The Effectiveness of the 2007 Educational Policy in Ecuador

Master Thesis

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I. Abstract

Since the 1950's, Latin America encountered a wave of public policies that aimed at increasing human development through education. This paper will look at the effectiveness of Ecuador's 2007 reform that attempted to expand the quality of public education attainment through the construction of schools named *Unidades Educativas del Milenio* (UEMs) around the nation. We look into the effect of investment in infrastructure and its effect on human capital by using a difference-in-difference estimator that calculates the impact of the reform on wages and years of schooling. The estimates suggest that there is a positive impact on wages while having a negative impact on years of schooling.

II. Introduction

Latin America is the region with the highest cross-country inequality rate in the world (Roser & Ortiz-Ospina, 2013). With a 0.53 Gini coefficient, Latin America is, on average, 65% more unequal than developed countries, 37% more than East Asia, and 19% more than Sub-Saharan Africa (Cuenca, 2014). All of these inequalities are reflected in socio-economic, educational, and demographic characteristics.

Following the Universal Declaration on Human Rights in 1948, equal educational access became, little by little, a political goal of many Latin American governments (Reimers, 2000). Starting from the 1950s, there is evidence of a series of educational reforms attempting to restructure the educational systems and their accessibility in Latin America. Throughout this educational movement, there were 3 main waves of reforms, all which had different approaches and purposes: coverage, quality, and equity.

The first wave, between 1950 and 1980, prioritized expanding access to education (coverage). Educational equity was, however, left aside as the countries focused on external debt and market policies rather than social policies during the 80s (Reimers, 2000). The second wave, in the 1990s, focused on quality of education (Martinic, 2001). Nonetheless, that new wave of reforms did very

little for quality and equity despite the increase in resources directed towards education (Reimers, 2000).

The third wave, from the 2000s, aimed for the expansion of access to all education levels, the recognition of rights of excluded and marginalized populations, an increase of educational financing and quality improvement (Suasnábar, 2017). In other words, these reforms highlighted the desperate need for equality and quality education. Ecuador joins the regional trends with the arrival of Rafael Correa's government in 2007, when a wave of reforms and public policies emerged with the aim of increasing the country's human development, which had been stagnant for years. During this period there was the implementation of the program which constructed schools all around the nation: *Unidades Educativas del Milenio* (UEMs). At this time many contemporary researchers have focused on the factors that contributed to these waves of reforms. Although there is not enough research that has focused on looking into the outcomes, it is important as unequal access to education can be a form of blocking development and transmitting intergenerational mobility in education attainment, occupation, and income (Binder, 2002).

In *Figure 1* and *Figure 2,* we can see an increasing trend of wages and education attainment over the years in the different Ecuadorian Cantons (regions). The question that arises is whether the investment in school infrastructure has something to do with these growing trends. Thereby, this paper will use an empirical regression to estimate the effects of the investment in infrastructure on human capital. More specifically, we will use Ecuador's construction of schools and age to understand the impact of this public policy on human capital. Our estimator will be a differences-in-differences which will compare the exposure to education attainment and wages depending on the exposure to the program (those who benefited from the UEMs and those who did not). The program is important to study as it helps policy-makers know the effects of reform on the population.

The paper is organized as follows. Firstly, the paper will describe the setting, and the reform enacted. Then, the literature review will outline previous research and results of studies that conducted a similar research procedure. Furthermore, the study will define in detail the identification strategy: research design and methodology (including models and the data used),

descriptive statistics, and output and results. Then, the study goes over the assumptions and limitations of this research study. Lastly, this paper will conclude the paper and its findings.

III. The Education Reform

A. Education Reform in Ecuador

The Ecuadorian ten-year education plan of 2006 proclaims eight educational policies to be implemented in the decade that would follow. The latter focused on the universalization of education, the eradication of illiteracy, and the improvement of the infrastructure and the quality of education. Particularly, regarding infrastructure improvement, the plan set a goal of building 85 new fully equipped schools: “Unidades Educativas del Milenio” (UEMs). Later in 2007, Rafeal Correa included the ten-year education plan into his Government Plan, and stated in his National Development Plan of 2007-2010 that the Government would build 210 UEMs until 2008.

Moreover, throughout his Government, Rafael Correa declared education as a fundamental basic capacity needed for the eradication of poverty and inequality, and put in place educational policies and investment projects, thereby addressing the problem of persistent illiteracy, low access to initial education, slow increase in access to basic education and low quality of education. As stated in the Guidelines of the UEM Project, the main purpose of building UEMs is to improve and to expand the supply of existing school infrastructure, following newly established quality standards.

The UEMs construction project continued long after Correa's Government. Until 2020, 116 UEMs were built in 75 Cantons (out of the 221), and in accordance with two different types of infrastructures: Mayor UEMs with an attendance capacity of 1140 students per day, and Minor UEMs with an attendance capacity of 570 students per day.

Table 1: Number of UEMs built by year and type, and the total number of comparable educational units

Year	Minor UEMs	Mayor UEMs	Total UEMs	Total n. of schools	N. of treated Cantons
2009	0	2	2	21	2
2010	1	2	3	14	3
2012	2	0	2	57	2
2013	5	1	6	51	6
2014	16	1	17	115	14
2015	5	4	9	39	7
2016	1	1	2	3	2
2017	13	18	31	100	19
2018	5	8	13	61	7
2019	3	27	30	264	12
2020	1	0	1	2	1
Total	51	65	116	727	75

Source:administrative database of the ministry of health

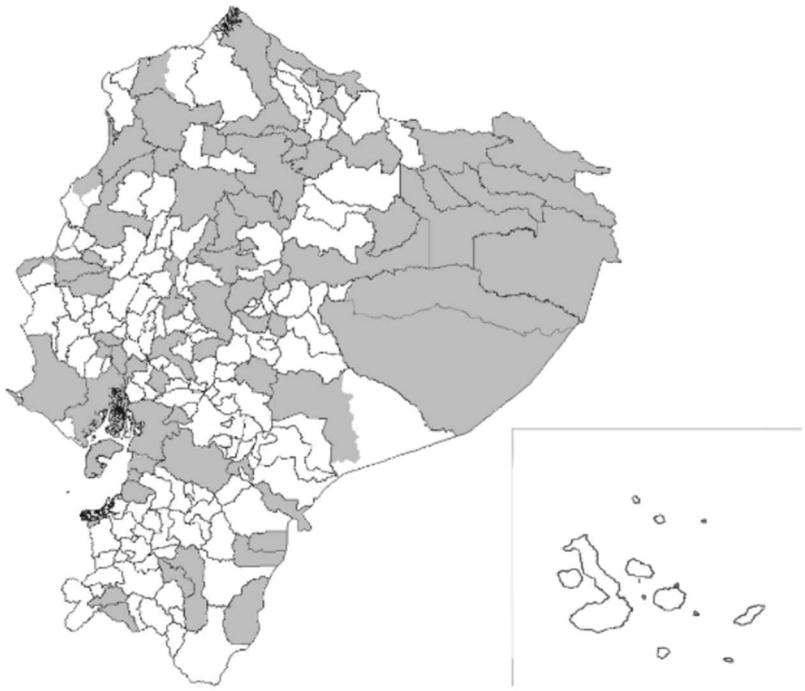

Figure 1: Treated Cantons until 2020

IV. Literature Review

Duflo (2001) questions whether investment in infrastructure can cause an increase in educational attainments and therefore, in earnings. The paper exploits the construction program of schools, known as INPRES schools, by the Indonesian government in 1973. To analyze the result of the dramatic school building, Duflo links the level of education and wages of adulting connected to district level data. This is used to create a difference-in-difference model depending on the exposure of an individual to the governmental program; regions being separated between "high exposure regions" and "low exposure regions," as well as dates of birth. Then compare the exposure to the educational attainment and the wages depending on the exposure to the program. The author concludes that the causal effect of the INPRES program is an increase in the educational levels and wages.

Alzua et al. (2015) examines the implementation of a law in Argentina in 1993 known as the *Ley Federal de Education*. This law seeked to increase the mandatory years of education and therefore increase the human capital of the children in the poorest communities. The paper uses several educational and labor outcomes to evaluate the impact of the educational reform. The authors used a difference-in-difference model that examined the heterogeneity of reform across provinces and time as some provinces quickly adopted the policy while others had slower changes. Estimators are carried out through the usage of several samples and different cohorts. The overall results were inconclusive as increasing mandatory years of schooling may be a component that is difficult to enforce additional to the component that controls variables and the reforms affect cohorts differently. However, it is concluded that in terms of education, the law had a positive significant effect in basic education enrollment outcomes. In terms of labor market outcomes, the reform also seems to have had a positive impact. The paper concludes that, on average, teenagers exposed to the reform obtained higher education and had a higher probability of finding a job, giving the reform positive effects on education and wage.

Similarly, in Burde et al. (2013), the authors conducted a randomized control evaluation to analyze the effect intervention of access to primary school access in Afghanistan. In the government utilized funds to create a village-based construction of schools. To test the efficacy of the program, the authors conducted an RCT to understand the effect of village-based programs. The researchers used school enrollment and test scores as the indicators of the success of the program and household information was taken into account in order to control for the general

context of each different village. Additionally, the econometric model looked at the socio-demographic differences between the control (villages that were not selected for the program) and treatment groups (villages that were selected for the program). The results concluded that the program induced a significant increase in test scores and enrollment, particularly for girls. The paper later states that the higher percentage growth for girls closes the gender gap in educational enrollment as well as test scores.

Lastly, Ponce et al. (2017), examine the effect of the program “Unidades Educativas del Milenio" (Educative Units of the Millennium) created by the “Plan Decenal de Educación.” This reform opted for an increase in funding to promote the quality and the coverage of education in Ecuador. These funds allowed for the development and construction of schools across the country. To complete this study, the authors compare a panel study for each individual school through a difference-in-difference estimator comparing the control and treatment groups. This analysis concludes that there is a positive relation to the years of education and the probability of high school graduation.

V. Methodology

A. Identification Strategy

In our analysis, we attempt to determine the effect of the construction of UEMs on the individual's years of schooling and monthly wages. To accomplish this, we implemented a similar strategy conceived by Duflo for her study on the effect of building schools on education and earnings in Indonesia. Duflo (2001) found that the biggest challenge we face with this kind of study is the fact that, for the most part, government resources are allocated to regions lagging behind, which may be the case in our study as the government schools were usually built in rural areas with insufficient educational supply.

The identification strategy implemented by Duflo (2001) exploits the fact that exposure to school construction varied across individuals' regions and date of birth. In other words, she used the difference in difference (diff-in-diff) estimator, thereby presuming that the education of individuals who were young enough to benefit from the schools construction had to be higher in all regions, but particularly higher in the regions that had more schools built. She, therefore, only treated the combination of these two variations (date of birth and regions with more exposure to school construction) as exogenous.

Callaway & Sant'Anna (2021) described a different strategy: a diff-in-diff estimator with multiple time periods. We may encounter many situations where there are more than two time periods and where the different units can be treated at different points in time. In our case, we deal with all UEMs not being built at the same time and thus Cantons not being treated at the same time. Ideally, we would have to develop Dufflo's strategy towards a framework of diff in diff with multiple time periods, however because Duflo does not use actual time periods both strategies seem to be incompatible.

B. Data

In this paper we will be using a combination of 21 databases from the survey ENEMDU (Encuesta Nacional de Empleo, Desempleo y Subempleo) which is an annual survey that collects data about the employment, education, housing, etc. of individuals 5 years of age or older. The data is collected on each individual in the different households. Furthermore, the databases were taken from the Instituto Nacional de Estadística y Censos (National Statistics and Census Institute) which is Ecuador's governmental center of databases.

For the purpose of analyzing how salaries and years of education vary over time and across Cantons, we merged the databases from the years 2000 to 2021. However, for the regression model we only used the database from 2021, which contains cross sectional data. We focus on the individuals that are older than 18 and younger than 42 years old, with the aim of comparing only those who supposedly finished High School (basic education) and thus could earn a salary.

C. Empirical Model

Like Duflo, we used the combination of the variation of ages and exposure to the program across Cantons, and likewise we treated it as exogenous. To help identify the exposure to the program of each village, we constructed a dummy variable that is equal to 1 if the Canton had at least one UEM built, and equal to zero if it had non UEMs built.

Similarly, to help identify the variation of ages across the individuals, we created a dummy variable that is equal to 1 if the individual is between 18 and 30 years old in 2021, meaning they would have been young enough to benefit from the program when it started, and equal to 0 if the individual is between 30 and 42 years old, meaning they would have been too old to benefit from the program when it started.

$$Y_{it} = \alpha + \gamma T_t + \delta D_i + \beta T_t \times D_i + \varepsilon_i$$

$$D_i = 1 \text{ (} \geq 1 \text{ UEMs)}$$

$$D_i = 0 \text{ (} < 1 \text{ UEMs)}$$

$$T_t = 1 \text{ (18-30 years old in 2021)}$$

$$T_t = 0 \text{ (30-42 years old in 2021)}$$

D. Double Differences

In the following tables we perform a nonparametric analysis of the effect of the program on wages and years of education, in order to support our identification strategy. Here we used simple

averages to calculate the double difference, and we find that the UEM construction program increased 1.6% of the wage of the individuals that are young enough and live in the regions where at least one UEM was constructed (*Table 2*). Moreover, the program also decreased 0,29 years of schooling of the individuals that are young enough and live in the regions where at least one UEM was constructed (*Table 3*).

Table 2: Wages

	D=0	D=1	Difference
T=0	5.907	5.980	0.073
	(0.026)	(0.020)	(0.049)
T=1	5.433	5.522	0.089
	(0.029)	(0.021)	(0.059)
Difference	5.835	5.939	0.016
	(0.063)	(0.045)	(0.077)

Note: The sample is made of the individuals who earn a wage. Standard errors are in parentheses

Table 3: Years of schooling

	D=0	D=1	Difference
T=0	11.890	12.754	0.864
	(0.119)	(0.080)	(0.143)
T=1	12.932	13.507	0.575
	(0.065)	(0.045)	(0.079)
Difference	9.008	10.340	-0.289
	(0.136)	(0.092)	(0.164)

Note: The sample is made of the individuals who earn a wage. Standard errors are in parentheses

E. Regression tables

We can see that we get the same results as with the double differences table: a coefficient equal to 0.016 for the effect of the program on wages (*Table 4*), and a coefficient equal to -0.289 for the effect of the program on years of schooling (*Table 5*).

Table 4: Wages

	Dependent variable:		
	log_salary		
	whole sample	women	men
	(1)	(2)	(3)
Dif	0.073	0.170*	0.008
	(0.060)	(0.097)	(0.076)
Tem	-0.475***	-0.618***	-0.427***
	(0.068)	(0.117)	(0.083)
Dif:Tem	0.016	0.198	-0.059
	(0.081)	(0.138)	(0.100)
Constant	5.907***	5.788***	5.991***
	(0.051)	(0.083)	(0.064)
Observations	4,424	1,727	2,697
R^2	0.035	0.043	0.036
Adjusted R^2	0.034	0.041	0.035
Residual Std. Error	1.240 (df = 4420)	1.301 (df = 1723)	1.196 (df = 2693)
F Statistic	53.057*** (df = 3; 4420)	25.749*** (df = 3; 1723)	33.696*** (df = 3; 2693)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 5: Years of schooling

	Dependent variable:		
	schooling		
	whole sample	women	men
	(1)	(2)	(3)
Dif	0.864***	0.655***	1.129***
	(0.117)	(0.161)	(0.172)
Tem	1.041***	0.971***	1.178***
	(0.126)	(0.177)	(0.179)
Dif:Tem	-0.289*	-0.123	-0.516**
	(0.152)	(0.214)	(0.217)
Constant	11.890***	12.116***	11.605***
	(0.097)	(0.133)	(0.143)
Observations	10,995	5,651	5,344
R^2	0.020	0.019	0.024
Adjusted R^2	0.020	0.018	0.023
Residual Std. Error	3.647 (df = 10991)	3.721 (df = 5647)	3.563 (df = 5340)
F Statistic	76.403*** (df = 3; 10991)	36.466*** (df = 3; 5647)	43.208*** (df = 3; 5340)
Note:			*p<0.1; **p<0.05; ***p<0.01

F. Common Trend Assumption

Within Difference-in-Difference models, the common trend assumption relies on the idea that in the absence of treatment, the difference between the 'treatment' and 'control' group is constant over time. The common trend assumption is violated if there are omitted variables that could potentially affect the control and the treatment groups differently. As mentioned by the common trends assumption implies if treatment had not occurred, the control and treatment group would have experienced the same time trends conditional to independent variables (Lechner, 2010).

According to *Figures 4 and 5* of the annex, the common trend is followed in this study. Regions with and without UEMs both follow the same trend of average education by year and average wage

by region. Before exposure to the treatment, it can be seen that regions that were treated and regions that were not treated followed the same pattern in both cases, education and wage.

G. Correlation between error terms

When we tested for correlation between error terms for the first regression (wages), we did not find any significant correlations. However, when testing for the second regression (years of schooling), we found significant correlations between the error terms. See *Figures 5 and 6* in the annexes.

Having correlated error terms could indicate a correlation within clusters' results. This is a problem because the true variance of the sampling distribution would be underestimated and thus the precision of the coefficient would be overestimated. Not taking this correlation into account could lead us to a type I error (i.e. reject H_0 when in fact the estimate is not significantly different from zero).

To fix the problem we clustered the error terms at the Canton level, which is our study's cluster. In *Table 6,* we can see that this correlation has been taken into account, thus making standard error more robust. We can also note that our coefficient of interest has decreased from -0.29 to -0.52.

Table 6: Years of schooling

	Dependent variable:		
	schooling		
	whole sample	women	men
	(1)	(2)	(3)
Dif	1.129**	0.655	1.129**
	(0.519)	(0.542)	(0.519)
Tem	1.178***	0.971***	1.178***
	(0.216)	(0.244)	(0.216)
Dif:Tem	-0.516*	-0.123	-0.516*
	(0.302)	(0.354)	(0.302)
Constant	11.605***	12.116***	11.605***
	(0.376)	(0.380)	(0.376)
Note:		*p<0.1; **p<0.05; ***p<0.01	

VI. Empirical results

The coefficients shown in *Table 4* suggest a positive effect of the program on individuals' wages. However, none of them are statistically significant. It is, nonetheless, interesting to interpret said coefficients. First, the coefficient related to the whole sample suggests that those who benefited from the program saw an increase of 1.6% of their salary. Second, the coefficient related to the women sample suggests that the effect of the program is also positive but the one related to the men sample is negative, meaning that the program only increased the salary of the women in the sample. Moreover, the R squared value shows that only 3.5% of the variation of salaries across Cantons is explained by our model.

Table 6 displays the results obtained once we clustered error terms at the Canton level. As mentioned before, we now have larger error terms because the correlations are taken into account. On the one hand, the coefficient related to the whole sample suggests that those who benefited from the program experienced a decrease of 0.52 years of schooling, and it is statistically

significant. Furthermore, the coefficient related to the women sample suggests that the effect of the program is also negative but smaller. In other words, the women who benefited from the program saw a decrease of 0.12 years of schooling. This coefficient is however not significant. These results could imply the ineffectiveness of the program as it decreases years of schooling instead of increasing them. Nonetheless, our model is very limited and requires further work which might be the source of this contradiction. All of this will be explained in the next section.

VII. Alternative specifications and limitations

A. Limitations:

One limitation is that there may be an endogenous relationship between school availability and household characteristics. For example, the government might have placed schools (Unidades Educativas del Milenio) in areas with high demand for education or with low demand for education (Burde, 2013). Therefore, it might create a bias on the enrollment rates and the access to school. Additionally, the Unidades Educativas del Milenio (UEMs) were not constructed and put in place at the same time. The time range of the end of construction is from 2019-2020, which gives little room for a complete understanding of the effects of schooling on wages.

Furthermore, this study does not fully follow perfect compliance and therefore may contain a selection bias. This is because there are other schools within the controlled regions that are not UEMs. Imperfect compliance occurs when individuals in the treatment group don't receive the treatment and individuals in the control group do receive the treatment. This paper does not guarantee that the treatment group attended UEM school and, contrarily, that the control group just enrolled in non-UEMs schools. This paper does not separate the attendance to ordinary schools versus to UEMS in controlled regions. Further research can look into differentiating this factor and testing for heterogeneity as it is an important variable in order to fully understand the effect of the reform.

An additional source of variation other than age and region is potential grade repetition and migration. This is because, on one hand, families may decide to mobilize to another canton, a treated one, in order to receive the treatment. On the other hand, students that retook a year may have benefitted from the treatment when, by definition, they were not in the age group that qualified to receive the treatment. This limitation may be included within the constraint of the imperfect compliance.

B. Alternative specifications:

As mentioned before, because the UEM construction program lasted several years, UEMs were not all built at the same time and therefore all Cantons were not treated at the same time. Our study deals with multiple periods and groups that could not be considered in our model, because it led us to undefined coefficients in the regression table.

The diff-in-diff model proposed by Callaway & Sant'Anna (2021) takes into account these different groups and time periods and could be used in further studies, not only using a cross-sectional database but a time series.

VIII. Conclusion and policy implications

This paper contributes to the measurement of the implementation of Ecuador's educational reform, the National Development Plan of 2007-2010. This reform focused on the universalization of education by constructing and establishing 210 fully equipped schools, Unidades Educativas del Milenio (UEMs). This difference-in-difference model estimated the relationship between the reform on years of schooling and wage by comparing individuals that were exposed to school construction and benefited versus the individuals that were not exposed. On the one hand, the whole sample suggests that the individuals that benefited from the reform, experienced an increase of 1.6% of the salary. However, none of the coefficients regarding an individual's wages are statistically significant, making it difficult to concretely establish a relationship between the reform and wages. On the contrary, the coefficient related to the whole sample shows a negative effect of the reform in the years of schooling. Therefore, demonstrating that the policy had a negative

relationship on education since the coefficient is statistically significant. However, this model has a R squared value of only 3.5% meaning that only a small percentage of the variation in wages is explained by the model.

Some recommendations are for further research to look into analyzing the quality of the program. This could be estimated by considering the student-teacher ratio as well as the effect of the reform on the literacy rate. Additionally, the R squared may be improved by controlling for more variables.

Analyzing the effects of the reform are important as they may better inform policymakers on actions to take when creating policies to improve education attainment and the development of human capital. It is also crucial to measure the quantity and the quality of the intervention as it can give important details on the effect of the program.

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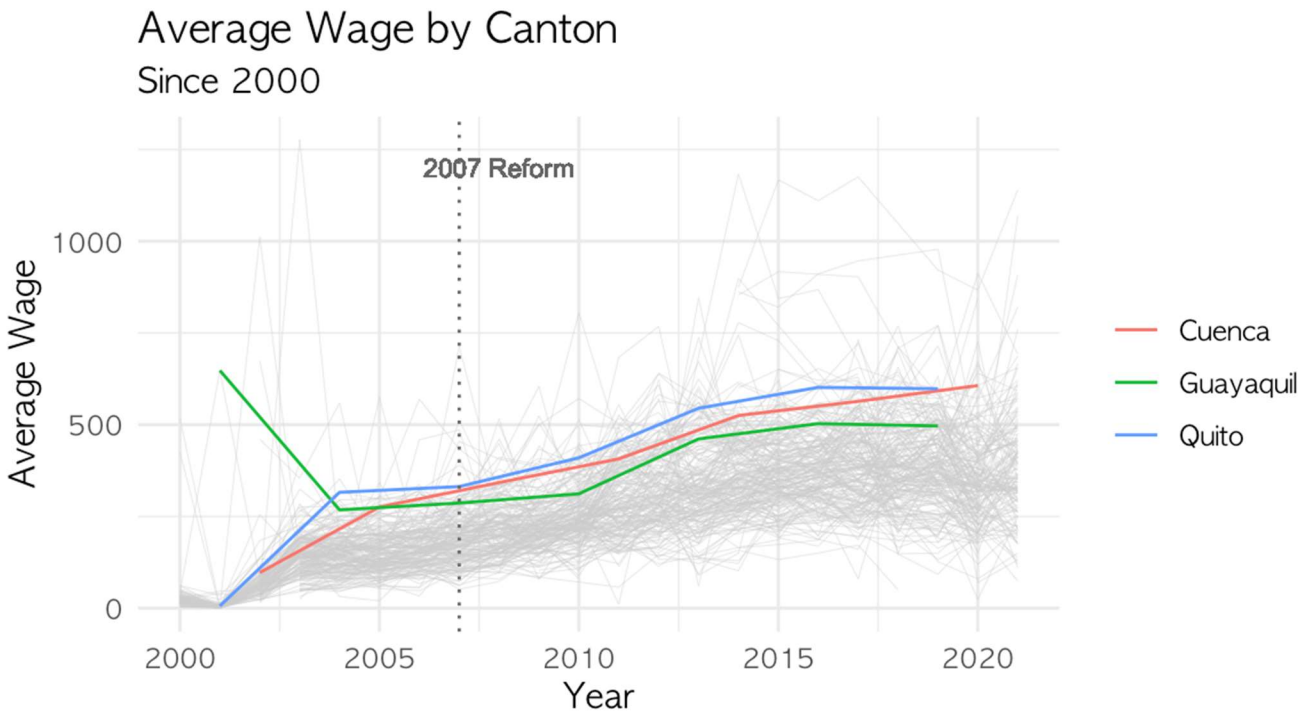
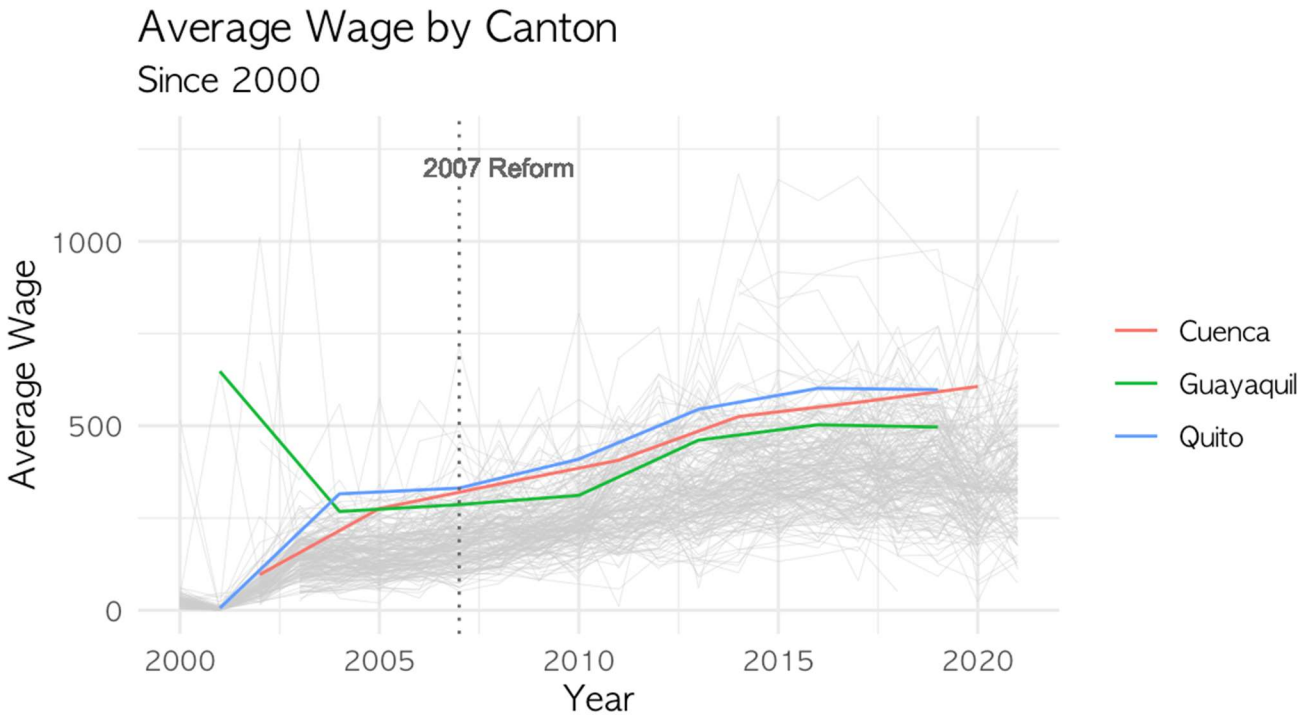
X. Annexes

Figure 1: Average Wage by Canton



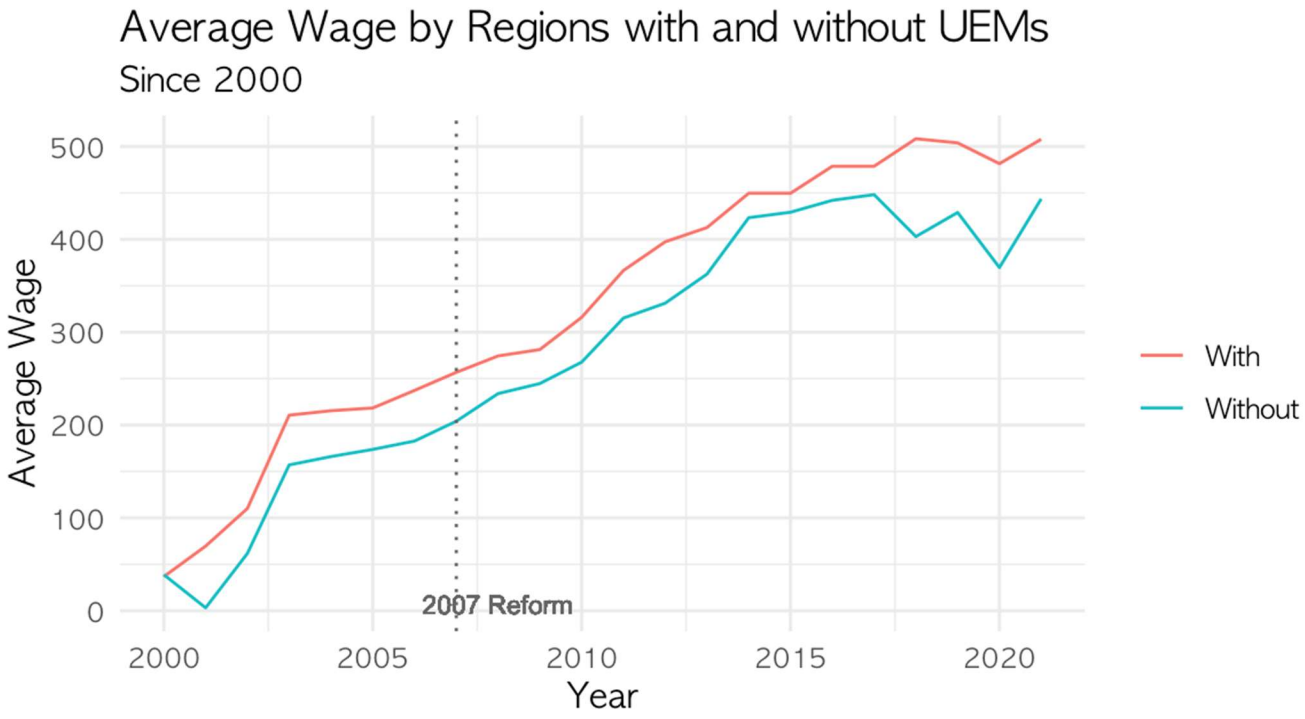
Data source: Encuesta de Empleo, Desempleo y Subempleo ENEMDU (2000-2021)

Figure 2: Average wage by Canton



Data source: Encuesta de Empleo, Desempleo y Subempleo ENEMDU (2000-2021)

Figure 3: Average wage by regions (Separated by regions with and without Unidades Educativas del Milenio)



Data source: Encuesta de Empleo, Desempleo y Subempleo ENEMDU (2000-2021)

Figure 4: Average years of education by regions (Separated by regions with and without Unidades Educativas del Milenio)

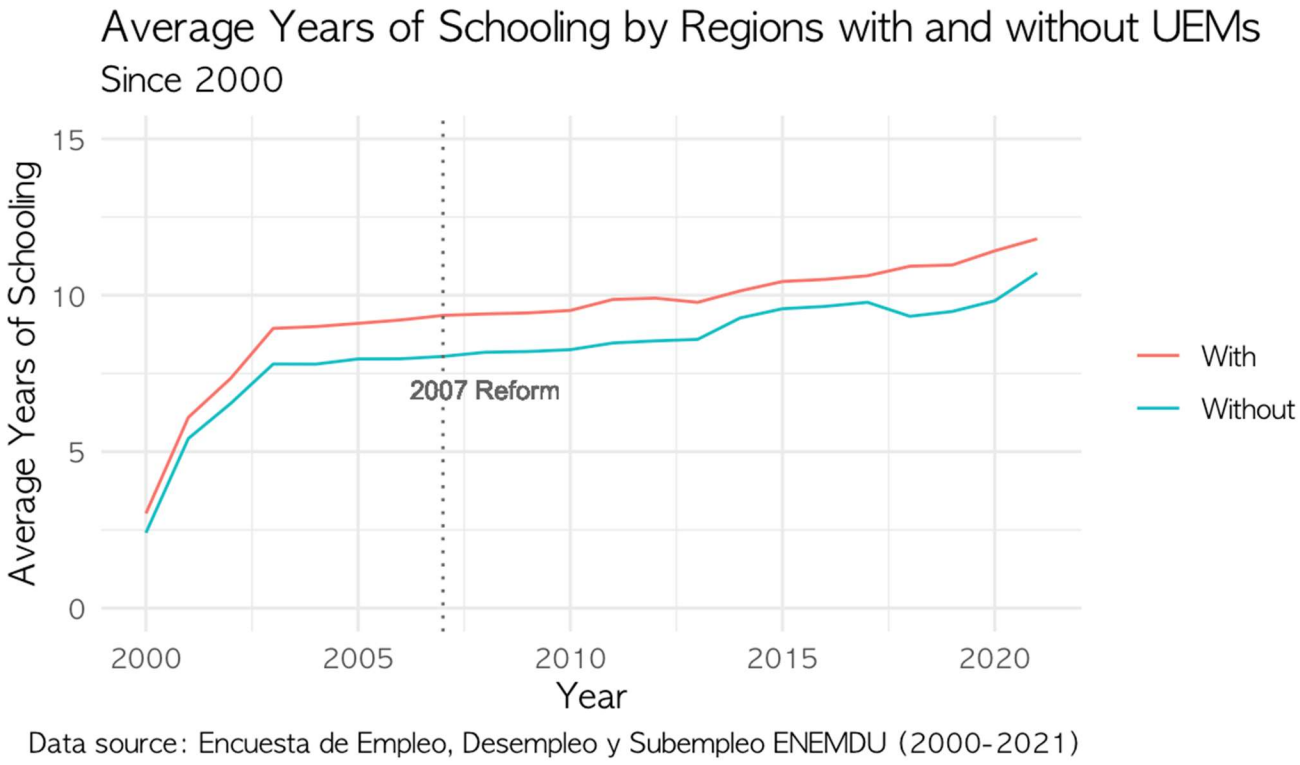
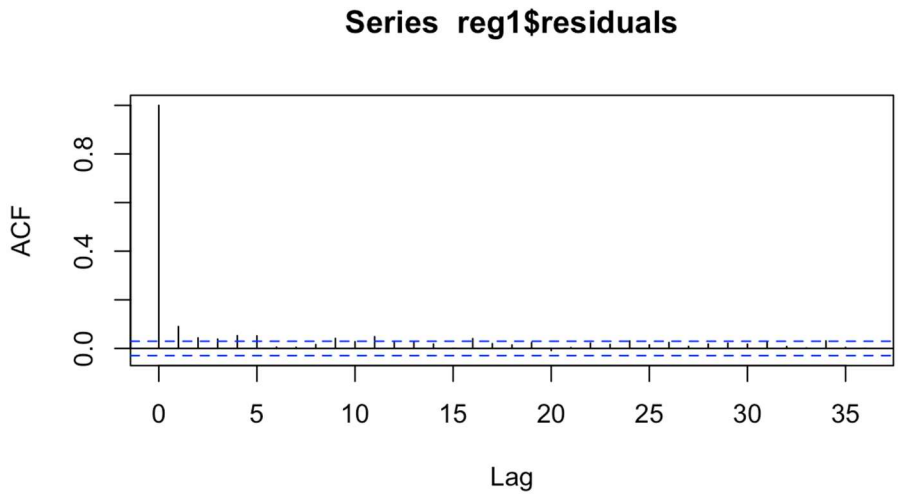
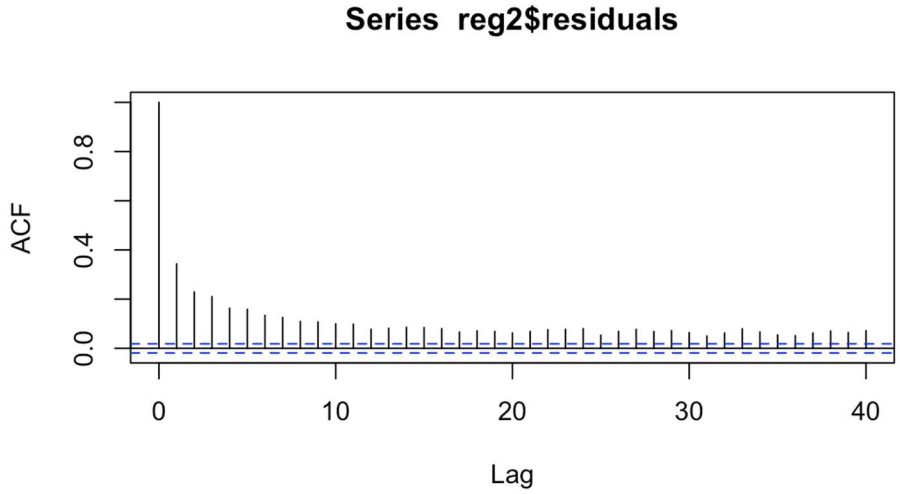


Figure 5: Autocorrelation of residuals - Wages regression



Note: in absence of autocorrelation the vertical bars drop to zero or in between the dashed blue lines which represent the significant level.

Figure 6: Autocorrelation of Residuals - Years of schooling regression



Note: In the presence of autocorrelation, the vertical bars do not drop to zero nor in between the dashed blue lines, which represent the significant level.