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Effect of Public Investment in Education on Economic Growth: A
Case Study on the program “Ser Pilo Paga” in Colombia

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Abstrakt

Diese Arbeit untersucht den Einfluss öffentlicher Investitionen in die Hochschulbildung auf das Wirtschaftswachstum. Das Programm "Ser Pilo Paga" wurde von 2015 bis 2018 in Kolumbien durchgeführt und ermöglichte leistungsstarken Studierenden aus einkommensschwachen Familien den Besuch von Qualitätsuniversitäten. Es dient daher in dieser Arbeit als natürliches Experiment. Die Ergebnisse zeigen, dass das kolumbianische BIP pro Kopf fünf Jahre nach Einführung des Programms um bis zu 4.2 % stärker wuchs als in einem "synthetischen Kolumbien" ohne vergleichbares Programm.

Abstract

This thesis investigates the effect of public investment in tertiary education on economic growth. "Ser Pilo Paga" was a program implemented in Colombia from 2015 to 2018, it helped students with remarkable scores, and who came from low-income families to attend high-quality universities. Thus, this program is used in this thesis as a natural experiment. It is found that five years after the implementation of this program, Colombian GDP per capita grew up until 4.2% more than the one of a "Synthetic Colombia" without a comparable program.

I. Introduction

Nowadays, education is considered worldwide as a basic need such as food, health, and shelter. The United Nations in the article 26 of the Universal Declaration of Human Rights recognizes education as a human right, affirming that “everyone has the right to education” (United Nations, 2025b). Similarly, the fourth United Nations Sustainable Development Goal calls for “inclusive and equitable quality education and lifelong learning opportunities for all” (United Nations, 2025a). This makes a lot of sense considering that in our modern economies, education is as a prerequisite for accessing employment, participating in civic life, and achieving overall well-being.

Moreover, education is vital for economic development. By providing individuals with specialized knowledge, skills, and the capacity to adapt to technological changes, education increases human capital formation. Considering modern economic growth theories, human capital formation boosts economic growth by increasing individual productivity, generating knowledge and positive externalities; by enabling innovation and technological progress through the creation of ideas; and by enhancing the effective labor input to raise output per capita (Barro, 1991; Lucas, 1988; Romer, 1986). “Education has demonstrated a positive correlation with economic development and GDP per capita in most Balkan countries” (Eri., 2018; as cited in Kovaci et al, 2025, p. 4).

Therefore, education has a direct impact not only on individuals, but also on the society. As the World Bank emphasizes, “Education is a human right, a powerful driver of development, and one of the strongest instruments for reducing poverty and improving health, gender equality, peace, and stability” (2025a). “Investments in education, viewed as public expenditures, play a vital role in enhancing various aspects of society. They contribute to improving living standards, boosting social welfare, increasing productivity, raising wages, and driving

economic growth” (Ciucu and Dragoescu, 2014; Fekri-Ziber et al., 2022, as cited in Kovaci et al, 2025, p. 1).

Although the importance of education and its positive effects on economic growth and social development are widely recognized, access to education remains limited in many countries. While nearly all nations provide primary education, ensuring that children acquire basic literacy and numerical skills, access to secondary education is more limited, particularly in low-income countries. Tertiary education, which offers specialized knowledge, innovation, and research capacity, is often concentrated in high-income countries and urban areas.

This limited access to education not only hinders individual potential but also constrains national economic growth. To have a clearer idea of this limited access, it is worth noting that as per the UNESCO, global completion rates in 2021 were 87% for primary education, 77% for lower secondary education, and 59% for upper secondary education (2023); tertiary education global enrollment rate was 43% in 2023 (2025). All these rates with significant regional disparities, for example, Sub-Saharan Africa registers only 64% for primary, 45% for lower secondary, 27% for upper secondary, and 9% for tertiary education (UNESCO, 2023/2025). Similarly, Cohen & Soto (2007) reported the years of schooling in high-income vs low-income countries¹ which makes evident the big unevenness between these two groups (see table 1).

Table 1. Years of schooling in high-income vs in low-income countries

	1960	1970	1980	1990	2000
High income	8.7	9.8	10.9	11.6	12.1
All poor countries	2.1	2.9	3.7	4.8	5.7

Source: Cohen & Soto (2007, p. 13)

¹ Colombia is included in the low-income countries' group or "All poor countries" group.

Considering the completion and enrollment rates previously presented, it is noticeable that access to tertiary education is the most limited one, yet it is the one that provides individuals with the specialized knowledge and advanced skills necessary for higher-quality and better-paying employment opportunities. Having a degree increases the probability of getting a job (Bornacelly, 2013, as cited in Zapana, 2021). It is important to highlight that in Colombia to get a formal job without tertiary education is quite difficult, and in the best-case scenario people without tertiary education will be paid the minimum legal wage which, in some countries such as in Colombia, is hardly enough to have a decent life.

Access to tertiary education varies widely depending on the structure and financing of national educational systems. Two extremes can be distinguished between countries, one mostly publicly funded in which it is tuition-free based, and public universities have enough capacity and quality for providing students with proper education; and another one mostly privately funded in which tuition fees are very expensive and in which private universities are the main source of high-quality education. Despite that most countries have hybrid systems, one can almost always tell which is the predominant system in a country. Here, it is crucial to mention that quality must be high to it to be fruitful for individuals to invest time, money, and effort in pursuing tertiary education. For example, one can say that Austria is a country which relies mainly in public funded tertiary education; the USA is a country which relies mainly in private tertiary education, where even the public universities do not offer cheap tuition fees; and Colombia has an interesting mix because although public education has high quality and cheap tuition fees, the number of accepted students is very limited due to insufficient capacity, hence the private sector, whose tuition fees are very expensive², plays a dominant role in terms of the number of high quality universities and the number of students.

² For example, by the end of 2025 one semester's price for a bachelor's semester in Economics in a high-quality private university (Javeriana University) is \$12,473,000COP, in total you need to attend at least 8 semesters to

It is worth noting that “there is evidence that prices matter, particularly those relating to health care and education.” (Attanasio et al., 2017, p. 245), consequently, the fact that tuition fees are very expensive implies that education is not accessible for everyone but only for those with a high-income, and that capital formation is being far away from its potential. There is “evidence showing that students from low socioeconomic status (SES) backgrounds are less likely to attend and graduate from college, especially from high-quality universities” (Bailey and Dynarski, 2011; Chetty et al., 2020; Hoxby and Avery, 2013; Pallais and Turner, 2006, as cited in Alvares et al., 2025, p. 1). Therefore, it is notorious that in countries where private education is mainly privately funded, programs focused on augmenting the access to tertiary education for individuals from low-income families are needed.

In response to this need, in Colombia from 2015 to 2018, the government implemented a Program called “Ser Pilo Paga” (SPP), which can be translated as “Being smart pays off”. This program provided scholarships to students from low-income families who had gotten a high score in the national post high school exam “SABER 11”, thus increasing tertiary education enrollment of individuals from low-income families. It worked as a loan which was forgiven if the student got the bachelors’ diploma. Hence, the observation for this thesis is that during the period 2015-2018 the SPP program took place in Colombia benefiting 40,000 students in total. The estimated public expenditure per student was 78,405,492 COP (Alvares et al., 2025, p. 39).

Considering the already exposed importance of human capital formation in the economic growth of countries, it is expected that this program had a positive impact on Colombian economic growth. Currently, there are studies regarding the impact of this program on the micro level, especially on the benefited individuals’ lives. There are also some other studies gauging the effects on the macro level regarding the impact of this program on some Colombian

get the diploma. (Pontificia Universidad Javeriana, 2025). This semester’s price corresponds to 8.8 times the minimum monthly Colombian wage.

education indexes. However, there is a gap concerning the causal impact of this program on Colombian economic development on the macro level. It is crucial to evaluate its macroeconomic effects to assess similar policies, and to analyze the appropriateness of future ones.

Therefore, the research question of this thesis is “What was the impact of the program “Ser Pilo Paga” on Colombian economic growth?”. To answer this question, the difference-in-difference method is used considering the SPP program as a natural experiment, and a synthetic control group (a “Synthetic Colombia”) is constructed to estimate the effect of the SPP program on the economic growth. The used regression model for economic growth is based on modern economic growth theories which include human capital as a key independent variable. The data used in this thesis corresponds to administrative data from Colombian and international databases.

To answer the research question, this thesis is divided into seven fragments. The first one is the introduction. The second section is the historical background in which detailed information about education in Colombia, and the characteristics of the SPP program are exposed. The third part corresponds to the data being used in this thesis and its descriptive statistics. The fourth fragment describes the applied model and method. The fifth part shows the results. The sixth section presents a brief comparison of the effects of similar programs in Peru and Chile. The last segment gives a general conclusion.

II. Historical background

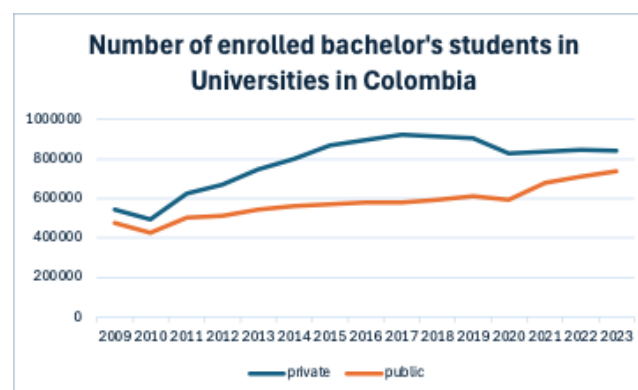
1. Primary, secondary, and tertiary education in Colombia

In Colombia’s constitution, education is recognized as a right, and it is defined by its Ministry of Education as “a process of lifelong, personal, cultural, and social development based on a comprehensive understanding of the human person, their dignity, their rights, and

their responsibilities” (MEN, 2024c). What is more, it is mandatory for Colombian children to attend to preschool education at least for one year, to primary education for five years, and to lower-secondary education for four years. After this mandatory period, students can decide whether they will complete secondary education by attending two additional years, and then whether they will pursue tertiary education which lasts approximately five years in the case of bachelor’s degrees which are the focus of this thesis (MEN, 2024a). Tertiary education covers undergraduate programs (professional technical, technological and professional programs) and postgraduate programs (specialization, master’s and doctorate programs) (MEN, 2024b).

Regarding the participation of the public vs the private institutions in the different levels of education, as per the data from the Colombian Ministry of Education, for primary and secondary education approximately 80% of total students go to a public institution (MEN, 2025); and for tertiary education only approximately 40% of total students go to a public institution (SNIES, 2025). Therefore, the private sector is the main supplier of tertiary education (see graph 1).

Graph 1. Number of enrolled bachelor’s students in private vs public universities in Colombia (2009-2023).

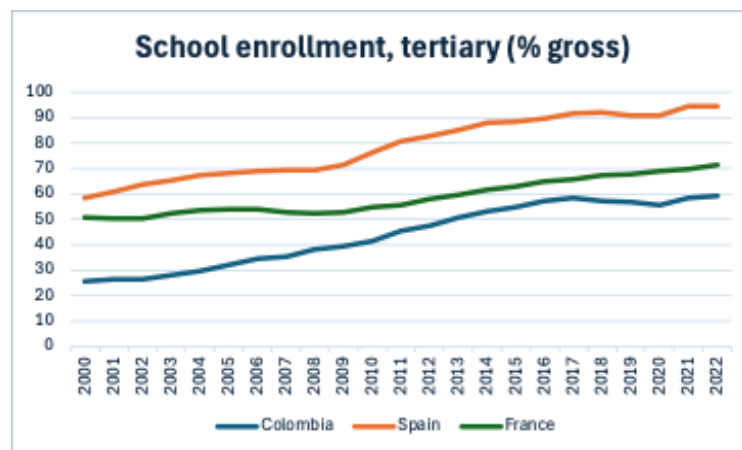


Source: graph constructed by the author with data from SNIES (2025).

Comparing average years of schooling of Colombia (9 years) with the ones of Austria (12 years) which has a mainly public funded educational system, it is evidenced that on average, Colombian individuals are under-educated (World Economics, 2025). Additionally, using France and Spain as comparable countries in terms of population size but with a mainly public funded educational system, it is shown in graph 2 that Colombia has a lower enrollment rate in tertiary education.

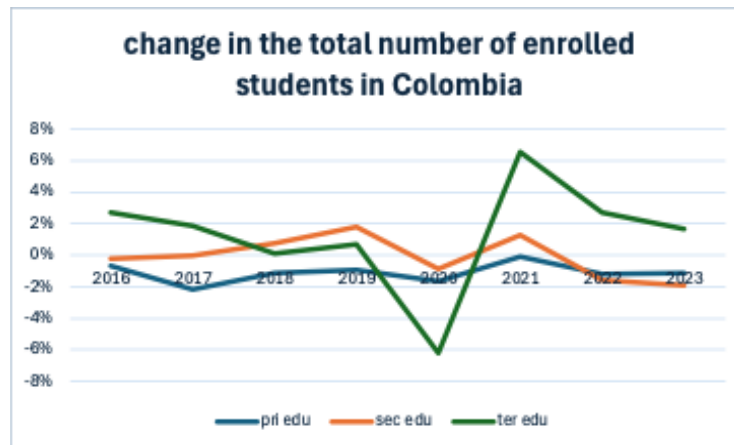
It is important to mention that as shown in graph 3, in the last years there have not been significant changes in the number of enrolled students in primary and secondary education in Colombia; in the case of tertiary education, it has been more volatile, showing a sharp decline in 2020 because of the COVID-19 pandemic, but in general it has presented a slightly growing trend, the change from 2010 to 2023 was approximately 3.4% .

Graph 2. School enrollment, tertiary (% gross) of Colombia, France, and Spain (2000-2022).



Source: graph constructed by the author with data from the World Bank (2025g).

Graph 3. Change in the total number of enrolled students in Colombia (2016-2023).



Source: graph constructed by the author with data from the MEN (2024c) and SNIES (2025).

It is worth noting that only students with a complete secondary education can pursue tertiary education. Additionally, students should present the “SABER 11” test which is the Colombian official post high school test and whose results are used as a key determinant for universities’ decision whether to accept or not a student. This is especially important for public high-quality universities as the demand usually is higher than the offered places.

In this way, a central fact to accentuate is that students from private secondary institutions get higher scores in this test than students from public ones. In 2024 for example, on average students from private institutions got 290/500, and students from public ones got 252/500 (ICFES, 2025). Consequently, it is easier for students from private institutions, who usually come from high-income families, to get accepted in the public universities. This fact combined with the reality that for individuals from low-income families it is almost impossible to pay a private university’s tuition fee, results in a very low probability for individuals from low-income families to attend tertiary education. This is of great importance when we consider that

most Colombians belong to low-income socioeconomic levels, for example by 2021, 53% of Colombian individuals belonged to low-income families³ (La Republica, 2022).

Regarding quality of universities, it is key to highlight that in Colombia there is an official high-quality accreditation which is used as a signal of prestige. By the year 2023, 72 universities had this high-quality accreditation, from those only 25 (34.7%) were public ones (MEN, 2023). This confirms the fact that the private sector is dominant in the tertiary education of Colombia not only in the number of enrolled students but also in terms of quality.

2. The “Ser Pilo Paga” (SPP) Program

Ser Pilo Paga was a public program launched in Colombia in October 2014 by the Ministry of Education to promote access to tertiary education (bachelor’s programs) for talented but economically disadvantaged students. The program covered full tuition and a modest stipend for living expenses for students who achieved high scores on the official secondary education test “SABER 11” and came from low-income families, allowing them to attend high-quality accredited universities, including private ones. Its main goal was to increase educational equity and social mobility by rewarding academic excellence from the lowest socioeconomic backgrounds. It is essential to note that the university chosen by the individual needed to be one with high-quality accreditation, hence, ensuring that benefited individuals had access to prestigious universities. It worked as a loan which was fully condoned if the individual got the bachelor’s diploma. It is key to underline that although the program was announced in 2014, the first benefited group began to study in 2015.

To be eligible, for example, for the first benefited group, individuals “had to score at least 310 out of 500 in the August 2014 SABER 11 exam, placing their score in the top 9.5%”

³ In Colombia, socioeconomic levels are divided into six statuses (SES), being 1 the lowest one, and 6 the highest one. By 2021, the population had the following distribution: 21% corresponded to SES 1, 32% to SES 2, 29% to SES 3, 11% to SES 4, and 7% to SES 5 and 6 (La Republica, 2022).

(Alvarez et al, 2025, p. 7). Additionally, individuals should come from low-income families, this was based on the official SISBEN⁴ index. A final prerequisite was that the individual was already admitted in a high-quality accredited university.

Considering that this program is being used in this thesis as a natural experiment, it is vital to emphasize that individuals could not anticipate this program existence, thereafter, its announcement was not expected. It was announced “nearly two months after students had taken the SABER 11 exam” (Alvarez et al, 2025, p. 8). Another significant fact to be highlighted is that in Colombia, this was the first large-scale program with a comparable financial aid. Before SPP, there were smaller or more fragmented programs, but none with a comparable scale, national reach, or financial scope. “Before SPP, financial aid was scarce, and private markets struggled to support college attendance for low-SES students—especially at high quality institutions—even among high achievers” (Alvares et al., 2025, p. 4).

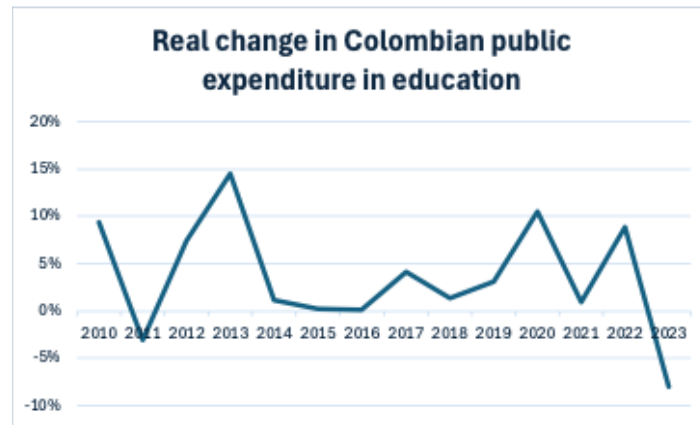
It is important to underscore that the program’s funding came from the same sources that came the previous tertiary education budgets, thus tertiary education’s public resources were redirected instead of new proportional resources being assigned because of this program (see graph 4).

By the end of 2018 it was announced by the Ministry of Education that the SPP program would not continue. From 2015 to 2018 SPP benefited 40,000 students in total (Londono et al, 2019, p. 39). SPP was replaced by the “Generación E” program, a broader program designed to maintain merit-based scholarships while strengthening support for public universities. While Ser Pilo Paga focused on awarding scholarships to high-performing, low-income students,

⁴ SISBEN is the official Colombian system that classifies the population by socio-economic status to identify potential beneficiaries of social assistance programs.

many of whom attended private universities, “Generación E” broadened access by supporting more low-income students in public universities and strengthening those institutions.

Graph 4. Change in Colombian public expenditure in education (2010-2023).



Source: graph constructed by the author with data from Minsiterio de hacienda (2025) and DANE (2025).

Regarding the economic impacts of this program, currently there are some studies that evaluate the effect of the SPP program on the micro level, especially on the effects of the benefited individuals' lives. From them, it is worth underlying that the probability for individuals from low-income families of attending a high-quality university “increased by more than 47 p.p. or over 1000%.” (Alvarez et al., 2025, p. 2).

This probability's increase did not affect negatively non-benefited individuals, but one can say that it even indirectly helped them since “immediate enrollment also rose for aid-ineligible students, and particularly low-income students just below the test score cutoff” (Londono et al. 2020, p. 225). Considering that benefited individuals chose private universities, and that they were individuals with good test scores, some places in public universities and institutions were freed up, and thereafter, available for students with lower test scores. Therefore, overall tertiary education enrollment was augmented because of the SPP program. Thus, “The overall enrollment effect is an increase of 9.6 p.p., or 12.4%” (Alvarez et al., 2025, p. 11).

Additionally, SPP raised the likelihood of getting a degree from a high-quality university by 32.3 percentage points which corresponds to a 333% increase as only 9.7% of the individuals from the control group go to high-quality universities (Alvarez et al, 2023, p. 20).

Concerning their professional lives, it is important to highlight that eligible students are much more likely to be employed in the Colombian formal market (Alvarez et al, 2023, p. 27) which guarantees quantitative and qualitative benefits that in the informal market people cannot have access to. In line with this, “eight years after high school the labor income of young SPP beneficiaries increased between 26% and 36%” (Alvarez et al., 2023, p. 6). In general, it has been stated that “SPP was a highly profitable program for the country, where each dollar invested generated a return of 4.8 dollars” (Alvarez et al., 2023, p. 3), which is “higher than those obtained in studies of other financial aid programs for university students around the world” (Hendren y Sprung-Keyser, 2020; y Angrist et al., 2021, as cited in Alvarez et al., 2025, p. 42).

III. Data and descriptive statistics

Administrative data from national and international sources was used in this thesis. The following national Colombian sources were used for getting the background details: “Ministerio de Educación Nacional” (MEN) which is the Colombian Ministry of Education official website (primary, secondary, and tertiary education-related details were gotten from it) ; “SNIES” which is the National Higher Education Information System of Colombia; “Ministerio de Hacienda” which is the Colombian Treasury Ministry website (the specifics budgets for education were gotten from it); “ICFES” which is the Colombian Institute for the Evaluation of Education (scores of the official post high school test were acquired from it).

To construct the synthetic control group, data from nine Latin American countries, considered as untreated ones (as they have not had a comparable policy) was used.

Contemplating as Latin American Countries Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela; it is essential to underscore that Cuba and Venezuela were not considered in this study due to lack of complete and reliable data. Additionally, the following countries were not considered as well because they are considered as treated countries: Peru which has been implementing the program “Beca 18” since 2012; Chile which has been implementing the “Gratuidad” program since 2016; Brazil which has been implementing the “Prouni” scholarships since 2005; Ecuador which has been implementing the “Eloy Alfaro” scholarships since 2017; Paraguay which has been implementing the “ITAIPU” scholarships since 2011; and, Uruguay and Argentina which have a combination of free tuition fees and no entry barriers policies for public universities. In this way, the remaining countries that were viable to be used for the donor pool are the following ones: Bolivia, Costa Rica, Dominican Republic, Guatemala, Honduras, Mexico, Nicaragua, Panama, and El Salvador.

This thesis’ model is composed of nine variables, the dependent variable, and eight independent ones. Considering that in Colombia and Latin American countries, it takes approximately five years to get a bachelor’s diploma, the tertiary education related variable used for time t corresponds to $t-5$, the same applies for the proxy variable for the SPP program which is “policy”. Thus, data being used for all the other variables corresponds to the period from 2015 to 2022, and for the education and policy variables corresponds to the period from 2010 to 2017. It is worth underscoring that all the variables are in terms of proportional changes from one year to the following one.

- Economic growth (y), which is the dependent variable, whose proxy in this thesis is “GDP per capita growth”, was acquired from the World Bank database. It measures “the total income earned through the production of goods and services in an economic

territory during an accounting period.” (World Bank, 2025b). “The core indicator has been divided by the general population to achieve a per capita estimate. This indicator denotes the percentage change over each previous year of the constant price (base year 2015) series in United States dollars.” (World Bank, 2025b). This variable was divided by 100 to get the proportional change.

- Capital available in the economy (cap), whose proxy in this thesis is “Gross capital formation (% of GDP)”, was gotten from the World Bank database. This variable “includes acquisitions less disposals of produced assets for purposes of fixed capital formation, inventories or valuables. This indicator is expressed as a percentage of Gross Domestic Product (GDP)” (World Bank, 2025c). This variable was transformed into proportional changes.
- Productivity of the economy (tfp), whose proxy in this thesis is “Total Factor Productivity” (TFP), was attained from the Penn World Table version 11.0. This variable measures TFP at constant national prices (2021=1). It is a measure of how efficiently an economy uses its inputs of labor and capital to produce goods and services (Groningen Growth and Development Centre, 2025). This variable was transformed into proportional changes.
- International trade openness (trad), whose proxy in this thesis is “Trade (% of GDP)” was acquired from the World Bank database. This variable “is the sum of exports and imports of goods and services. This indicator is expressed as a percentage of Gross Domestic Product (GDP)” (World Bank, 2025h). This variable was transformed into proportional changes.
- Savings (sav), whose proxy in this thesis is “Gross savings (% of GDP)” was extracted from the World Bank database. This indicator is "calculated as gross national income less total consumption, plus net transfers. This indicator is expressed as a percentage of

Gross Domestic Product (GDP)” (World bank, 2025d). This variable was transformed into proportional changes.

- Inflation (infl), whose proxy in this thesis is “Inflation, consumer prices (annual %)” was obtained from the World Bank database. It “reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services” (World bank, 2025e). This variable was divided by 100 to get the proportional change.
- Unemployment (unem), whose proxy in this thesis is “Unemployment, total (% of total labor force) (modeled ILO estimate)” was taken from the World Bank database. It “refers to the share of the labor force that is without work but available for and seeking employment” (World Bank, 2025i). This variable was transformed into proportional changes.
- Human capital (tere), whose proxy in this thesis is “Net attendance rate for higher education”, was gotten from the SITEAL – UNESCO database. It corresponds to the percentage of students in the age group supposedly corresponding to higher education who are enrolled in higher education (SITEAL- UNESCO, 2025). This variable was transformed into proportional changes.
- SPP program, whose proxy in this thesis is “policy”, is a dummy variable which is only equal to 1 for Colombia five years after the SPP program began benefiting individuals (for 2020, 2021, and 2022) considering its lagged effect.

The sample consists of ten countries (including Colombia) for eight years (from 2015 to 2022). Table 2 presents the descriptive statistics, from it, it is important to mention that on average, countries have an economic growth of 1.8%, they had an inflation rate of 3.4%, an unemployment proportional change of 4.6%, and a tertiary education proportional change of 1.5%. The proportional changes in their TFP, capital formation, savings, and trade were modest.

It is worthy clarifying that the maximum levels of unemployment correspond to the year 2020 due to the COVID-19 pandemic.

Table 3 shows the correlation matrix. The results indicate a strong positive correlation between proportional changes of TFP and capital formation with GDP per capital growth, and a strong negative correlation between proportional changes of unemployment and GDP per capita growth. It is also important to highlight that tertiary education proportional changes are negatively correlated with inflation and unemployment proportional changes, its strongest positive correlations are with trading proportional changes and GDP per capita growth.

Table 2. Descriptive Statistics

Statistic	Mean	St. Dev.	Min	Max	N
y	0.018	0.053	-0.189	0.151	80
tfp	-0.004	0.033	-0.139	0.104	80
cap	0.007	0.114	-0.371	0.357	80
infl	0.034	0.025	-0.016	0.105	80
sav	0.015	0.101	-0.316	0.337	80
trad	0.012	0.104	-0.203	0.297	80
unem	0.046	0.294	-0.356	1.344	80
tere5	0.015	0.051	-0.205	0.185	80

Source: table constructed by the author with sample data

Table 3. Correlation Matrix

	y	tfp	cap	infl	sav	trad	unem	tere5
y	1	0.726	0.745	0.216	0.201	0.642	-0.701	0.166
tfp	0.726	1	0.703	0.181	0.139	0.503	-0.531	0.006
cap	0.745	0.703	1	0.153	0.308	0.577	-0.552	0.116
infl	0.216	0.181	0.153	1	-0.172	0.358	-0.276	-0.135
sav	0.201	0.139	0.308	-0.172	1	0.026	-0.249	0.060
trad	0.642	0.503	0.577	0.358	0.026	1	-0.587	0.192
unem	-0.701	-0.531	-0.552	-0.276	-0.249	-0.587	1	-0.145
tere5	0.166	0.006	0.116	-0.135	0.060	0.192	-0.145	1

Source: table constructed by the author with sample data

IV. The model and method

1. Economic growth model.

Neoclassical theories of economic growth, like the Solow model, are based on the idea that long-run economic growth is exogenous-driven, meaning that technological progress (which is the main driver of sustained growth in these theories) is determined outside the model and not explained by the behavior of economic agents (Lucas, 1988). In contrast, modern theories, such as the ones developed by Romer (1986) and Lucas (1988), make technological progress and knowledge accumulation endogenous outcomes of the model, hence growth arises from decisions made within the economy itself. These theories emphasize mechanisms such as human capital accumulation, innovation, knowledge spillovers, and research and development (R&D) as endogenous drivers of sustained growth. Therefore, while neoclassical models highlight convergence and exogenous innovation, modern theories focus on persistent differences across countries arising from policy, institutions, and incentives that affect innovation and learning. Consequently, in modern theories of economic growth it is found the suggestion that “it is growth in ideas - not merely in capital – that drives the system” (Lucas, 1998, p. 68).

In this way, “based on the Lucas' model of endogenous growth (1988), education is a key factor in developing human capital, driving social progress and sustainable economic development; similarly, investments in education are vital for the economic growth of every country” (Patel and Annapoorna, 2019, as cited in Kovaci et al, 2025, p. 5). More specifically, “higher tertiary education enrollment rates consistently enhance a country's economic activities and positively impact growth” (Marquez-Ramos & Mourelle, 2019; as cited in Kovaci et al, 2025, p. 4). Additionally, Barro states that “increases in the quantity of human capital per person tend to lead to higher rates of investment in human and physical capital, and hence, to higher per capita growth” (1991, p. 2).

Nevertheless, it is important to mention that some literature about the importance of primary education states that it is better to invest in the first years of education instead of in tertiary education; public spending on early childhood education is essential and more cost-effective than later investments; early interventions greatly shape children's development and future academic paths, offering higher returns and a stronger impact than programs introduced during adolescence or adulthood (Carneiro & Heckman 2003; Cunha et al., 2006; Shonkoff and Phillips, 2000; as cited in Kovaci et al, 2025, p. 4). "The available evidence suggests that for many skills and abilities, later remediation for early disadvantage to achieve a given level of adult performance may be possible but is much more costly than early remediation" (Cunha & Heckman, 2007, p. 34).

This point of view can be argued in the case of Colombia, since even if children are well educated, considering the pre-experiment reality regarding access to third education, people from low-income families would still have very limited access to high quality third education. What is more, Bernal & Penney, found that after the introduction of the SPP program, students who come from low-income families, and thereby qualify regarding the socioeconomic threshold, put more effort in preparing for the post high school official test "SABER 11", which resulted in the fact that "students who qualify for the scholarship score about 0.09 test score standard deviations higher than those who do not" (2019, p. 121), and "the program increased the representation of the poorest students in the top 9% of test takers" (2019, 121). This demonstrates that third education focused programs have positive spillovers in secondary education in Colombia, this taking into account that in Colombia the third education is the one with more limited access.

There are other statements that argue that education is not enough or not suitable for some groups of people "because those individuals who are at the margin of attending are also the ones who have the lowest treatment effect; their abilities are relatively better suited to the

noncollege market and they are likely to choose majors with low premiums” (Arcidiacono, 2005, p. 1479). Nonetheless, the existing studies about the SPP program which are focused on the impact of this program on the individuals’ lives have demonstrated that SPP has had in fact a remarkable effect on their professional lives.

Considering the previous exposed ideas, in this thesis, a model based on the modern theories of economic growth is used. Thus, human capital is included in the regression model of this thesis as tertiary education enrollment, and as the policy impacting the access to third education (which is the focus of this thesis). Regarding productivity, the Total Factor Productivity (tfp) variable accounts for it, and concerning capital, the capital formation (cap) variable is its proxy. Additionally, some other relevant variables that gauge the stability, openness and prosperity of the economy are included as well (inflation, savings, trading, and unemployment).

Considering g_{xit} is the proportional change from one year to the next one as follows,

$$g_{xit} = \frac{x_{it} - x_{i,t-1}}{x_{i,t-1}}$$

the regression model of this thesis is expressed as:

$$\begin{aligned} g_{yit} = & \beta_0 + \beta_1 g_{tfpit} + \beta_2 g_{capit} + \beta_3 g_{inflit} + \beta_4 g_{savit} + \beta_5 g_{tradit} \\ & + \beta_6 g_{unemit} + \beta_7 g_{tere^{i,t-5}} + \beta_8 policy_{i,t-5} + \gamma_t + \varepsilon_{it} \end{aligned}$$

Where β_0 is the constant term, coefficients from β_1 to β_7 measure the impact of one unit change in the growth rate of each independent variable on the GDP per capita growth (y), β_8 captures the difference in growth between the treated unit that

implemented the policy five years earlier and those that did not, γ_t are the year fixed effects (from 2016 to 2022), and ε_{it} is the error term.

It is worth mentioning that the decision to use lagged variables for the tertiary education and policy variables was taken after gauging the effect of their corresponding variables at time: 0, -1, -2, -3, and -4, and showing no significant effect on economic growth. This was expected, as in Latin America the average time to get a bachelor's diploma is five years. Hence, the human capital increase is properly put into the labor market after five years of enrollment in a bachelor's degree.

2. The applied method

For gauging the effect of the SPP program in Colombia, a difference-in-difference method is used. This method is considered as quite appropriate in this investigation because it leverages the quasi-random variation provided by the natural experiment exposed in this thesis to estimate causal effects. By comparing the changes in the outcome variable over time between a treatment unit (exposed to the policy) and a control group (unaffected by the policy), DiD controls for time-invariant differences between groups, and for common shocks that affect all units such as the COVID-19 pandemic in 2020. This approach is particularly suitable in the context of this thesis where the policy intervention impacts only Colombia, and the outcomes of interest are measured both before and after the intervention across countries. Assuming that parallel trends assumption holds, DiD provides a robust estimate of the policy's effect while mitigating potential noisy factors.

Regarding the control group, the Synthetic control group method applied by Abadie & Gardeazabal (2003) is used in this thesis to fulfill as much as possible the parallel trend condition. A synthetic control group is a weighted combination of untreated units that is constructed to serve as a counterfactual for a treated unit in the absence of an intervention. The

method selects weights for each control unit so that the pre-treatment characteristics and trends of the synthetic control closely match those of the treated unit. Thus, at the beginning of this investigation all Latin American countries were taken into account, however the ones that have had similar programs to the SPP program, were discarded. At the end, a pool of nine countries was used as donors for the Synthetic control group construction, from which Bolivia, Costa Rica, and Mexico got positive weights (see table 4). It is worth noting that the main donor is Mexico, followed by Bolivia.

Table 4. Synthetic control group weights

country	weights
Bolivia	0.33
Costa Rica	0.05
Dominican Republic	0
Guatemala	0
Honduras	0
Mexico	0.62
Nicaragua	0
Panama	0
El Salvador	0
Total	1

Source: table constructed by the author

Table 5 presents the mean data corresponding to the pre-treatment period (from 2015 to 2019) of Colombia vs the one of the “Synthetic Colombia”. There are some variables that could not be well matched such as the capital formation, savings and unemployment related ones, the “Synthetic Colombia” shows better economic conditions (lower proportional decrease of capital formation, higher proportional increase of savings, and lower proportional increase of unemployment). Although the ideal case is that all the variables have the same values, it is preferable that the “Synthetic Colombia” has better economic conditions to avoid noise in favor of the treated country (Colombia) when estimating the treatment effect.

After getting the results to be presented in the next fragment, placebo tests were run to check the reliability of the estimated treatment effect of the SPP program. For doing this, the treatment is reassigned to units that were not treated, and synthetic controls are built for them in the same way as it was made for Colombia. If these placebo units show effects as large as or larger than the estimated effect for Colombia, the original result may not be reliable. Conversely, if the Colombian effect stands out clearly compared to the placebos, it strengthens confidence that the observed impact is truly due to the treatment. First the placebo test is run with Mexico and Bolivia which are the two countries with higher weights for the “Synthetic Colombia”. Then, the average placebo gap considering these two countries is presented.

Additionally, an event study plot will be shown to get a graphical representation of the dynamic effects of the SPP program by plotting the difference between Colombia and its synthetic counterfactual at each relative time before and after the intervention.

Table 5. Treated vs Synthetic mean data from 2015 to 2019

	Treated	Synthetic	Sample Mean
tfp	-0.005	-0.007	-0.007
cap	-0.023	-0.005	-0.011
infl	0.047	0.035	0.026
sav	-0.023	0.014	0.037
trad	0.001	0.000	-0.023
unem	0.032	0.011	0.023
tere5	0.023	0.014	0.015

Source: table constructed by the author

V. Results

Table 6 shows the regression results, the TFP, capital formation, and policy related variables are significant different from zero, all of them having a positive effect on the GDP per capita growth. On average, the SPP program is associated with a 2.3% increase in GDP per growth holding the other variables constant. Regarding the time fixed effects’

coefficients, the ones of 2015 (captured in the constant term), 2020, 2021, and 2022 were significant different from zero, from them, the one corresponding to 2020 is negative which is not a surprise considering the COVID-19 pandemic.

Table 6. Regression results

Dependent variable:	
y	
tfp	0.314*** (0.088)
cap	0.144*** (0.032)
infl	-0.141 (0.100)
sav	0.015 (0.023)
trad	-0.063 (0.044)
unem	-0.007 (0.011)
tere5	0.020 (0.042)
policy5	0.023** (0.011)
as.factor(year)2016	0.005 (0.008)
as.factor(year)2017	0.003 (0.009)
as.factor(year)2018	-0.002 (0.009)
as.factor(year)2019	-0.001 (0.008)
as.factor(year)2020	-0.087*** (0.009)
as.factor(year)2021	0.044*** (0.014)
as.factor(year)2022	0.025** (0.012)
Constant	0.025*** (0.007)
Observations	80
R2	0.915
Adjusted R2	0.895
Residual Std. Error	0.017 (df = 64)
F Statistic	45.894*** (df = 15; 64)
Note: *p<0.1; **p<0.05; ***p<0.01	

Source: table constructed by the author

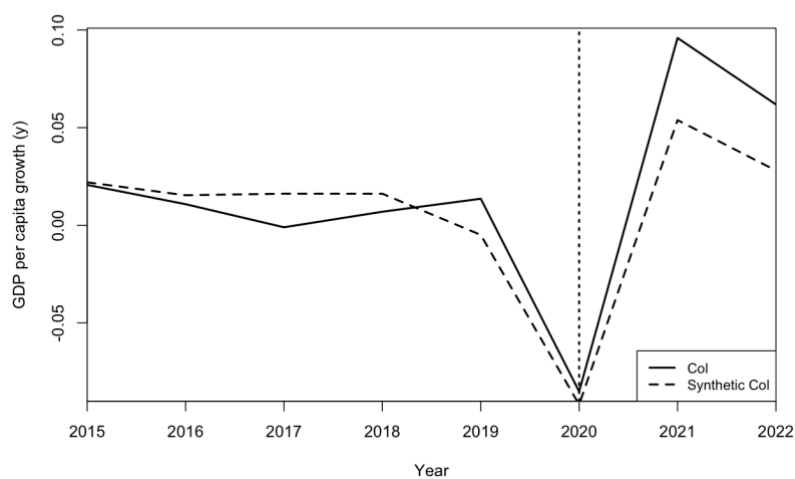
It merits attention that although not significant different from zero, savings and tertiary education enrollment related variables show positive effects on the GDP per capita growth; and inflation, trading⁵, and unemployment related variables show negative effects on the GDP per capita growth. These results are in line with the modern theories of economic growth discussed previously. In general, the model explains the 89.5% of the variation of the GDP per capita growth.

Graph 5 presents the results of the DiD of Colombia and the “Synthetic Colombia”. It is essential to underscore that the treatment year is 2020 considering that the variable policy is used as a 5-years lagged one. Therefore, since the first benefited group began to study in 2015, the treatment year is five years after that moment. In this way, it is shown how after the treatment year, the GDP per capital of Colombia (the treated unit), grows more than the one of the “Synthetic Colombia” (the untreated unit). This higher growth can be perceived from 2019 on, the widest gap corresponds to the year 2021 with a 4.2% of difference in the GDP per capita growth. In graph 6 this gap is zoomed up, and it is evidenced how from 2020 on this gap begins to increase significantly.

To evaluate if this treatment effect is reliable, graph 7 shows a placebo test with the two main donors for the “Synthetic Colombia”, in this graph it is evidenced how the gap of Colombia presents a different and positive pattern compared to the ones of Mexico and Bolivia. This is also depicted in graph 8 where the average placebo gap is presented.

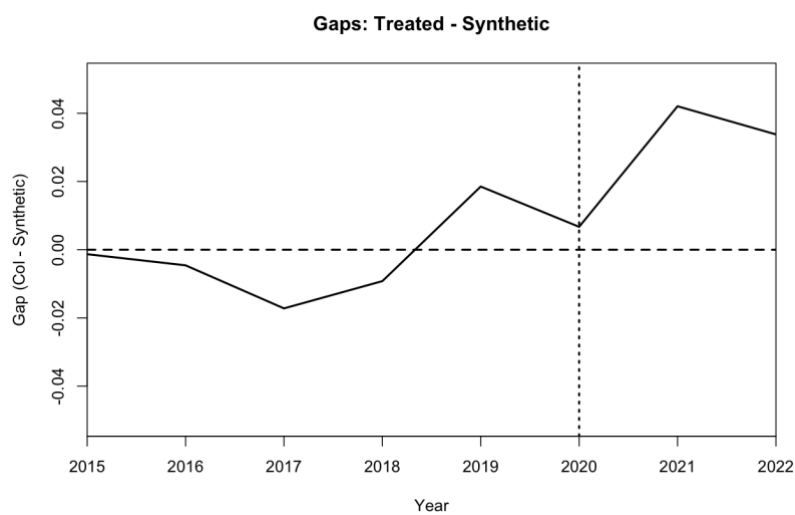
⁵ It is important to underscore that usually Latin America countries present trade deficits, and the imports hinders their internal industries, thus it is coherent that the trading coefficient has a negative sign.

Graph 5. GDP per capita growth of Colombia vs the “Synthetic Colombia”

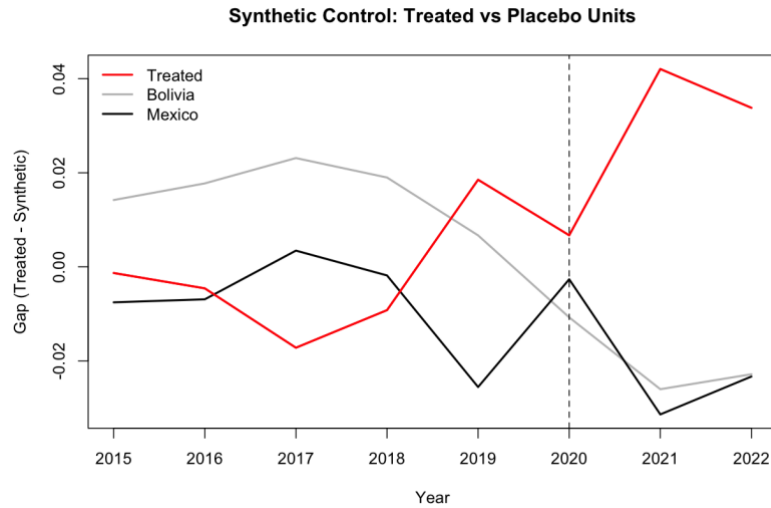


Source: graph constructed by the author

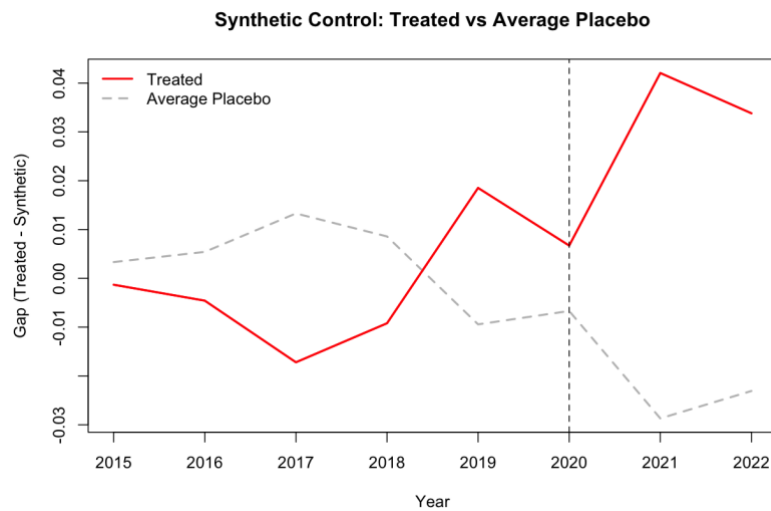
Graph 6. GDP per capita growth Gap of Colombia vs the “Synthetic Colombia”



Source: graph constructed by the author

Graph 7. Placebo Test with Mexico and Bolivia

Source: graph constructed by the author

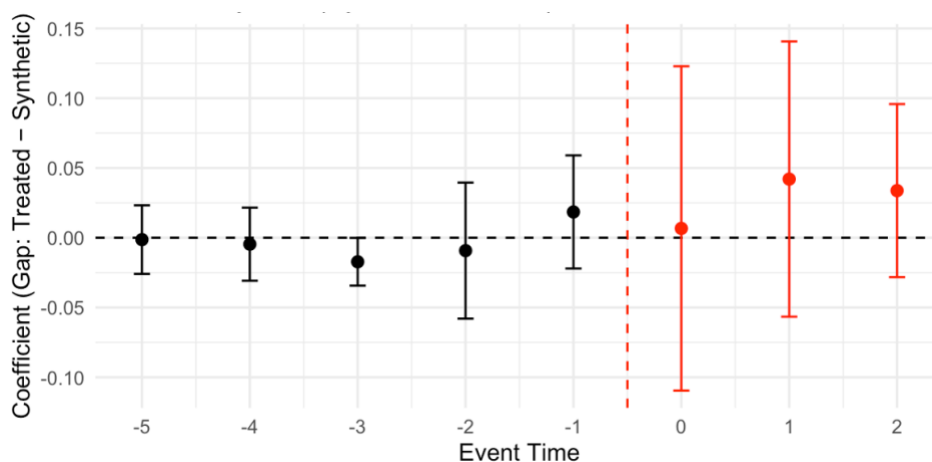
Graph 8. Average Placebo Test (Colombia)

Source: graph constructed by the author

Graph 9 shows the Event Study Plot, which shows that Colombia closely followed its synthetic counterpart prior to 2020 (the treatment year) suggesting a strong pre-treatment

fit. After the intervention year, the gap becomes increasingly positive, indicating that Colombian GDP per capita growth evolved more favorably than the synthetic control would predict in the absence of the SPP program. Therefore, there is a positive estimated effect of the treatment, however based on the plot, this effect is not statistically significant at 95% confidence intervals, as they include zero.

Graph 9. Event Study Plot

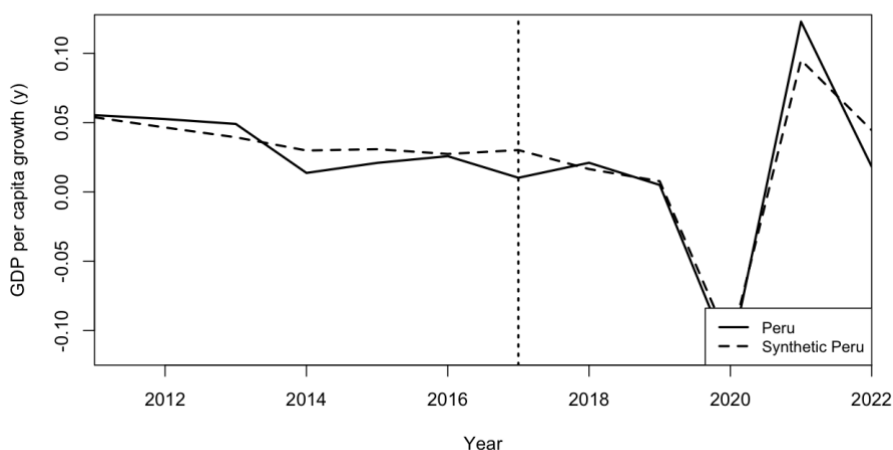


Source: graph constructed by the author

VI. Comparable programs' effects

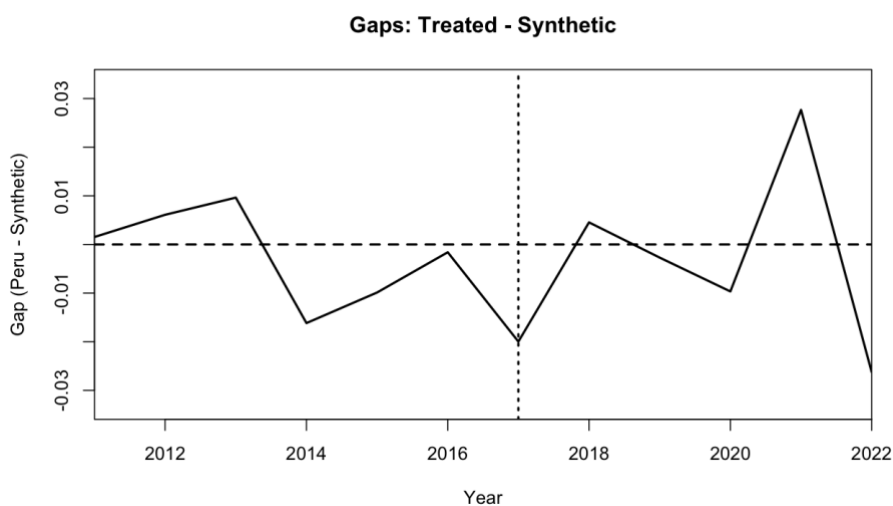
In 2012 the program “Beca 18” was launched in Peru to help low-income students with high academic performance to access tertiary education. This program provides students with a very complete and integral scholarship covering full tuition, living expenses, English courses, personal computer, and even emotional support. Thus, “Beca 18” is more complete than SPP. From 2012 to 2024 it has benefited 96,170 individuals, and in the last years it has been increasing the number of benefited individuals (Gestion, 2024). However, at its beginning, the number of benefited individuals was very volatile, and from 2016 to 2018 it was sharply contracted, for example in 2018 the program had less than 2,000 benefited individuals (CAPPEP, 2025).

Graph 10. GDP per capita growth of Peru vs the “Synthetic Peru”



Source: graph constructed by the author

Graph 11. GDP per capita growth Gap of Peru vs the “Synthetic Peru”

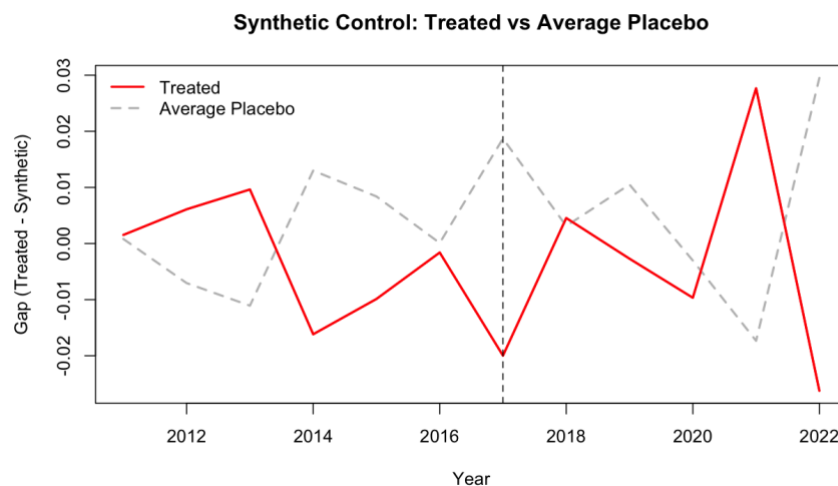


Source: graph constructed by the author

Graphs 10 and 11 present the “Beca 18” effect on Peru’s GDP per capita growth compared to a synthetic control group, before the treatment year, in general the gap is

negative suggesting that the synthetic control does not track Peru very well. After the intervention, the negative gap tries to become positive, in 2018 and 2021 the gap is positive. The widest gap is in 2021 corresponding to a 2.8% GDP per capita growth of difference. Nevertheless, the gap later declines and becomes negative by 2022, highlighting that the treatment effect is not consistently positive over time. This can also be seen in graph 12 which shows an average placebo test considering Peru's synthetic control group. The negative gap can be due to the sharp decline in the number of benefited individuals between 2016 and 2018 considering the 5-years lagged effect; to a strongest shock of the COVID-19 pandemic in Peru than in its synthetic control group; or due to reallocations, distortions, or unintended consequences of the program.

Graph 12. Average Placebo Test (Peru)



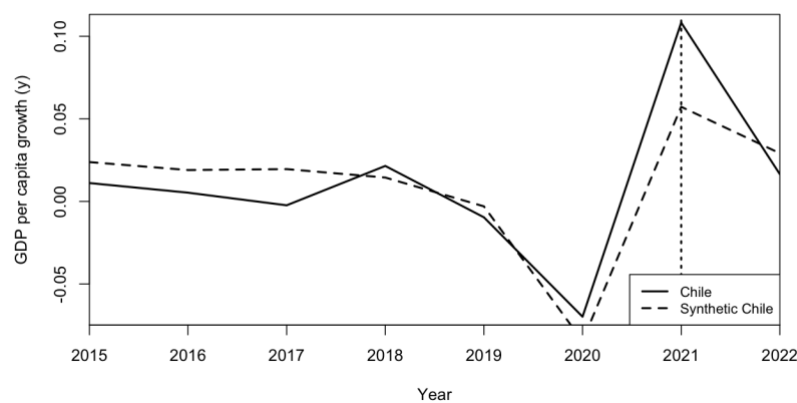
Source: graph constructed by the author

Another program with the goal of increasing the access to tertiary education for low-income individuals is the “Gratuidad” Program that Chile has been implementing since 2016. It provides tuition-free university and technical education to students from lower-income households, individuals are not required to have high academic performance. This

program has a larger number of benefited students, for example in its first year it benefited almost 139,000 students (Ministerio de Educacion de Chile, 2026). This number is larger in absolute and relative terms considering that Chile has the lowest population compared with Colombia and Peru.

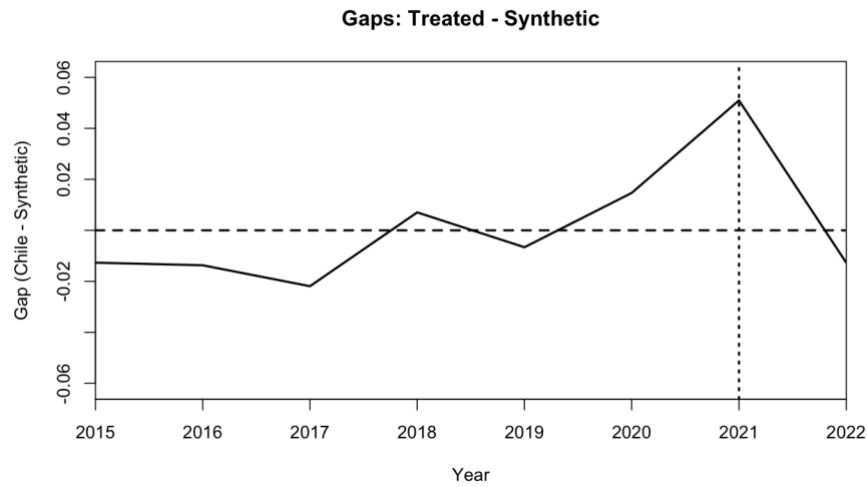
Graphs 13 and 14 present the “Gratuidad” effect on Chile’s GDP per capita growth compared to a synthetic control group. Considering the 5-years lagged effect, it is notorious that the gap becomes positive four years after the introduction of this program (in 2020), probably because this program included technical’s degrees which last less than a bachelor’s degree. The widest gap is in 2021 corresponding to a 5% GDP per capita growth of difference. However, the gap later declines and becomes negative by 2022. This can also be seen in graph 15 which shows an average placebo test considering Chile’s synthetic control group.

Graph 13. GDP per capita growth of Chile vs the “Synthetic Chile”



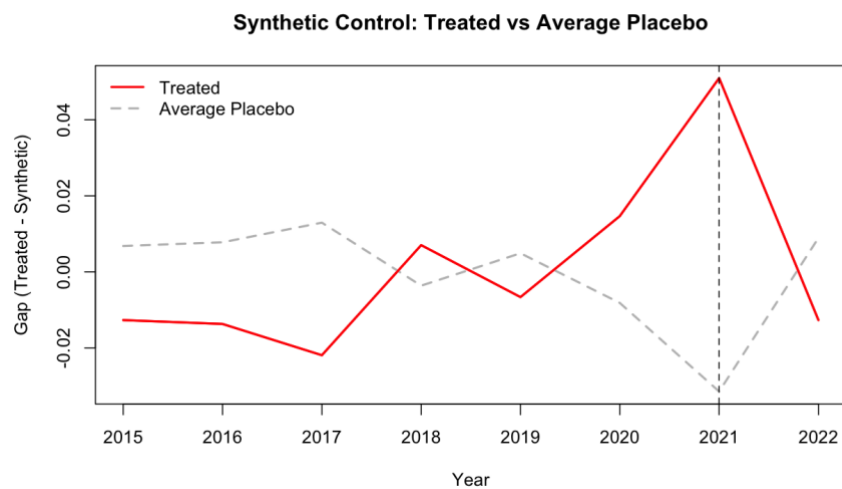
Source: graph constructed by the author

Graph 14. GDP per capita growth Gap of Chile vs the “Synthetic Chile”



Source: graph constructed by the author

Graph 15. Average Placebo Test (Chile)



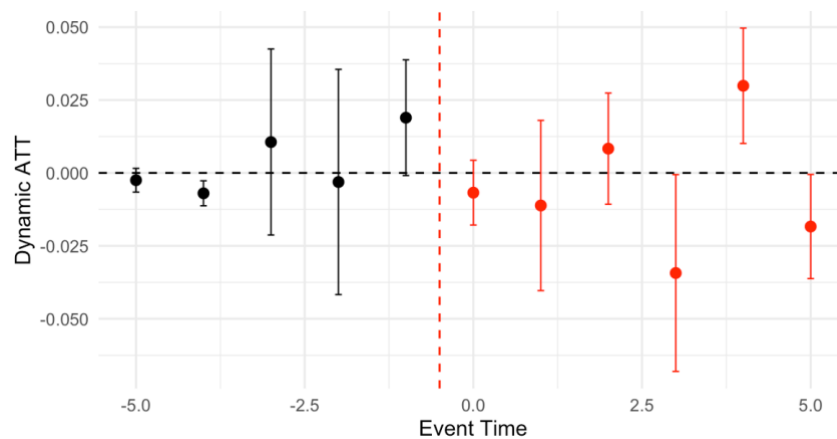
Source: graph constructed by the author

Graph 16 presents the Staggered DiD Event Study Plot considering as treated countries Colombia, Chile, and Peru with their respective treatment years. This graph shows that there is little evidence of strong or immediate treatment effects. Pre-treatment trends are mostly flat with one small deviation, which validates the core parallel trends assumption

required for causal inference. Regarding the post-treatment trends, the only statistically detectable impact occurs four years after treatment (that is to say, nine years after the introduction of the programs considering the 5-years lagged condition used in this thesis), showing a positive effect. Overall, treatment effects appear weak, noisy, and not systematically different from zero except at event time +4.

Therefore, despite that Peru's program is more financially complete than SPP was, and that Chile's program has benefited more students in absolutely and relatively, the one showing a clearer and positive effect on the GDP per capita growth is SPP. Nevertheless, these results need to be carefully interpreted as a more extensive and integral study could highlight other benefits from more complete and/or extensive programs which increase access to tertiary education, such study could involve measuring tax revenues, criminal rates, mental health rates, equity rates, etc. This, considering that education benefits cannot be diminished to the GDP per capita growth.

Graph 16. Staggered DiD Event Study Plot



Source: graph constructed by the author

VII. Conclusion

In this thesis the positive macro-economic effect of the SPP program in Colombian economic growth is shown, reaching a maximum gap in the GDP per capita growth of 4.2% compared with the constructed “Synthetic Colombia” which was mainly composed by Mexico and Bolivia. This is a significant effect considering that although this program was the first one in Colombia with a comparable scope, it did not benefit millions of individuals but only 40,000 students. However, this program had some characteristics that perhaps made its impact bigger compared with a less focused program benefiting more individuals. SPP had very a specific target and goal that was to increase access to high quality and prestigious tertiary education to remarkable students from low-income families. “To affect growth, a policy must alter the choices people make” (Lucas, 1998, p. 64), and that was the case of this program. These results combined with the already existing investigations about the micro effects of this program on the benefited individuals’ lives confirm that human capital plays a central role in the economic growth of a country as predicted by modern theories of economic growth.

Concerning the limitations of this thesis, it is noteworthy that a “Synthetic Colombia” with more similar variables’ values would have made the treatment effect more precise. Also having had data for more countries and years would have allowed the model to be more robust and to get a broader horizon regarding the scenarios after the SPP program.

Regarding the possible extensions of this thesis, it is key to remember that the SPP program existed only until 2018, thus, in the future, the DiD with data from Colombia before and after the program can be evaluated. Also, studies integrating monetary outcomes regarding taxes, criminal costs, health costs, equity rates, etc, can be an interesting extension of this thesis showing how education indirectly affects the economy of a country.

What is more, the different characteristics between the scholarships implemented in Latin American countries can be exploited to determine which characteristics are the ones that make these programs more successful in terms of economic growth impact.

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