Box 3
The CPI for Upper Income School Tuition and Admission Fees: Biases and an Alternative Calculation

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In February 2018, the annual change in the CPI for school tuition and admission fees was 8.4% and 7.4%, respectively. These figures exceeded annual inflation on the same month (3.4%) and surpassed the average increase in wages in the Colombian economy.[1] It is difficult to explain such a large increase, especially in the absence of inflationary pressures, as illustrated by the slack in the job market and the excess amount of installed capacity in the economy throughout 2017 and during 2018 to date. Also, according to DANE, about 44% of the sample is comprised of public schools, where education is free of charge. Therefore, if the increase in tuition at public schools was zero (or very low), the average increase in tuition at private schools could have reached double digits.

The annual rise in the CPI for tuition also is inconsistent with the regulation that limits increases in fees for private education. For 2018, the National Ministry of Education set the base increase at 4% for private schools that offer preschool, basic and secondary education. Those with better results in terms of quality may make additional hikes, but the total increase may not exceed 7.8% (the base and maximum increases for 2017 were 6.77% and 8.97%, respectively). The only exception to this upper limit is the first course offered by a school; it is classified as subject to regulated or supervised freedom,[2] a grade level for which the institution can set the price freely. This adjustment in the fee for that first year will be called an "admission cost", since the school can increase the value of the fee or tuition by much more than what is allowed for the other grades.[3] Therefore, at a school classified in this group, one feasibly can find major differences between the costs of tuition for students who are only one year apart in school.

Therefore, it will be argued in this box that increases in admission costs are a possible source of bias when calculating the CPI for school tuition, because the DANE methodology allows adjustments in admission costs from several years back to be included in the current calculation of the CPI for school tuition. As this bias would be found in highly rated and more expensive schools, only the CPI calculation for high-income fees will be referred to this box. The respective methodology is described in Point 1. The origin of the measurement bias is explained in the following section, and an alternative method is proposed that could reduce it. Moreover, the two methods are compared to a sample that contains the value of school tuition and admission fees for the children of *Banco de la República*'s employees in Bogotá. It is important to clarify that, because it uses a small and non-representative sample, this work does not intend to measure the extent of the bias in the calculation of the CPI associated with the cost of admission. It simply is intended to identify it. The conclusions are presented in the last section.

1. Methodology for calculating the CPI for High Income School Tuition

To calculate this index,[4] DANE takes four groups into account: 1) preschool, 2) primary, 3) middle school and 4) high school. Then, for each one $(j = 1,\ldots,4)$, it surveys a broad sample of schools, asking what they charge in tuition for a particular course or grade level, so as to compare it to the price of the tuition paid for the same course or grade level the year before $(P_t^{i/P\,i}{}_{t-1})$[5]. In the next step, the geometric average of these annual changes is calculated for each group $(\bar{\pi}_t^j)$[6] and, finally, a weighted arithmetic average of the geometric averages for all the groups is calculated $(\bar{\pi}_t)$[7]. This last variation is what DANE uses to index the tuition index.[8]

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1 In that month, the increase in the minimum wage was 5.9%., as opposed to 5.3% in industry, 6% in commerce and 5.1% in housing.

2 As per Article 202, Law 115 of 1994, schools may be classified in one of three regimes: regulated freedom, supervised freedom or the controlled regime, according to the scores they obtain in quality assessments. See Ministry of Education Resolution 18066 of 2017.

3 Schools do it, for example, to finance investments, increase profits, improve quality, etc.

4 The CPI for enrollment fees is calculated the same way.

5 For example, the value of tuition for the sixth grade in February 2018 versus the value for the same grade in February 2017.

6 This paper does not contain these weighted averages, since they are flexible and DANE does not publish them.

7 $\bar{\pi}_t = \sum_{j=1}^{4} w_j\,(\pi_t^j - 1)$ *donde* $\bar{\pi}_t^j = \sqrt[nxm]{\prod_{k=1}^{n}\prod_{i=1}^{m}\frac{P_t^{j,k,i}}{P_{t-1}^{j,k,i}}}$ With w_j = weighted average for group *j*, *n*= number of schools, *m* = number of courses or grade levels in the group *j*, $P_t^{j,k,i}$ = tuition for course or grade level *i* offered by school *K*, and what is in group *j*.

8 $IPC_t^{pensión} = IPC_{t-1}^{pensión} \times (1+\bar{\pi}_t)$

The reason for calculating the annual increase in the tuition for the same course is to elude changes in the quality of the service. This is because the CPI must measure the increase in consumer spending to maintain the same level of utility and, therefore, changes in quality could imply greater utility. However, as will be explained, this variation could be overestimating the increase in tuition because, for a school with "regulated or supervised freedom," increases in admission costs several years back may be included when calculating the CPI for current tuition.

2. Average Annual Change in Fees at a School with "Regulated or Supervised Freedom"

To indicate the price level of tuition at each school for a current year (t), we assume a typical school with regulated freedom that offers twelve grade levels: kindergarten ($i=0$), first ($i=1$), ..., tenth ($i=10$), eleventh ($i=11$). For the grade levels other than kindergarten, the school will adjust the tuition annually, up to a maximum percentage (δ_t) set by the Ministry of Education. In these cases, when a student passes from one grade level ($i-1$) to the next one (i), the new tuition (P_t^i) will be the value of the previous tuition (P_{t-1}^{i-1}) adjusted by two rates of increase: changes in costs (π_t) and change in the quality of service (a^i), where $(1+\pi_t)(1+a^i) \leq \delta_t$. As inferred from the notation, it will be assumed the adjustment in tuition due to changes in quality (a^i) would not vary with time.

Kindergarten is the exception to the foregoing. At this level, the school is free to set tuition (P_t^0) and may increase its value annually by a percentage beyond what is allowed for other grade levels. Consequently, the variation in tuition between P_t^0 and P_{t-1}^0 will be $(1+\pi_t)(1+e_t^0)$, where e_t^0 is the increase due to the "*cost of admission*" to school in year t. Since e_t^0 is set freely by the school and there are parents who accept it, there may be a case where $(1+\pi_t) \times (1+e_t) \geq \delta_t$. The general formula will be the following.

$$P_t^i = \begin{cases} P_{t-1}^0 \times (1+\pi_t) \times (1+e_t^0), \; i=0 \\ P_{t-1}^{i-1} \times (1+\pi_t) \times (1+a_i), \; i=1,2,\ldots,11 \end{cases} \quad (1)$$

Where P_t^i = the value of tuition for grade level i in year t, ($i=1,2,\ldots,11$), π_t = the annual increase in school costs in year t; e_t^0 = the increase in tuition for kindergarten (0) in year t due to the cost of school admission, and a^i = the increase due to changes in the quality of instruction in grade i.

It should be noted that the value of tuition P_t^i also can be expressed as the tuition the student began to pay when enrolling in the school, P_{t-i}^0, adjusted by all the changes in costs and in quality that were accumulated until the student reached grade level i, as follows.

$$P_t^i = P_{t-i}^0 \times \prod_{j=1}^{i} (1+\pi_{t-j+1})(1+a^{i-j+1}) \;\; i=1,2,\ldots,11 \quad (2)$$

2.1 Annual Change in the Tuition CPI for a School, according to DANE

To calculate the CPI for tuition, DANE compares the value of the tuition paid by a "representative student" for grade level (i) to the amount another "representative student" paid for the same grade (i) the year before, both at the same school.[9] Since it is the same grade level that is being compared, this annual change should be free of biases originating with a change in quality. This is verified when calculating the annual change using (2) and (1):

$$\frac{P_t^i}{P_{t-1}^i} = \frac{P_{t-i}^0 \times \prod_{j=1}^{i} (1+\pi_{t-j+1})(1+a^{i-j+1})}{P_{t-i-1}^0 \times \prod_{j=1}^{i} (1+\pi_{t-j})(1+a^{i-j+1})} = (1+\pi_t) \times (1+e_{t-i}^0) \quad (3)$$

Indeed, as shown in (3), the annual change in DANE's methodology does not depend on a^i. Rather, it depends on the change in the cost of admission (e_{t-i}^0) that existed between the two "representative student" years ago. As illustrated in Chart B3.1, this annual change compares two students who will always have a difference of one year in seniority and, consequently, there will always be a difference in the cost of tuition, which is equal to the increase in the cost of admission (e_{t-i}^0). Accordingly, the methodology has two types of bias: 1) the bias from an annual change (t–i) that will be present when the change in tuition for the current year is being calculated; and 2) the extent of a delayed or lagging admission cost, which – as indicated – can be so high that it can go beyond the increases permitted for the current year $(1+\pi_t) \times (1+e_t) \geq \delta$.

As shown in equation (4), when calculating the annual average (geometric) variation in all courses for year t ($\bar{\pi}_t^D$) using the DANE methodology, the aforementioned biases are also averaged:

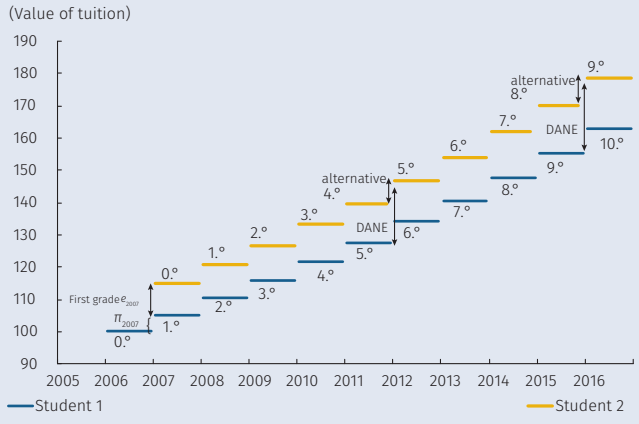
$$(\bar{\pi}_t^D) = \prod_{i=0}^{11} \left[\frac{P_t^i}{P_{t-1}^i} \right]^{1/12} = (1+\pi_t) \times \prod_{i=0}^{11} [(1+e_{t-i}^0)]^{1/12} \quad 4)$$

2.2 Alternative Methodology for Calculating the Annual Change

The alternative methodology consists of calculating the annual change in the value of tuition when a student moves from one grade (or course level) *(i–1)* to the next *(i)*. This proposal is argued as follows:

9 As an example, note the annual increase in tuition paid for the ninth grade between 2017 and 2018. For this comparison, one student is identified who is in the ninth grade in 2018, and another with similar characteristics, who attended the same grade in 2017. This last student should be in the tenth grade in 2018.

Chart B3.1
Example of Calculating the Annual Change in Tuition without Changes in Quality



Sources: DANE and *Banco de la República*

- There may be parents for whom the utility function does not change if their child remains in the school they have chosen. In other words, they know and accept the fact that the tuition can change considerably as their child progresses in school from one grade to another, since the quality of the service can improve.[10] If this assumption is valid, to keep the family's satisfaction constant, the variation in the CPI for tuition would have to take into account all the items; that is, it also would have to include the costs associated with changes in the quality of service within the same school.
- Even if there are major changes in quality from one course or grade level to another, so as to imply a variation in the utility function for the parents, these courses could be detected and could be excluded from the sample, or the value of tuition without the costs associated with this change in quality could be requested.[11] In fact, as will be illustrated, by segmenting the sample between preschool, primary, middle school and high school, most of these changes in quality would be controlled already.
- The same student can be tracked for several years. If the student fails a year or leaves school, it would be easy to change the student for another one in the same course.
- As will be seen, this annual change does not depend on the cost of admission and has no lags.

Even so, one must accept that this alternative methodology may still have a bias, which is not easy to measure, given the change in the quality of education offered when a student progresses to the next course or grade level, which may produce even a higher result than the one obtained with the DANE methodology (Chart B3.2). As shown in equation (5), this change in quality is present when the annual change is calculated with (1). Similarly, the (geometric) average of the annual changes in tuition with this alternative methodology $(\overline{\pi}_t^A)$ also averages quality changes (equation 6).

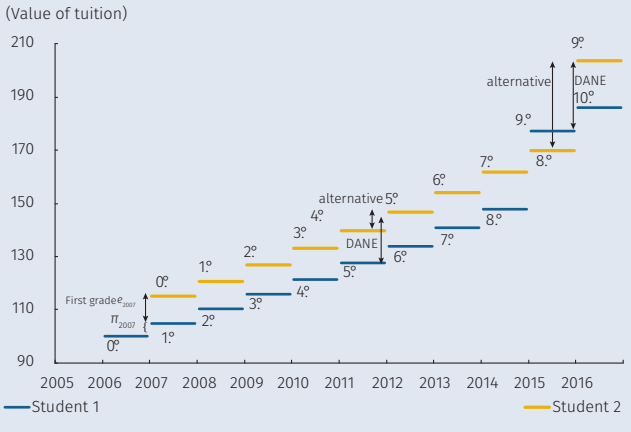
$$\frac{P_t^i}{P_{t-1}^{i-1}} = (1+\pi_t)\times(1+a^i), \quad i=1,2,\ldots,11 \tag{5}$$

$$(\overline{\pi}_t^A) = \prod_{i=1}^{11}\left[\frac{P_t^i}{P_{t-1}^i}\right]^{1/11} = (1+\pi_t)\times\prod_{i=1}^{11}[(1+a^i)]^{1/11} \tag{6}$$

2.3 Calculation of the Annual Change according to the DANE Methodology and the Alternative

In this box, we used a database that contains the name of the school and the values of the tuition and other educational costs charged to the children of *Banco de la República*'s employees. The information is annual, in terms of its frequency, and it is available for the years between 2004 and 2018. With this base, it was possible to extract information on six schools in Bogotá that offer preschool, elementary, and middle and high school education, and where it was possible to find continuous information on students who stayed throughout the period covered by the sample. According to the Colombian Institute for the Evaluation of Education (ICFES), these schools have decidedly superior rankings. They are classified as "regulated or supervised," and could be part of the CPI for high-income tuition or enrollment fees in the city of Bogotá.

Chart B3.2
Example of Calculating the Annual Change in Tuition When the Only Change in Quality is between the Eighth and the Ninth Grade



Sources: DANE and *Banco de la República*; authors' calculations

Given the aforementioned sample, the results of the annual changes were the following.

10 For example, due to the right to use laboratories or have access to exchange courses, international baccalaureate programs, etc.

11 For instance, at some schools that offer an international baccalaureate degree, the costs associated with this certification are charged when a student progresses from the tenth to the eleventh grade. Therefore, one possibility is to exclude the step from the tenth to the eleventh grade from the sample, or to request information on the value of the tuition (or enrollment) without the international baccalaureate costs.

a. In all the schools, there was evidence of a change in quality when proceeding from one course or grade level to another. The first change is when the student goes from preschool to primary education, where the tuition and admission fees are less. The second change occurs when the student progresses from middle school to high school (from the ninth to the tenth grade), a time where there is a sizeable increase in tuition (and registration), more so than the one registered in the other courses and surpassed only by the increases in the admission costs. In this context, the classification done by DANE when calculating the CPI for education would help to control this bias.
b. If we exclude the courses or grade levels when the change in quality was significant, the increase in the average cost for admission surpasses or equals the increases in the other courses. As shown in Table B3.1, the most relevant differences occurred in 2008 and 2009 (the results are consistent with the calculation for tuition or registration).
c. As shown in charts B3.3 and R3.4 and in Table B3.1, with information from the sample, the alternative methodology always shows lower average annual changes than the DANE ($\overline{\pi}_t^D > \overline{\pi}_t^A$) methodology. This provides indications that the bias for admission costs far exceeds the biases for changes in quality.[12] The same charts show the annual changes with the alternate methodology (done with the sample) also are lower than the annual changes in the CPI for high-income tuition and fees for the city of Bogota.

3. Conclusions

This box shows evidence of upward biases in the calculation of the CPI for high-income school fees and tuition. The reason for this bias is the so-called cost of admission, defined as the increase by a school (with regulated or supervised freedom) in the tuition charged for the first grade of preschool education. Generally, this registration or admission cost is much higher than the increase applied to the tuition charged for the other courses. When calculating the average annual change in a school's tuition, it was found the DANE methodology gives too much weight to these admission costs, by allowing all such costs that were applied several years back to be included. An alternative method proposed in this box could help reduce that bias.

It is important to clarify that the empirical exercises shown in this box are not representative in sample terms and, accordingly, they cannot be used to assess the size of the measurement bias due to the cost of admission. They simply serve as evidence to illustrate the existence of that bias and to explain the difference between the two methodologies: that of DANE and the alternative proposal.

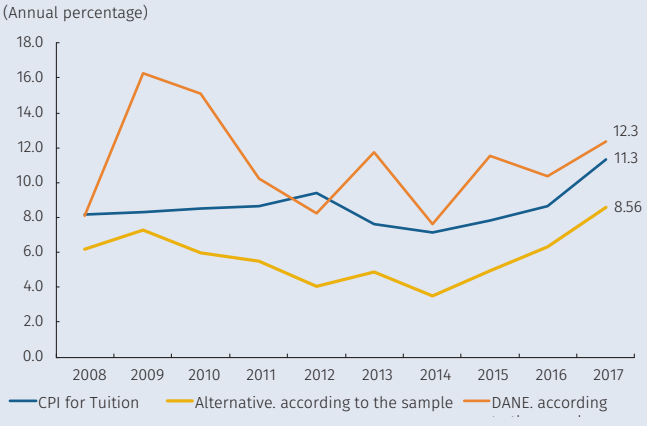
Table B3.1
Average of the Annual Changes in the First Grade Compared to the All Other Grades

Year	Annual Increase in Admission Fees			Annual Increase in Tuition		
	First grade[a/]	All other grades (alternative method)[b,c/]	All other grades (DANE method)[b/]	First grade[a/]	All other grades (alternative method)[b,c/]	All other grades (DANE method)[b/]
2008	23.9	6.3	8.1	23.9	6.2	8.1
2009	43.4	7.4	16.2	25.0	7.3	16.3
2010	13.0	6.1	16.8	13.0	6.0	15.1
2011	5.5	5.6	10.0	5.5	5.5	10.2
2012	12.1	5.2	9.4	12.1	4.1	8.2
2013	9.9	4.7	10.5	10.0	4.9	11.7
2014	3.5	3.5	8.9	3.5	3.5	7.6
2017	9.6	8.6	16.7	9.6	8.6	12.3

a / Its value is a function of the adjustment for entry or admission costs and inflation (1 + πt) × (1 + et). A simple arithmetic average is used to estimate it.
b / The calculation of the annual changes in the other courses is that described in section 1 of this box.
c / In the alternative method, a correction is made for changes in quality.
Sources: *Banco de la República*; authors' calculations

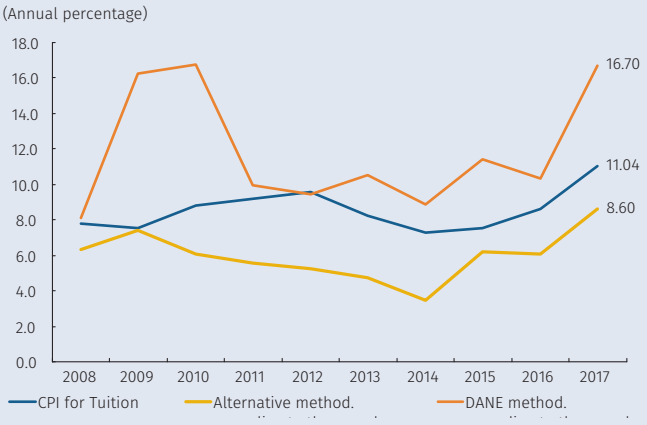
12 As expected, this difference is greater when the possible quality changes found in point a. are excluded in the alternative methodology.

Chart B3.3
Annual Changes in the CPI for Upper-income Tuition in Bogota and Comparison to the Two Methods (DANE and the Alternative Method), According to the Sample[a/]



a/ The calculations using the alternative method and the DANE method are based on the sample comprised of the children of *Banco de la República*'s employees. The CPI for tuition is the published
monthly by DANE.
Sources: DANE and *Banco de la República*; authors' calculations

Chart B3.4
Annual Changes in the CPI for Upper-income Admissions in Bogota and Comparison to the Two Methods (DANE and the Alternative Method), According to the Sample[a/]



a/ The calculations using the alternative method and the DANE method are based on the sample comprised of the children of *Banco de la República*'s employees. The CPI for admissions is published
monthly by the DANE.
Sources: DANE and *Banco de la República*; authors' calculations