UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ

Colegio de Administración y Economía

DOES COVID-19 IMPROVE ACADEMIC PERFORMANCE? EVIDENCE FROM A HIGH-SCHOOL IN ECUADOR

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Economía

Trabajo de titulación presentado como requisito

para la obtención del título de

Economista

Quito, 20 de mayo de 2021

UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ
COLEGIO DE ADMINISTRACIÓN Y ECONOMÍA

HOJA DE CALIFICACIÓN
DE TRABAJO DE TITULACIÓN

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Quito, 20 de mayo de 2021

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AGRADECIMIENTOS

Agradezco a mi esposa y mi hijo, quienes me dieron la fuerza diaria

Agradezco a mis padres y a mi hermano por el constante apoyo

Agradezco a mi familia política

Agradezco a Diego por la calma y la inmensa ayuda

Agradezco a mis profesores

Agradezco a la USFQ

Agradezco a mis amigos cercanos, ellos saben quienes son.

RESUMEN

El COVID-19 cerró todas las instituciones académicas de Ecuador, forzando el comienzo de la educación virtual debido a las medidas de confinamiento. Utilizando un panel dinámico sobre datos institucionales de un colegio en Quito, Ecuador, este estudio se enfoca en los efectos de la pandemia sobre la brecha en notas por género y los efectos de tener descuentos ligados hacia los ingresos del hogar. Además, considera las repercusiones directas de tener un familiar infectado de COVID-19 en las notas del estudiante. Los resultados sugieren que las notas mejoraron debido a la pandemia. Sin embargo, las notas de los hombres mejoraron más que las de las mujeres, reduciendo la brecha previa. Por otra parte, debido a la creciente necesidad de descuentos debido a la caída de los ingresos del hogar durante la pandemia, el aumento de los descuentos incrementó las notas. Tener un infectado de COVID-19 en la familia perjudica el desempeño académico.

Palabras clave: Ecuador, COVID-19, pandemia, brecha de género, ingreso del hogar, MGM, ACP.

ABSTRACT

COVID-19 closed all academic institutions in Ecuador, forcing the start of virtual education due to lockdown measures. Using dynamic panel analysis on institutional data from a school in Quito, Ecuador, this study focuses on the effects of the pandemic on the gender grade gap and the effects of having discounts tied to household income. Additionally, it considered the direct repercussions of having a family member infected with COVID-19 on the student's grades. The results suggest that grades improved due to the pandemic. However, men's grades improved more than women's, narrowing the previous gap. Further, due to the increasing need for discounts following the fall in household income during the pandemic, the increase in discounts was associated with higher grades. Having a person with COVID-19 in the family has a negative effect on academic performance.

Keywords: Ecuador, COVID-19, pandemic, gender gap, household income, system GMM, PCA

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1 Introduction

After more than a full year living with the pandemic, still half of the world's students have their schools partially or completely closed and are being part of the online learning challenge (UNESCO, 2021). The repercussions for students are not certain, yet it is clear that learning is compromised and that developing countries are being especially affected by restrictions around access to academic technological tools and other mechanisms related to home stability (UNESCO, 2021). At the same time, there are gender and household income repercussions that have an effect on education. In this context, this study answers the following question: What is the effect of the pandemic on students' grades in a secondary school of a developing country?

Research about the expected academic performance during the COVID-19 crisis points towards a likely decline in grades as a consequence of the lockdown (Aucejo, French, Ugalde, and Zafar, 2020). Yet, results using objective data actually show that the pandemic contributes positively to academic performance as measured by students' grades (Gonzales, et al. 2020). In this thesis we consider the effect of the pandemic on a high-school in Quito Ecuador, also looking at the mediating effect of gender, discounts and having a household member affected by Covid-19.

The literature on education inequality often focuses on the equality of opportunities among men and women (Miyake, et al. 2010; Jacobs, 1996; Schmader, 2002). Yet currently women actually tend to have more years of education than men and also tend to perform better on average. Since positive external shocks tend to affect worse-off groups more than better-off groups, we analyze the *positive* impact of the pandemic on grades, distinguishing the effect by gender.

The pandemic also had a large economic impact. We address this effect on grades by looking at the high-school issuance of discounts. Since discounts are provided based only on household income, they provide a basis to understand the economic effect of the pandemic. This is important because previous evidence shows that low household income has a negative effect on children's academic performance (Elstad and Bakken, 2015; Korenman, Miller and, Sjaastad, 1995; Klebanov, et al. 1998). Moreover, because Ecuador suffered one of the biggest

COVID-19 outbreaks in the world (Cabrera and Kurmanaev. 2020), we also consider the effect of nearness to an infected person. The findings of this study contribute to an understanding of the effects of the pandemic because we use a unique data set with objective administrative information about grades, grades by subject, discounts, and COVID-19 infection. The results contribute to the developing literature about COVID-19 repercussions on vulnerable populations such as secondary students of a developing country.

By using a dynamic panel data analysis we conclude that the causal effect of the pandemic on grades was positive while we also found a gender academic performance gap whereby females outperformed males *before* the onset of the pandemic. When referring to discounts, we found that discounts during the pandemic had a positive causal effect on grades. Finally, the infection of COVID-19 on a familiar had a negative causal effect on grades.

2 Literature Review

2.1 Gender effects on grades

The reality about whether males or females have a higher academic performance is a current debate. While there is a common belief that girls are outperforming boys in high school and college, studies show different results for different samples.

A report from the Organization for Economic Co-operation and Development (OECD) (2009) showed that across OECD countries, males outperformed females in mathematics in the Programme for International Student Assessment (PISA) tests. At the same time, girls had better results than boys on reading skills. Legewi (2012) considered a sample of 5th and 9th graders from Berlin's schools. He concludes that, for an average school, females have a reading advantage of .12 and .21 standard deviations for the 5th and 9th grades respectively. In the 5th grade, girls are .36 school years ahead in reading test scores. Nevertheless, for some schools in the study males have the advantage to a maximum extent of .12 school years.

Fryer and Levitt (2010) used data from the Early Childhood Longitudinal Study Kindergarten Cohort (ECLS-K) and found that boys outperform girls in math in all the United States starting

in the 5th grade. Similar outcomes were shown by Lee, Grigg, and Dion in The Nations Report Card: Mathematics 2007 from the United States. Studying the 4th and 8th grades, boys had better results than girls in math for the last two decades with a decreasing gap. A meta-analysis analyzing 100 studies confirmed the male advantage in math (Hyde, Fennema, and Lamon, 1990).

Conger and Long (2010) aimed to answer the question with data from colleges from Florida and Texas. They found that females have higher grade point averages (GPA) in the first semesters of college. The difference increases slightly as the students keep progressing in their majors.

Peter (2005) in a Descriptive Analysis Report of the National Center for Education Statistics from the USA, compared two cohorts (1982-1992) measuring high school GPA of graduates that entered postsecondary education after their second year out of High School. The First cohort in 1982 showed that the average GPA for men was 2.68 while for women it was 2.85. In the second cohort from 1992, men had an average GPA of 2.74, while women had an average GPA of 2.91. In conclusion, women had an average GPA advantage of 0.17 against men. A study from a Czech sample of 9th graders showed that girls have higher grades than boys in reading and mathematics (Mateju and Michael, 2014).

Investigation towards reducing the gender gap in education often focuses on equality of opportunities for women (Miyake, et al. 2010; Jacobs, 1996; Schmader, 2002). Miyake, et al. (2010) conducted an experiment to evaluate a values affirmation psychological intervention to reduce the difference in grades between men and women for an introductory college physics class. The intervention benefits all the treatment cohorts but as women had lower grades than men before the intervention, they benefited more.

Nevertheless, considering that apparently females tend to have an advantage in grades, to the best of our knowledge, only one intervention aims for equality towards men in grades. Schippers, Scheepers and, Peterson (2015) tested the effectiveness of a goal-directed conceptualization intervention on grades of first-year college students. Their findings show that the intervention cohort reduced the gap in grades between males and females, favoring males as they had the worse academic performance. At the same time, academic performance improved for all the intervention cohort.

Considering the inequality in economic participation and salaries in Ecuador favoring males (World Economic Forum, 2021), it is crucial to understand employers' incentives to hire females. Currently women tend to have higher academic performance than men, but men have advantage on economic participation and salaries. Therefore, if the pandemic had a disproportionate effect on closing the academic performance gap, this could lead to a deepening of the labor market gender gap.

2.2 Discount effects on grades

Given the COVID-19 pandemic, the Ministry of Education of Ecuador had to impose some ground rules for schools. Consequently, private institutions negotiated with their clients about discounts. While everyone received a discount because of the change to virtual learning, families were able to present income information for applying to a greater discount. As a result, discounts observed during the pandemic are not linked with academic performance but with evidenced drops in household income.

Previous research holds that household income affects children's test scores. Klebanov, et al. (1998) analyzed the effect of being in a low-income family for the IQ of children ages 1 to 3. Their results showed that a lower family income causes lower IQ test scores for 2 and 3-year-olds. To evaluate the long-term effects, Korenman, Miller and, Sjaastad (1995) studied a sample with a 13-year exposure to low-income and conclude that children age 0-10 have lower grades on cognitive tests. Likewise, Crane (1996) studied a sample of children aged 5 to 9 and their performance on math tests. As he aimed to find the effect of socioeconomic status, family income was a key independent variable. The effect of increasing family income was an increase in math grades, proving a causal relationship between family income and grades.

Elstad and Bakken (2015) analyzed a sample of Norwegian 16-year-old graduates during 2002-2011. Their results show a causal negative effect of low income on education performance. However, through a quartile regression, they found that the effect was higher for families that were on the lowest end of the income distribution. At the same time, a discussion about if

the effect on performance was caused by the access to academic resources that can improve academic performance or by the family stress caused by low household income was made.

2.3 COVID-19 Impact on Education for Ecuadorian High School Students

The first case of COVID-19 in Ecuador was reported on February 29, 2020 (El Comercio, 2020) and the first death on March 13 (Reuters, 2020). Immediately, the government suspended classes for students of all levels of education, and the lockdown was issued on March 16. It wasn't until April 6 that the Ministry of Education announced that all face-to-face school programs will remain suspended for the rest of the academic year, meaning that students will not go back (physically) to their institutions.

As Ecuador is a developing country, it is of special interest for researchers to understand the implications of the academic lockdown and the process of adaptation to online learning. To the best of our knowledge, the only research analyzing this issue in the case of Ecuador is Asanov, Flores, Mckenzie, Mensmann, and Schulte (2021). With a sample of 2412 students from 126 schools aged 14 to 18, they conducted phone surveys. Interviews occurred during weeks 3, 4, and 5 after the announcement of the academic lockdown. Their main focus was on access to remote learning technologies, mental health, and time use for students.

They found that 67% of students have a computer or tablet in their home, 74% have internet and 59% have both. Another way to access learning during lockdown is radio o television education programs. 92% of students have a television in their home and 59% radio. 74% of the students surveyed used online or television learning options in the week before the survey. The usage of the Ministry of Education's platform Educa was low (8%) and it is accessible online, by television, and by radio. Students found a way to learn about their interests and their class topics with YouTube being the platform used by the highest percentage (48%). At the same time, platforms for online live classes were utilized by 41% of the students. By the time of the survey, just 37% of students had online classes, 94% received homework, and 83% materials to work. Moreover, females were more likely to have done educational activities online or on television.

Mental Health response was measured by the MHI-5 questionnaire. Their findings suggest that 16% of the students could have major depression. This result is not comparable with a baseline as the authors do not have a previous measure of depression. Females showed higher levels of depression. Another measure was the identification of the major problem of the COVID-19 for the students personally. The highest concern was with schooling, then social isolation, and, for some students, finances of the household.

Finally, the study evaluated time usage. 82% of the students did not leave their house the day before the survey. Nevertheless, they have similar time usage tendencies. Gender established a special difference as men were more likely to engage in work while women helped in household tasks. In the mornings, both men and women use their time for education, while in the afternoon, men stopped pursuing education and got more involved with leisure activities while women kept studying.

2.4 Relationship between the COVID-19 pandemic and students grades

As the access to objective data on grades is limited, studies have used self-reported GPA changes to assess the effect of COVID-19 on academic performance. Here, expectations about the duration of the shock become crucial for the interpretation of results. Aucejo, French, Ugalde, and Zafar (2020) used data from a survey of undergraduate students at Arizona State University. The key question was meant to find the current GPA of the students and an approximation of their GPA at the moment of the survey if the pandemic didn't occur. The survey was posted until April 23, 2020, results show low expectations about future academic performance. The average effect was negative.

Another study with objective data listed some of the possible mechanisms for performance improvement. First of all, most academic institutions changed their assessments with easier exams. Then, there were challenges when controlling cheating during exams. Third, students developed better learning strategies. Fourth, there was a lower opportunity cost of studying because of the drop in employment (Rodríguez-Planas, 2021). This study used a difference in difference approach using data from semesters before the pandemic focusing their results

on the difference in performance between lower-income students and their high-income peer's students. They find that lower-income students increased their GPA 3.4% relative to their high-income peers with the pandemic.

Gonzales, et al. (2020) conducted an investigation with students from the Universidad Autónoma de Madrid with a sample of 458 students. The semesters of COVID-19 were the treatment cohort and the two previous academic years the control group. For academic performance, they considered the results of an adaptive online test for the subjects of *Applied Computing* and *Design of Water Treatment Facilities*. At the same time, they studied the results on traditional testing for the subject *Metabolism*. The results show that the academic performance of students improved in the treatment cohort. Nevertheless, their results do not indicate what mechanism caused the improvement.

3 Methodology

3.1 Data

We had access to a unique dataset containing academic and demographic records from an Ecuadorian private high school. The analysis is focused on a panel of 10755 observations with 3314 groups.

To organize the demographic and academic information from the students the school uses the academic software Idukay. This contains records of grades by subject and semester along with other demographic information such as the gender of the student and students per Academic School Year. The school management provided information about discounts and COVID-19 infections.

Table 5 is a summary of grades by year and semester from 2016-2017 to 2020-2021. Mean grades have increased with time and females have always had higher grades than males (Table 1). Figure 2 shows a Kernel Density approximation of the distribution of grades by year. There is a tendency towards higher grades over time.

Table 1: Students and Grades per Gender and Academic School Year

Academic School Year	Gender	N. Students	Total students	Mean grades	Total mean grades
2016-2017	Female	65	149	9,045	8,731
	Male	84		8,485	
2017-2018	Female	64	141	9,101	8,882
	Male	77		8,694	
2018-2019	Female	74	156	9,194	8,954
	Male	82		8,739	
2019-2020	Female	80	155	9,375	9,293
	Male	75		9,019	
2020-2021	Female	85	163	9,603	9,423
	Male	78		9,230	
Average			153		9,057
Source:	Made by the Author				
Data:	Idukay				

As shown in Table 1, the gender distribution changed over time. From the Academic School Year 2016-2017 to 2018-2019, males were a majority. From that period forward the distribution lean towards females. Since COVID-19 forced students to lockdown, the percentage of females in the sample raised to its higher value.

Historic information on discounts was provided from the institution from 2017-2018 to the 2020-2021 school year (Table 3). Since COVID-19 generated a large negative shock on household income for the school year 2020-2021, the management decided to negotiate discounts with the families that needed it. For this purpose, the institution asked for bank statements as evidence. At the same time, families with more than two children in the school had an increased discount. These measures led to an increase in the share of students with discounts (See table 3) and an increase in the discount for families that already had it. Figure 1 shows the movement of the families that increased their discount.

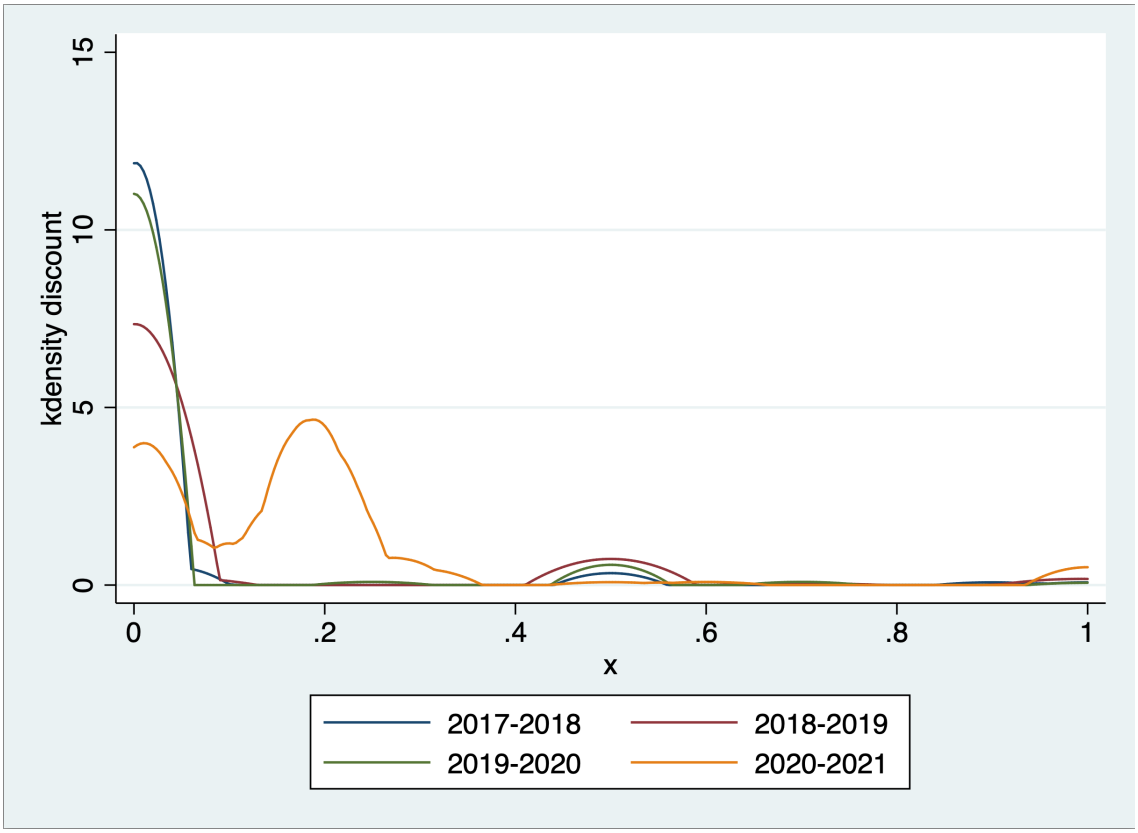
COVID-19 cases were reported in 2 families. One of them was in the spring semester 2019-2020 and the other in the fall semester 2020-2021. In both cases, the virus did not spread to the rest of the family but in one case the infected person died. (See Table 4)

Table 2: Subjects by Class

Juniors	Freshmen and Shophomores	Seniors
Art	Biology	Biology
Physical Education (PE)	PE	PE
Social Studies Social Studies	Artistic and Cultural Education	Entrepreneurship
History	Citizenship Education	Physics
English	Entrepreneurship	History
Spanish	Filosofy	History in Spanish
Mathematics	Physiscs	English
Music	History	Spanish
Science	History in Spanish	Operatives
	English	Chemistry
	Spanish	Electives:
	Mathematics	Psichology
	Chemistry	Critical Reading
		Writing
		Creative Writing
		Investigation
		High-Level Mathematics
		Contemporary World Problematics

Source: Made by the Author
Data: Idukay

Figure 1: Kernel Density Estimation of Grades per Academic School Year



Source: Made by the Author
Data:Directives of the Institution

Table 3: Discounts per Academic School Year

Academic School Year	Number of Students	Mean Discount
2017-2018	11	37.36%
2018-2019	20	51.50%
2019-2020	11	54.09%
2020-2021	117	22.32%

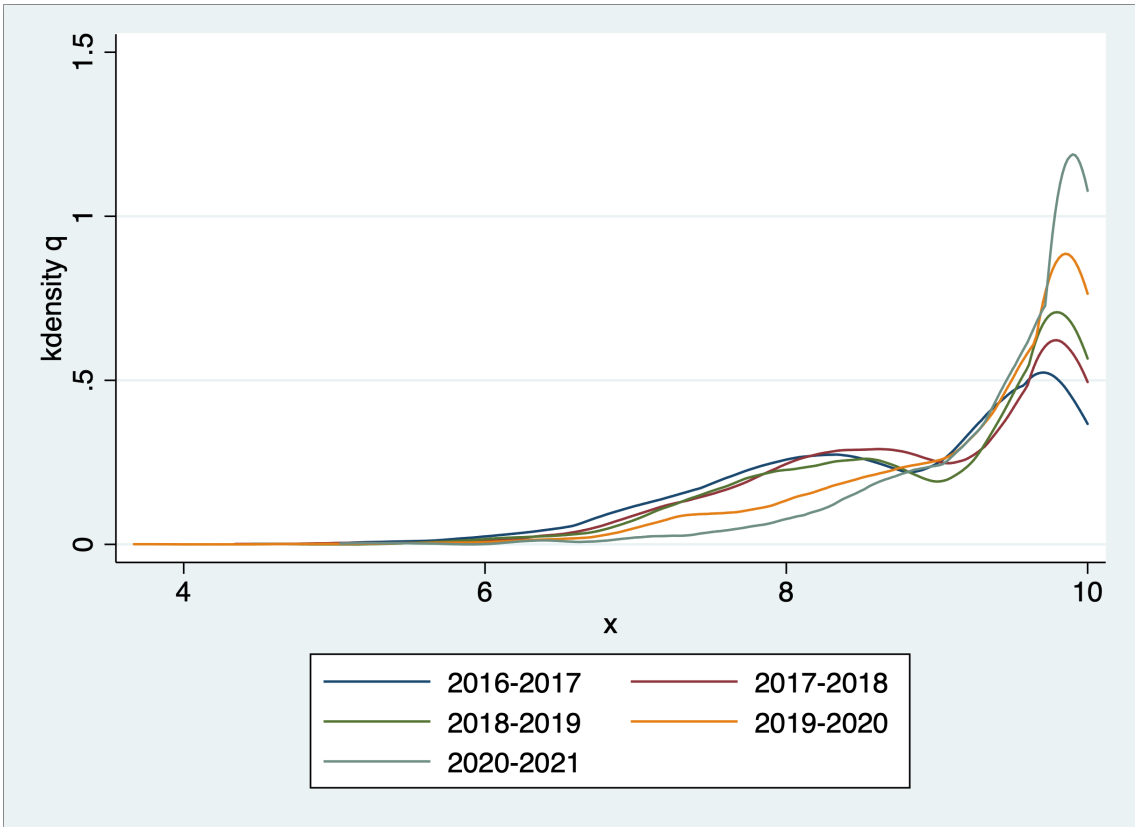
Source: Made by the Author
Data: Directives of the Institution

Table 4: COVID-19 Infection

Date of Infection	Infection	Quantity	Dead
2019 - 2020 Spring	Familiar	1	Yes
	No	154	No
2020 - 2021 Fall	Familiar	1	No
	No	162	No

Source: Made by the Author
Data: Directives form the Institution

Figure 2: Kernel Density Estimation of the Discounts



Source: Made by the Author
Data:Directives of the Institution

3.2 Method

We use panel data to establish the causal effect of the COVID-19 pandemic on grades with emphasis on gender and discounts. Understanding the variation of grades over time is key for the model. Students that had good grades in a certain subject tend to keep those levels over time. The same happens with lower grades. Consequently, intuitively grades have a strong correlation over time, causing the need to include a lagged variable of grades. To address this issue we used a similar model to the ones Forbes (2000) and Perotti (1996) structured for economic growth through real per capita GDP. The econometric model is the following:

$$\begin{aligned} y_{sit} =& \beta_0 + \beta_1 y_{sit-1} + \beta_2 pand_t + \beta_3 f_i + \beta_4 f_i \times pand_t + \beta_5 d_i + \beta_6 d_i \times pand_t + \beta_7 covid_i + \\ &+ \beta_8 \gamma_s + \beta_9 \gamma_i + \beta_{10} \gamma_t + \beta_{11} \gamma_c + \beta_{12} \gamma_j + \mu_{ist}, \end{aligned} \tag{1}$$

where (y_{ist}) represents the grade in subject s for student i during period t. The period is defined as each semester in each academic year. y_{sit-1} is the lagged grades, included to control for serial correlation. A dummy variable $(pand)$ is equal to 1 when the period corresponds to the pandemic (periods 8 and 9) and 0 before. The beta (β_3) next to female (f) shows the difference in grades between females and males before the pandemic. The coefficient (β_4) on the interaction with pandemic $(f * pand)$ explains the difference in grades between females and males due to the pandemic. Furthermore, the effect of increasing the discount (d) by 1% on grades is assessed by β_5. When interacting with pandemic, the coefficient (β_6) shows the effect of having a discount on grades during the pandemic. *covid* is a dummy equal to 1 if the student had a familiar infected with Covid-19 and 0 if not. The model includes a vector of fixed effects including subject (γ_s), individual (γ_i), period (γ_t), class (γ_c) and semester (γ_j). Finally, μ_{sit} are the errors.

Standard panel data models are fixed effects and random effects. Fixed effects models incorporate variation within individuals and random effects incorporate information from variation across individuals as it assumes that covariates are uncorrelated with the effect of each individual. Random effects are more efficient at the cost of the additional assumption.

In our case, each individual can have specific conditions or traits that correlate with the error term. Therefore, we include all the above mentioned fixed effects and we would expect random effects to be inconsistent. Following the standard for panel data models, we should work with a fixed-effects model. However, the inclusion of a lagged dependent variable for turns the fixed effects approximations also inconsistent.

The alternative is a dynamic panel data estimation. Arellano and Bond (1991) developed an estimator providing an instrumental variable framework with the lagged variables. Yet, the "weak instrument problem" was recognized in this case (Mátyás and Sevestre, 2008). Moreover, in other contexts, this estimation tends to be biased (Hauk and Wacziarg, 2009). Arellano and Bover (1995) and Blundell and Bond (1998) proposed another estimator, the system generalized method of moments (System GMM). This estimator solves the problems described above and reduces the measurement error bias while imposing a moment condition (Hauk and Wacziarg, 2009). System-GMM estimator is not perfect either. Instrument proliferation can occur as T increases. Difference-GMM and system-GMM were made on the assumption that panel data has small T and large N. Since this is not always the case, and both estimators use lagged variables of the dependent variable that go from two periods backward as the instruments, over-fitting of the endogenous variable can occur as T increases, leading to biased estimates. Altonji and Segal (1996) and Ziliak (1997) analyzed this problem showing that as the moment conditions increase, the bias of the GMM estimators increases too. This conclusion invalids the Sargan-Hansen test for the identification of overidentified restrictions. However, this problem can be solved by restricting the number of instruments utilized in the estimation.

When estimating dynamic panel data models, it is important to work with robust standard errors and consider the autocorrelation tests of the first and second orders (AR1 and AR2) from Arellano and Bond. As we estimate first differences, rejecting the AR1 is not possible. Yet, we should be able to reject the null hypothesis of the existence of second-order autocorrelation. To accomplish this, principal component analysis (PCA) is helpful being a statistical analysis method that reduces the number of variables, keeping the principal components utilizing reduction techniques that leave the most relevant information of the variables that are being used (Ming-ming, Jing-lian, 2015). At the same time, rejecting the Hansen overidentifying

restriction test is relevant. This can be solved by controlling the number of instruments used in the estimation.

4 Results

In this section we show the main results of the model. Starting from a description of fixed and random effects models and converging to a system GMM with one lagged variable and principal component analysis. Results are not consistent with the literature about grade expectations during the pandemic as the effect was positive. Moreover, females had higher grades than males before the pandemic but improved less with its occurrence. Discounts harmed grades as they were a sign of low household income, yet with the pandemic, the effect became positive as the sample of the students with discounts increased.

4.1 Converging to the Appropriate Model

As mentioned above, panel data analysis is usually made with fixed or random effects models, usually implying a choice between consistency and efficiency. First, we conducted a Hausman test to identify which of these two models is more appropriate. Based on this test, we conclude that fixed effects were the better option $(Prob > chi2 = 0.0000)$. We regressed both random and fixed effects models with controls for semester, COVID-19, class and, period (Equation 2). The results are presented in columns 1 and 3 of table 6. As fixed effects omit variables that do not vary with time, the gender variable was not considered for a first comparison. In column 2 we added subject and individual controls to the random effects analysis. Since these controls do not vary over time, it was not possible to incorporate them into the fixed effect model. Consequently, the random-effects model (column 2) appeared as a good approximation with all the available controls. However, the inclusion of a lag for the dependent variable makes both fixed and random effects inconsistent for the analysis.

$$y_{sit} = \beta_0 + \beta_1 y_{sit-1} + \beta_2 pand_t + \beta_3 f_i \times pand_t + \beta_4 d_i + \beta_5 d_i \times pand_t + \beta_6 covid_i + \\ + \beta_7 \gamma_s + \beta_8 \gamma_i + \beta_9 \gamma_t + \beta_{10} \gamma_c + \beta_{11} \gamma_j + \mu_{ist}, \quad (2)$$

Hence we implemented an Arellano and Bond approximation without subject or individual controls (column 4), a system generalized method of moments (GMM) without controls for individual (column 5), a system GMM with all the available controls (column 6), a system GMM with all the available controls, and considering principal component analysis (PCA) (column 7), a system GMM with all the available controls and restricting the number of lags to two (column 8), a system GMM with all the available controls and restricting the number of lags to two with PCA (column 9), and finally a system GMM with all the available controls and restricting the number of lags to one with PCA (column 10).

Due to the "weak instrument problem" the system GMM estimator is preferred to the Arellano and Bond estimator. At the same time, this approach restricted the number of observations. Since the system GMM approach solves this issue the challenge is to identify the model that provides the best approximation.

To answer the question, our main concern was around the second-order Arellano and Bond autocorrelation test. The goal is to reject this test with the highest possible level of significance since it establishes as a null hypothesis of second-order serial correlation. Adding control variables, principal component analysis, and control over the number of lags of the instruments were the tools to reach the desired outcome. Table 6 shows that the model in column 10 gives the highest significance for rejection of the null hypothesis, thus becoming our preferred specification. It is important to clarify that we were not able to reject the null hypothesis of overidentification of restrictions as shown by the Hansen test for any of the models presented. Given that results over models are consistent, we argue that the effects and the significance of the System GMM estimator with controls for individuals, one lagged instrument, and PCA are relevant, although there seem to be problems with the lagged instrumental variables.

4.2 Results of the estimation

With the System GMM estimator with controls for individuals, one lagged instrument, and PCA results show a .492 effect of the pandemic on grades.This magnitude explains the difference in grades between students before and after the pandemic occurrence. On the one hand, females have higher grades than males before the pandemic $(.408)$. On the other hand, given the positive effect of the pandemic on grades, females improved less than men $(-.157)$ during the pandemic periods. All of these results are significant at the 1% level. Discounts prove not to be significant, although the negative sign is consistent in all the models estimated, suggesting that the effect of having a discount before the pandemic is negative on grades. In the pandemic year, students with discounts have grades that are .259 points higher than the ones that do not with a 5% significance level. Finally, for the two students of the sample that had familiars infected with COVID-19 grades went down by a magnitude of $-.588$, with a significance of 1%.

For the AR1 test, we do not reject the null hypothesis of the existence of the first-order autocorrelation given that we are estimating the first differences. The AR2 null hypothesis is

Table 6: Regressions

VARIABLES	(1) RE y_{sit}	(2) RE1 y_{sit}	(3) FE y_{sit}	(4) AB y_{sit}	(5) SGMM y_{sit}	(6) SGMM y_{sit}	(7) SGMMp y_{sit}	(8) SGMM2L y_{sit}	(9) SGMMp2L y_{sit}	(10) SGMMp1L y_{sit}
y_{sit-1}	0.652***	0.397***	-0.012	0.205***	-0.068**	0.028	0.020	0.022	0.013	-0.027
	(0.007)	(0.012)	(0.014)	(0.024)	(0.028)	(0.027)	(0.025)	(0.027)	(0.025)	(0.026)
$pand_t$	0.211***	0.366***	0.604***	0.511***	0.504***	0.457***	0.496***	0.472***	0.503***	0.492***
	(0.026)	(0.053)	(0.046)	(0.044)	(0.035)	(0.048)	(0.043)	(0.048)	(0.045)	(0.048)
f_i		0.402***			0.487***	0.372***	0.405***	0.379***	0.402***	0.408***
		(0.129)			(0.037)	(0.097)	(0.092)	(0.095)	(0.095)	(0.098)
$f_i \times pand_t$	0.046***	-0.111***	-0.165***	-0.200***	-0.147***	-0.150***	-0.174***	-0.156***	-0.181***	-0.157***
	(0.017)	(0.031)	(0.039)	(0.048)	(0.038)	(0.050)	(0.043)	(0.049)	(0.045)	(0.048)
d_i	0.010	-0.109**	-0.178***	-0.180**	-0.039	-0.146*	-0.112	-0.145*	-0.117	-0.112
	(0.045)	(0.050)	(0.056)	(0.073)	(0.082)	(0.078)	(0.076)	(0.078)	(0.076)	(0.078)
$d_i \times pand_t$	0.153**	0.195**	0.272**	0.249**	0.303***	0.283**	0.221*	0.276**	0.253**	0.259**
	(0.074)	(0.086)	(0.106)	(0.110)	(0.106)	(0.127)	(0.117)	(0.128)	(0.120)	(0.124)
$covid_i$	-0.036	0.235			-0.208*	-0.533***	-0.625***	-0.532***	-0.621***	-0.588***
	(0.056)	(0.171)			(0.121)	(0.204)	(0.195)	(0.189)	(0.181)	(0.200)
AR(1)				0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)				0.000	0.875	0.056	0.075	0.070	0.111	0.423
Hansen t				0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	10,775	10,775	10,775	7,448	10,775	10,775	10,775	10,775	10,775	10,775
S and I contrs.	No	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes

Random and Fixed effects (RE and FE) models with controls for semester, COVID-19, class and, period are in columns 1 and 3. Random effects (RE1) with subject and individual controls is on column 2. Arellano and Bond approximation without subject or individual controls (column 4), a system generalized method of moments (SGMM) without controls for individual or subject (column 5), a system GMM with all the available controls (column 6), a system GMM with all the available controls, and considering principal component analysis (PCA) (column 7), a system GMM with all the available controls and restricting the number of lags to two (column 8), a system GMM with all the available controls and restricting the number of lags to two with PCA (column 9), and finally a system GMM with all the available controls and restricting the number of lags to one with PCA (column 10).

S and I contrs. stands for Subject and individual controls

Robust standard errors in parentheses

*** $p< 0.01$, ** $p<0.05$, * $p<0.1$

rejected with a 42% significance level. As mentioned, we were not able to reject the Hansen test.

5 Discussion and Conclusions

Given the multiple COVID-19 effects, this study is a starting point for understanding the consequences among high-school students. In our case, the pandemic had a positive impact on grades. Yet the mechanisms that drive this result are not clear. Contrary to the literature around expectations on grades (Aucejo, French, Ugalde, and Zafar. 2020), students appear to adapt easily to the academic change and develop better on their school work and tests. Also, students appear to have found better learning or studying techniques as adaptive tools. Still, considering factors mentioned by (Rodríguez-Planas, 2021) the effect could be attributed to the challenges for controlling cheating or easier exams as a consequence of the difficult social situation. Our result are in line with studies that use objective grades data (Rodríguez-Planas, 2021; Gonzales, et al. 2020). Academic performance seems to improve with the new academic reality of online learning. This opens a new chapter on investigation for long-term consequences of online learning and raises questions about whether students are, indeed, learning.

Moreover, a key issue for secondary and high school students is opportunity costs. As the results on grades for gender on the pandemic show, overall, grades improved, female grades improved less than those of males. It is key to understand the ceiling effect here. As females have higher grades, they don't have much space to grow. Males have the opposite situation. Since their grades were lower, they had better chances to improve and they did. Asanov, Flores, Mckenzie, Mensmann, and Schulte (2021) conclude that females study when most men are getting involved with leisure activities. The opportunity costs for females are higher than for males because of their involvement in household tasks. This means that when men may rest, females start working again on academic activities. This could take females to a counterproductive state of fatigue, affecting their mental health and consequently their grades.

In addition, our results are consistent with the literature on external shocks and their consequences on education (Miyake, et al. 2020; Schippers, Scheepers and, Peterson. 2014).

The cohort with the lower grades before the occurrence of the shock had the biggest improvement, closing the academic performance gap for males. During the pandemic, females used more time per day to study (Asanov, Flores, Mckenzie, Mensmann, and Schulte 2021) however, their improvement was lower than for males due to the smaller space of improvement given their higher baseline grades.

As this result closes the academic gap that favored females on academic performance, it might widen the gap on the labor market. In Ecuador, females have lower participation than males in the labor market, plus women get paid less for similar jobs. Consequently, they earn less income and have smaller opportunities to work (World Economic Forum, 2021). With the academic performance gap reduction, long to medium-term consequences could include a bigger gap in economic participation and salary for females. If employers had incentives to choose females for their excellence in academic performance and still hired more males before the pandemic, the new reality would reduce the chances for females. This is an area where further research will be needed as these effects become apparent in the labor market.

Before the COVID-19 crisis, this institution did not have discounts related to academic performance but to financial needs only. Therefore low household income earned families discounts. Studies suggest that low household income impact negatively students grades. The mechanisms behind this result could include lower opportunities to access educational material such as computers and lack of a safe space to work on assignments. At the same time, low-income families often involve stressed parents that affect the mental health of their children in multiple ways such as pressure to succeed, low patience, etc. (Elstad and Bakken, 2015). Our findings on the effect of discounts on grades are not significant for the majority of the models presented, yet the negative effect is present in all of them and it is consistent with this literature as discounts seem to be associated with lower grades before the pandemic.

In contrast, the school's response to the pandemic changed the sample of students with discounts. Even though government directions caused a general discount for schools, the school provided an opportunity for household to show their financial needs. As a consequence, students with discounts before the pandemic sum to a maximum of 20 from 2017-2018 to 2019-2020 while the 2020-2021 (pandemic period) academic year had 117 students with discounts. It is

easy to identify low-income as a consequence of the pandemic for most of the families with discounts. For Elstad and Bakken (2015), students in families in the lower quartile were the ones exhibiting the biggest repercussions on grades, meaning that the effect is higher when household income is really low. In our study, discounts before the pandemic were equal to 47,65%, with the pandemic the average is 22,32% with 81,20% of the families having a discount of 20% or less. Families before the pandemic had discounts only related to low household income, so intuitively those families had a bigger impact on their income with the pandemic. Students getting discounts when the pandemic started incremented the sample of students with low discounts. Consequently, their household income may not have dropped enough to harm their performance in school. Yet, this mechanism is not clear.

COVID-19 has unpredictable effects on mental health and welfare for students. Yet, conclusions can be made with this unique data set. For the two students that officially reported that a family member was infected, grades lowered by a significant amount. The sanitary situation in Quito is difficult as the hospital supply is limited and even if people have the resources there is not enough supply for medicine nor beds inside hospitals. This way, it is understandable that having a person infected with Covid-19 in a household can cause anxiety or other problems related to mental health that negatively affect grades. However, it is important to note that because of the very few cases observed, these results need to be considered with care.

In conclusion, this paper provides evidence on the existence of an impact of Covid-19 as an exogenous shock on the grades of students in secondary school. Considering the gender gap, it works as a shock that closed the gap favoring men, i.e. the group with lower grades before the shock. At the same time, students who received discounts during the pandemic tend to have higher grades.

There is still much to say about the response mechanisms within the context of virtual classes as well as their long-term effects.

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