this study, have not been empirically explored, which allows for providing new explanatory variables for school dropout. To assess the possible heterogeneous effects of school retention programs on the probability of student dropout in relation to student sociodemographic variables, we use the variable interaction model of Equation (3). Letter C_j represents the interacting sociodemographic variables of interest in this study as *Stratum012, Colombia*, and *Woman.*, to identify whether there are differences in favor of economically vulnerable students (over non-vulnerable students), locals (over overseas), and women (over men).

$$z = \beta_0 + \beta_1 PAE + \beta_2 Transp + \beta_3 JEC + Controles + \sum_{j=1}^{2} \delta_j \, PAE \cdot C_j + \sum_{j=1}^{2} \delta_j \, Transp \cdot C_j + \sum_{j=1}^{2} \delta_j \, JEC \cdot C_j + u \qquad (3)$$

Routine statistical tests confirm the presence of heteroscedasticity in the errors (through the Breusch–Pagan/Cook–Weisberg test), which is corrected through robust standard errors. The variance inflation factor test yields a value of 1.02, indicating that a perfect or quasi-perfect multicollinearity between explanatory factors is not present (Wooldridge, 2020). The existence of low associations between independent variables is confirmed through tetrachoric correlations, which are commonly used in models with binary explanatory variables (Brown, 1977; StataCorp., 2021).

Table 1 presents a summary of descriptive statistics. In 2019, 3.8% of public elementary and high school students dropped out. Around 67 students out of every 100 benefited from the PAE, 3.6% were enrolled in the School Transportation program, and 3.05% participated in the Complementary School Day program. Almost 79% of students belong to strata 0, 1, and 2; 4.9% are overage (i.e. they are at least 3 years older than the average age required in the grade); 5% are repeaters; and 5.9% are victims of armed conflicts. Additionally, 1.9% of students belong to an ethnic group (indigenous, Romani, black, or Afro-descendants); 3.5% suffer from some type of disability (visual, intellectual, multiple, hearing, physical, psychosocial, or mental); 4.3% are children of mothers who are heads of households; 87% of the students are Colombian (the remaining are students from other countries, mostly Venezuelan, Ecuadorian, or Spanish); 50.3% of the students are female; and 5.9% reside in rural areas.

[Table 1 here]

Table 2 shows, as expected, that 98.4% of the students with access to PAE and 97.9% who used the Transportation Program did not drop out within the school year. Further, 99.1% who participated in the Complementary School Day program remained at school. This contingency analysis shows the apparent effectiveness of the three retention programs in reducing student dropout.

[Table 2 here]

Results

The results estimated in Equations (2) and (3) are shown in Table 3. For the two equations, the likelihood ratio test between the logit and scobit models (LR test) rejects the hypothesis that the scobit model is equal to the logit model. Therefore, better goodness-of-fit of the scobit model for statistical inference is confirmed. Analyses are presented in two analytical parts. The first shows the results of Equation (2), which allow for assessing the average marginal effect of a discrete change in the explanatory variables concerning the student dropout probability in public schools from Medellin. *PAE, Transp*, and *JEC* coefficients are used to test the first study hypothesis presented in the introduction. The second section shows the results of Equation (3), and the estimated coefficients of interactive variables are used to test the second hypothesis; this is, whether the marginal effects expected from the *PAE*, *Transp*, and *JEC* programs for the lower probability of student dropout differ among students, in function of the socioeconomic level (*Stratum012*), nationality (*Colombia*), and sex (*Woman*).

Impact of School Retention Programs

The main study findings show that students who are beneficiaries of the retention strategies under study, *PAE, Transp*, and *JEC,* have a lower probability of dropping out compared to students who are not beneficiaries of these programs. Specifically, the probability of student dropout falls, on average, by 6.6 pp if students are beneficiaries of the *PAE* (from 8.2% to 1.6% at the mean levels) by 1.64 pp if students are enrolled in the School Transportation program -*Transp* (from 3.9% to 2.3%), and by 2.84 pp if students receive Complementary School Day - *JEC* (from 3.9% to 1%). The results are statistically significant at the 1% critical value.

[Table 3 here]

These results show that the three retention strategies under study help reduce the probability of student dropout in official schools from Medellin, being *PAE* the most effective in reducing school dropout, followed by *JEC*. The results are in line with the findings obtained by Caicedo et al. (2021) for Ciudad Bolívar (Bogotá) and those reported by Rosales (2020) for Ecuador, showing that the PAE is an important incentive to attend classes, stay in school, and be promoted to the next grade, especially for low-income students. Likewise, the results are consistent with Leal and Oliveira (2022) and Carvalho et al. (2010), who consider that providing school transportation contributes to decreasing dropouts and increasing attendance. The findings also support the results by Pedroza et al. (2021), García et al. (2013), and Tenti (2010), which showed that extending school hours favors retention and prevents students from lagging or repeating grades.

The estimated coefficient of *Stratum012,* Equation (2), shows that, at the 1% significance level, it is 1.52 pp more likely for students who belong to a low socioeconomic level (strata 0–2) to drop out of school, compared with those from higher socioeconomic levels (strata 3–6). This result is associated with the findings obtained by Abril et al. (2008), Nita et al. (2021), and Barragán and Lozano (2022) in other countries, where poverty and low-income levels are decisive factors for school dropout. The estimated coefficient of *Colombia* is also statistically significant at 1% and shows that the Colombian students' probability of dropping out is 2.58 pp lower than the probabilities of dropping out of students from other countries (especially from Venezuela, Ecuador, and Spain). The challenges faced by migrants when settling in Colombia, associated with the difficulties in achieving financial and emotional stability, affects the permanence of immigrant students (Tovar, 2024). Finally, the estimated parameter for *Woman*, at a significance level of 1%, shows that it is less likely for women to drop out of school than men (0.66 pp).

The results for the control variables of Equation (2), not presented in Table 3, are of high interest to the literature. The estimated coefficients of *Victim*, *Ethnic*, and *Disab* indicate that students who are victims of conflicts, belong to ethnic groups and/or are disabled are more likely to drop out of school than their respective control groups. The result obtained for *Rural* suggests that students who are settled in rural areas are more likely to drop out too, reinforcing the relevance of school transportation programs for the improved mobility conditions of students, from their rural homes to the educational institutions. According to Rute and Verner (2011), lowering the costs of going to school reduces the dropout risks related to geographic isolation and the families' low income. Finally, the results concerning *Overage* and *Repeat* indicate that students who are overage or repeaters are more likely to drop out of school, which is in line with

the findings made by Román (2013) and the empirical study conducted by Rodríguez (2021) for Medellin.

Heterogeneous Effects of School Retention Programs

The results obtained from Equation (3) in Table 3, and summarized in Figure (1), show that the average marginal effects of each school retention strategy on the decrease in school dropout differ among students, according to their socioeconomic class, nationality, and sex. The results are statistically significant at the 1% level. Figure (1a) shows that while the probability of dropout of students receiving PAE is reduced by 7.29 pp if the student belongs to a low socioeconomic level (stratum 0–2), the same probability is only reduced by 4.12 pp in students of a different socioeconomic level. Thus, the reduction in the probability of dropout for students who are beneficiaries of the PAE is 3.09 pp higher for students in stratum 0–2 compared to students in the control group. This result implies a more positive effect of PAE in the reduction of school dropout in students that face economically vulnerable situations, which is the expected outcome in programs of this kind.

[Figure 1 here]

Figure (1a) also shows that the student retention effect of PAE in Medellin is much greater for the immigrant population than for Colombians (Medellín students), since in the former, the probability of dropping out is reduced by 11 pp when receiving the PAE, whereas in

locals, the probability of dropping out is reduced by 6 pp in PAE beneficiaries. Therefore, the decrease in the probability of student dropout of PAE beneficiaries is 5.08 pp higher for students who are not Colombian. Considering the results for female students, the *PAE · Woman* coefficient in Figure (1a) shows that the decrease in the probability of student dropout for PAE beneficiaries is 1.37 pp greater if the student is male compared to the control group. This is, although the probability of female student dropout is reduced by 5.93 pp when receiving the PAE, the probability of student dropout among the male population is reduced by 7.30 pp for PAE beneficiaries. This result leads to unbalances in the student dropout statistics between men and women in the short-term from the implementation of PAE. In the long term, this implies a more favorable labor inclusion for men than for women, thanks in part to lower school dropout rates for men that arise from the access to PAE.

Figure (1b) analyzes effects from the Transportation program. The reduction in the probability of dropout for beneficiaries of the School Transportation program is 0.55 pp greater for students of low socioeconomic status (*stratum012*) compared to students in the control group (-1.9 pp vs -1.3 pp, respectively). Therefore, the positive effect of transportation in student dropout reduction is greater for students from economically vulnerable classes as expected. Figure (1b) also shows that the decrease in the probability of student dropout in students enrolled in transportation programs is 2.6 pp greater for international students compared to Colombian students (-3.9 pp vs -1.4 pp, respectively), and 0.29 pp greater for male students compared to female students (-1.9 pp vs -1.6 pp, respectively). These two results imply a greater effect of the transportation service on school retention in the immigrant and male populations, compared to the local and female populations, respectively.

Finally, Figure (1c) shows that while the probability of dropout in students of vulnerable socioeconomic level is reduced by 3.2 pp in JEC beneficiaries, the probability of student dropout

in the population of higher stratum is reduced by 1.83 pp when JEC is available. Therefore, the decrease in the probability of student dropout for those who receive Complementary School Day benefits is 1.36 pp greater if the student belongs to stratum 0–2 compared to the control group. These results show the importance of extracurricular activities in the avoidance of student dropout in the case of economically vulnerable populations. The outcomes for *JEC · Colombia* coefficients showed in Figured (1c) identify better results from the Complementary School Day program in the immigrants compared to locals, as the reduction in the probability of student dropout is 1.28 pp greater for immigrant beneficiaries of JEC compared to local beneficiaries of JEC (-3.95 pp vs -2.67 pp, respectively). Also, the results for *JEC · Woman* coefficients find better results from the Complementary School Day program in male students compared to female students, since the reduction in the probability of student dropout is 0.37 pp greater for men enrolled in the JEC program compared to women enrolled in the same program (3.02 pp vs 2.65 pp, respectively).

Conclusion and Discussion

This article analyzes the impact of the School Meals Program (PAE), School Transportation program (Transp), and/or Complementary School Day program (JEC) on the probability of dropping out of school in public schools from Medellin. Other relevant variables associated with student dropout are included, such as the students' socioeconomic level (approximated by socioeconomic stratum), nationality, and sex, in addition to various control variables. The scobit model is used based on data from Colombia's Ministry of National Education and Medellin' Secretary of Education, year 2019.

The results suggest that the school dropout probability is reduced by 6.62 pp when students have access to PAE, by 1.64 pp when they are beneficiaries of Transp, and by 2.84 pp

when they are enrolled in the JEC program. The program with the largest impact on reducing student dropout is the PAE, which provides students with daily food supplements during the school day. The success in reducing school dropout rates driven by the PAE can serve as a lesson for other territorial entities that face challenges with the program, including Vichada, La Guajira, and Soacha as the Unit of Meals to Learn has highlighted. The predicted probability of student dropout falls, on average, by 11.08 pp for students who are beneficiaries of all three programs at the same time. These results imply that school retention strategies are a great vehicle to continue driving educational retention by reducing financial burdens for low-income families.

Sources of heterogeneity are observed regarding the effects of each school retention program on the probability of student dropout. It was found that the decrease in the probability of dropping out is higher in students of vulnerable socioeconomic status than in students with better living standards, thanks to the access to PAE (higher by 3.09 pp), school transportation service (higher by 0.55 pp), and/or the Complementary School Day (higher by 1.36 pp). These outcomes show the effectiveness of school retention programs, not just to lower the overall students' probability of dropout, but also to balance dropout rates between poor and nonpoor students; a matter that will ultimately affect the students' economic opportunities in the long run.

The decrease in the probability of school dropout is found to be lower in local students who are beneficiaries of the retention programs compared to immigrant students receiving the same programs (mainly from Venezuela, Ecuador, and Spain). The differences in the reduction of the probabilities of dropping out between Colombians and immigrants are 5.08 pp (in PAE), 2.60 pp (in Transp), and 1.28 pp (in JEC). Similarly, in the case of female versus male students who are beneficiaries of any of the retention programs, the decrease in the probability of dropping out of school is lower for female than for male; the differences are 1.37 (in PAE), 0.29 pp (in Transp), and 0.37 pp (in JEC). The significant heterogeneous effects of school retention program

on the likelihood of dropping out favoring immigrants more than locals, and favoring male more than female, should bring the attention to education authorities in Medellin, who may examine whether the outcomes are in line with their expectations.

A limitation of this research is the impossibility of using a more accurate variable for the socioeconomic level of the students, such as the SISBEN score, due to the presence of errors and missing data in SIMAT records. Future research may include other variables associated with student dropout, including the parents' educational level and history of psychoactive substance use, among other variables, if other external data sources allow so. Finally, the Complementary School Day's second operator is Comfenalco, which work with many students, so it may be reasonable to think that the estimation of this program's effect on the decrease in student dropout is underestimated.

Given the importance and magnitude of some of the control variables used in the research, such as overage and grade repetition, which are some of the conditions that increase the probability of dropping out the most, it would be pertinent for future research to analyze the incidence of strategies focused on these problems. These include "Aceleración del Aprendizaje" (*Accelerated Learning*) in elementary school and "Caminar en Secundaria" (*Walking through High School*), which seek to even out students who are lagging after having repeated several times, who may be thus at a higher risk of dropping out of school, according to the results of this research.

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Table 1
Descriptive Statistics

Variable	***Value***	***Standard deviation***
Dropout	.0380	.1912
PAE	.6745	.4686
Transp	.0361	.1865

JEC	.0305	.1719
Stratum012	.7865	.4098
Overage	.0491	.2161
Repeat	.0499	.2177
Victim	.0587	.2350
Ethnic	.0194	.1380
Disab	.0352	.1842
HouHead	.0049	.0696
Colombia	.8768	.3285
Woman	.5030	.5000
Rural	.0593	.2363

Source: Prepared by the authors based on data obtained from the MEN and SEM.

Table 2
School dropout by student retention program (%)

DROPOUT (%)	***PAE (%)***		***Transp (%)***		***JEC (%)***	
	No	*Yes*	*No*	*Yes*	*No*	*Yes*
No	91.6	98.4	96.1	97.9	96.1	99.1

Yes	8.4	1.6	3.9	2.1	3.9	0.9
Total	100	100	100	100	100	100

Source: Prepared by the authors based on data obtained from the MEN and SEM.

Table 3
Results from the scobit model (marginal effects)

Dependent variable *Dropout*		
Independent variables	Equation (2)	Equation (3)
PAE	-.0662***	
	(.0009)	
Transp	-.0164***	
	(.0015)	

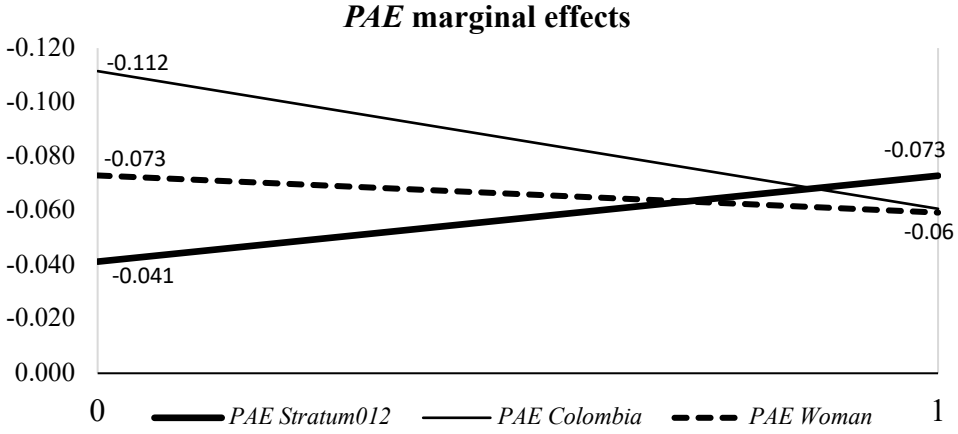
Dependent variable *Dropout*		
Independent variables	Equation (2)	Equation (3)
JEC	-.0284***	
	(.0012)	
Stratum012	.0152***	
	(.0007)	
Colombia	-.0258***	
	(.0012)	
Woman	-.0066***	
	(.0006)	
Control groups[1]	Yes	Yes
PAE · Stratum012		-.0309***
PAE · Stratum012 = 0		-.0412***
PAE · Stratum012 = 1		-.0729***
PAE · Colombia		.0508***
PAE · Colombia = 0		-.1115***
PAE · Colombia = 1		-.0607***
PAE · Woman		.0137***
PAE · Woman = 0		-.0730***
PAE · Woman = 1		-.0593***
Transp · Stratum012		-.0055***
Transp · Stratum012 = 0		-.0132***
Transp · Stratum012 = 1		-.0187***
Transp · Colombia		.0260***
Transp · Colombia = 0		-.03989***
Transp · Colombia = 1		-.01386***
Transp · Woman		.0029***
Transp · Woman = 0		-.01866***
Transp · Woman = 1		-.01573***
JEC · Stratum012		-.0136***
JEC · Stratum012 = 0		-.0183***
JEC · Stratum012 = 1		-.0319***
JEC · Colombia		.01282***
JEC · Colombia = 0		-.03953***
JEC · Colombia = 1		-.02671***
JEC · Woman		.0037***
JEC · Woman = 0		-.03029***
JEC · Woman = 1		-.02651***
Remarks	299 071	299 071
Log Pseudolikelihood	-41 687	-41 667
Lnalpha	1.1703**	.7887**
LR test (Prob > Chi2)	0.001	0.01

[1] *Overage, Repeat, Victim, Ethnic, Disab, HouHead, Rural*

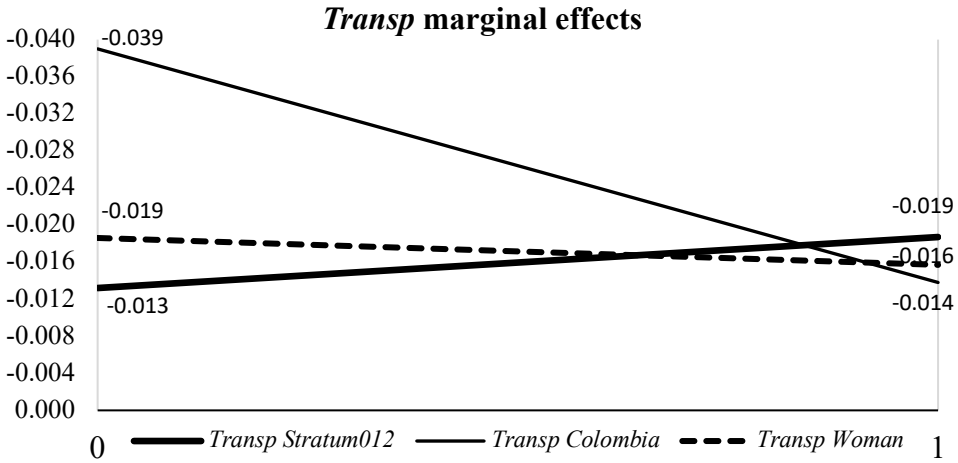
Source: Prepared by the authors based on data obtained from the MEN and SEM.

Figure 1

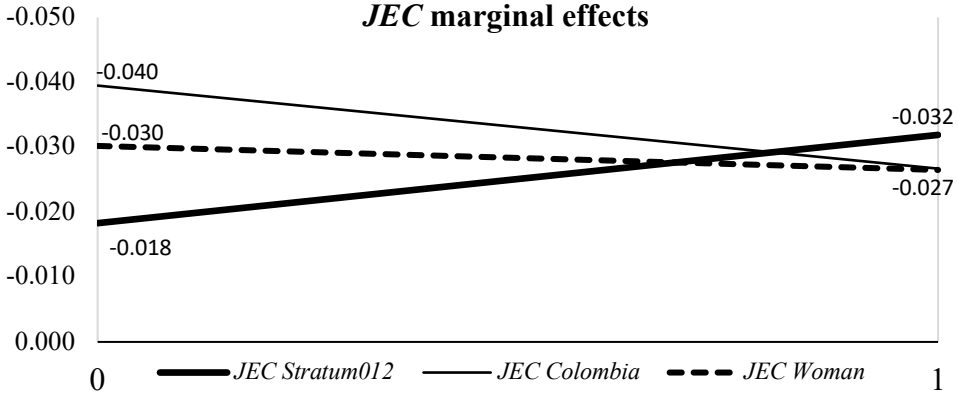
Heterogeneous Marginal Effects from *PAE*, *Transp*, and *JEC*


PAE marginal effects
-0.120
-0.100
-0.080
-0.060
-0.040
-0.020
0.000
-0.112
-0.073
-0.041
-0.073
-0.06
0
1
PAE Stratum012
PAE Colombia
PAE Woman

(1a)


Transp marginal effects
-0.040
-0.036
-0.032
-0.028
-0.024
-0.020
-0.016
-0.012
-0.008
-0.004
0.000
-0.039
-0.019
-0.013
-0.019
-0.016
-0.014
0
1
Transp Stratum012
Transp Colombia
Transp Woman

(1b)


JEC marginal effects
-0.050
-0.040
-0.030
-0.020
-0.010
0.000
-0.040
-0.030
-0.018
-0.032
-0.027
0
1
JEC Stratum012
JEC Colombia
JEC Woman

(1c)

Appendix A
Estimation of Discrete Choice Models for Binary Response (Marginal Effects)

Dependent Variable: Dropout

	LPM	***probit***	***logit***	***scobit***
PAE	-.0673***	-.0650***	-.0662***	-.0662***
	(.0009)	(.0009)	(.0009)	(.0009)
Transp	-.0178***	-.0137***	-.0162***	-.0164***
	(.0014)	(.0016)	(.0015)	(.0015)
JEC	-.0252***	-.0267***	-.028***	-.0284***
	(.0010)	(.0013)	(.0012)	(.0012)
Stratum012	.0174***	.0152***	.0153***	.0152***
	(.0007)	(.0007)	(.0007)	(.0007)
Colombia	-.0260***	-.0247***	-.0255***	-.0258***
	(.0012)	(.0012)	(.0012)	(.0012)
Woman	-.0071***	-.0064***	-.0065***	-.0066***
	(.0006)	(.0006)	(.0006)	(.0006)
Overage	.0861***	.0671***	.0640***	.0623***
	(.0027)	(.0023)	(.0022)	(.0023)
Repeat	.0486***	.0418***	.0396***	.0381***
	(.0023)	(.0020)	(.0020)	(.0020)
Victim	.0604***	.0523***	.0549***	.0549***
	(.0021)	(.0019)	(.0020)	(.0020)
Ethnic	.0114***	.0102***	.0100***	.0096***
	(.0030)	(.0025)	(.0025)	(.0025)
Disab	.0048**	.0069***	.0070***	.0071***
	(.0021)	(.0019)	(.0018)	(.0018)
HouHead	.0051	.0060	.0060	.0060
	(.0053)	(.0051)	(.0051)	(.0051)
Rural	.0034**	.0027**	.0032**	.0033**
	(.0015)	(.0014)	(.0014)	(.0014)
lnalpha				1.1703**
				(.5445)
Pseudo R^2		.1348	.1374	
Properly classified	94.25%	96.20%	96.21%	
Area under the ROC curve		.7764	.7764	

Source: Prepared by the authors based on data obtained from the MEN (2019) and SEM.

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