The Conflict in Colombia: A Political Economic Analysis.

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Abstract

This research explores the armed conflict in Colombia. It consists of two parts: Part I attempts to provide a theoretical framework for the analysis of the Colombian conflict using a dynamic model. The second part, co-authored with Manuel Pulido Velásquez, uses both difference-in-differences and the synthetic control methods to study the effect of conflict intensity on the country's unemployment rate. The key element connecting both parts is the level of activities run by the agents involved in this conflict. In the theoretical model, the level of each agent's activity represents the control variables determining the state variables and payoff functions. In the empirical model, identification of years with the highest levels of violent activities, helps us divide our period of analysis into pretreatment and treatment periods. Additionally, this identification provides a basis for defining potential control units in constructing our difference-in-differences and synthetic counterfactual.

Through the dynamic model we find that an interior solution implies that the sum of the marginal costs imposed by the agents through the activities they conduct on other agents' payoff functions is equal to the sum of marginal benefits generated by those activities. In the empirical model we find that for the difference-in-indifferences approach unemployment rate in Colombia increases 3.7 percentage points relative to the control group. Meanwhile, for the same variable, our synthetic control shows an increase of 4.9 percentage points relative to the synthetic Colombia. Both estimations represent at least one third of the average unemployment rate for the treatment period (1995-2014).

Contents

1   A General introduction

This research explores the conflict in Colombia. It consists of two parts: Part I is devoted to a political-economic analysis of the conflict. Part II contains a statistical analysis of the economic consequences of the conflict.

Specifically, the first part attempts to provide a theoretical framework for the analysis of the Colombian conflict. I list the main illegal armed groups, drug cartels, the Colombian government and the U.S. government as the players of a game.[1] These players undertake military and non-military activities affecting assets in dispute with a goal of maximizing their payoffs. The second part, co-authored with Manuel Pulido Velásquez, uses the synthetic control method to study the effect of conflict intensity on the country's unemployment rate. The key element connecting both parts is the level of activities run by agents involved in this conflict. In the theoretical model, the level of each agent's activity represents the control variables determining the state variables and payoff functions. In the empirical model, identification of years with the highest levels of violent activities, helps us divide our period of analysis into pretreatment and treatment periods. Additionally, this identification provides a basis for defining potential control units in constructing our synthetic counterfactual.

The rest of this paper is organized as follows: Section 1 contains a general introduction. Part I, Section 2 introduces the theoretical model. Section 3 discusses literature relevant to analyzing the modern Colombian conflict (1958-2018). Section 4 briefly describes the Colombian conflict. Section 5 describes and analyzes the main variables affected by the conflict and how activities conducted by agents modify them. Section 6 proposes a dynamic model. Section 7 describes three simplified versions of the main model. One of these versions examines the effects of coca legalization on the Colombian conflict. Section 8 provides a conclusion. An appendix presents a duopoly model of legalization effects on prices, quantities, and profits.

In part II, Section 9 contains an introduction. Section 10 presents a detailed literature

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[1]Through all this document when I mention the word "game" I do this in the sense of game theory.

review describing studies examining economic impacts of conflict worldwide and in Colombia. Section 11 offers a brief context on the Colombian conflict pointing out key elements for the period selection. Sections 12 and 13 present the empirical strategy for our analysis and the results obtained. Section 14 contains some conclusions and comments. An Appendix presents results from a series of robustness tests.

Part I

2 Introduction to Part I

The conflict in Colombia is one of the longest internal conflicts in the world. It has evolved, and has taken multiple shapes since its beginning in the 1950s. There are many factors that have contributed to the continuation of the conflict. For example, the limitation of the political participation of parties different from those that traditionally occupied positions of governmental power at the regional and national level, the emergence of armed groups (different from the Colombian army) supported by the government to fight subversives, and the beginning of drug trafficking and its proliferation around the country. Similarly, the pressure of the international community, the poor performance of Colombian institutions, the ambiguity of the peace processes, and the democratic changes which, in 1991, gave rise to a new political constitution, have also contributed.

Through the years, new agents have joined the conflict; others have left; some others had been close to leaving, but then they came back supported by new alliances that have made them stronger than before. The key is that to survive and be an active part of the Colombian conflict, an agent has to continuously adjust its strategies to improve the payoff that it gets from the conflict. This paper attempts to provide a theoretical framework for the analysis of the Colombian conflict using a differential games approach, in which the agents involved are the players, assets in dispute are the state variables, and levels of activities conducted by players are the control variables. The main idea is to model the internal war in Colombia to obtain results that give us insights about the dynamic relationship of the players in this conflict, which from our perspective is a situation involving rational agents who are looking for an optimal path that guarantees them a maximum payoff.

Our model contains five players, a dynamical system describing the evolution of what we define as the main assets of the conflict (state variables), the level of activities run by players (control variables), and the payoff function of each player. Given that in this first part of the

3

research we are interested in describing the conflict using a theoretical tool, we first define and describe a general model which includes five players, three assets and the set of activities conducted by each player; then we describe the concept of solution used to solve the problem stated, and we establish the first order conditions that the general model has to meet.

After fully describing the general model we construct three simplified versions of it to explore some possible scenarios that can give us an insight into how the complete model would behave. The first of these three models describes a situation with two agents, the Colombian government and the drug cartels. These two players are involved in a conflict in which there are two assets, the number of hectares under coca cultivation and the levels of unrest and insecurity. Each player conducts one activity with the objective of maximizing its payoff function which depends on the assets and the activities conducted by each agent. The second model adds guerrilla groups as a new agent involved in the conflict. We assume that the main role playing by the guerrillas in this second model is to cooperate with the drug cartels.[2] Finally, we describe a hypothetical situation in which the U.S and the Colombian governments simultaneously legalize the production and commercialization of cocaine. In the appendix we use a duopoly model to describe the situation in the late 1980s and during the 1990s, period in which the strongest drug cartels in Colombia were Medellin's and Cali's cartels.

The combination of the dynamic model and the Cournot model gives us a good sense of the behavior of the agents under a scenario of legalization, and of how the prices and the profits of the business would be affected. The reason why we chose the legalization scenario for these simplified models is two-fold. First, the market of the illegal drugs has permeated the armed Colombian conflict as a whole. As such, every agent would somehow be affected by a legalization law. Second, drug trafficking is an issue across the globe, and in that sense our

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[2]I want to emphasize that this research does not intend to say that the only objective of the guerrillas is to cooperate with the drug cartels or that guerrillas are the only groups conducting illegal activities. There are illegal armed groups including paramilitaries, bacrims (criminal groups), and other groups outside of the law that participate in several illegal activities, one of which is drug trafficking.

study appeals to a broader audience.

Through the dynamic model we find that an interior solution implies that the sum of the marginal costs imposed by the agents through the activities they conduct on other agents' payoff functions is equal to the sum of marginal benefits generated by those activities. Using the Cournot model to analyze the period in which the two cartels mentioned above dominated the market of coca in Colombia, we find that prohibition increases the prices in the illegal drug market. In addition, we find that under an internal conflict which involves many illegal armed actors, the unrest and insecurity can persist even under a legalization scenario.

3 Literature Review

The study of the conflict in Colombia through a framework of differential games-using the approach of activity analysis-can be divided into three sets of works. The first describes the conflict in a manner that gives us the basis to define the activities, the assets, and the main actors involved in it, the second are studies describing the impact of the conflict on some specific economic sectors in Colombia, and the third set of documents are those directly related with dynamical games.

In the first group, the general report of the Historical Memory Group (2013), provides a description of the origins of the Colombian conflict. It illustrates the impact of the conflict on Colombian society in terms of economic, political and socio-cultural impacts. In addition to this report; *Leave us in Peace (Déjennos en Paz, 2008)* and *As Lambs among Wolfs (Como Corderos entre Lobos, 2012)* give us a nuanced understanding of the conflict from the perspective of the people who were forcibly displaced, as well as the recruitment strategies of children used by the subversive groups. These last two works are more focused on the tragic experiences of the civilian population who are trapped in the middle of the conflict.

From my perspective, *25 years of decentralization in Colombia (25 años de descentralización)*, is an important text due to two reasons. One, it provides an excellent description of the im-

plications of the process of governmental decentralization in Colombia. Two, it explains in a clear way how corruption and subversion in Colombia have been linked to administrative and technical flaws of the decentralization mechanism, which creates illegal contracts, electoral manipulation, and agreements between political leaders, public workers, and paramilitaries.[3]

Sevillano and Lopez (2008), in Political Balance of the Para-politics, make an analysis of the Para-politics phenomenon highlighting the large proportion of the senators in Colombia belonging to parties in which paramilitaries have a big influence. The phenomenon of Para-politics was also analyzed from an economic perspective by Acemoglu et al (2013). In this work, the authors show how paramilitaries have influenced the elections at local and national levels in Colombia to the point that the campaign of president Uribe and the election of many senators had the participation of these armed groups.[4]

Using theory of the conflict and game theory, Salazar and Castillo (2001) find patterns that help them to explain the evolution and expansion of violent conflict in Colombia. In the first part of their analysis the authors describe the conflict and the actors participating in it emphasizing the rationality of those agents involved in violence. In the second part of their analysis, Salazar and Castillo describe several game theory approaches that can fit the problems and the strategies implemented by the population, guerrillas, paramilitaries, and the Colombian government. Salazar and Castillo make evident that the Colombian conflict is one in which rational actors, who are participating in a "game" that has lasted for more than 50 years, have to make adjustments to their strategies to survive the conflict and continue being active in it.

Other researches have sought to study the effect of the conflict on specific markets or economic sectors in Colombia. For example, Ibáñez et al (2013), and Arias and Ibáñez (2012) analyze the impact of the conflict in the agricultural sector. Similarly, Camacho and Rodriguez (2013)

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[3]That kind of agreement between political leaders, public workers, and paramilitaries constitutes what is commonly known as the Para-politics.

[4]In the article "Las Bandas Criminales y el Post-Conflicto", Valencia (2016) says that 250 mayors, 12 governors, and one third of the senate were part of the alliance between politics and the illegal groups.

study the causal effect that the conflict has over entrepreneurial activity in Colombia using panel data method. Most important they found that one standard deviation increase in the number of guerrilla and paramilitary attacks in a municipality increases the probability of firm exit in 5.5 percentage points.

Mejia and Restrepo (2013) model the war on illegal drugs in source countries as a conflict over scarce inputs in successive levels of the production and trafficking chain. The model studies Plan Colombia, which was a U.S government's "aid program" to the Colombian Government to fight the drug cartels, seeking to target the illegal crops, and blocking the transport of cocaine outside this source country. Similarly, Mejia (2016) describes cocaine production and trafficking in Colombia providing an analysis of the main anti-drug policies implemented under Plan Colombia aimed at curbing the supply of drugs.

Ibáñez and Moya (2010) assess the vulnerability of households through information collected from a representative sample of forcefully displaced people (IDPs) in Colombia. They found that victims of forced displacement face difficulties to generate income and significant drops in levels of consumption. This reveals the limitation of the effectiveness of the public interventions aimed at promoting peace. Similarly, Ibáñez and Vélez (2008) examine the causes of the forced displacement in Colombia, and estimate the welfare losses while providing some evidence regarding policy instruments for preventing displacement.

For their part, Calderón-Mejía and Ibañez (2016) use forced migration caused by the Colombian conflict as a natural experiment to examine the impact of exogenous labor supply shifts on labor outcomes.[5] They emphasize the behavior of wages in both formal and informal sectors of the labor market, and assess their data through gender analysis. The main finding of this work is that migration flows produce large negative impacts on wages and employment opportunities of all workers, but particularly larger for low-skilled workers.

The third set of the literature emphasizes works using economic game theory and dynamical

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[5]In their model, the authors use the number of victims of massacres and distance between origin and destination city as an instrumental variable.

models to analyze the Colombian conflict. Among them, Isaza and Campos (2007) created a model in which there are three armed actors involved in the conflict: guerrillas, Colombian army, and paramilitaries. One of the conclusions that this paper drew is that the presence of the Colombian government in the marginal rural zones- promoting projects with the community, creating jobs, and improving the life conditions of these people- gives rise to demise of subversive actions. The Colombian government's active presence in the most vulnerable regions of the country makes it more difficult for rebel forces to recruit new people into their groups. Additionally, Isaza and Campos show that financially speaking it is less expensive for the government to promote activities involving the generation of productive projects, and improvements in the health and educational system than continuously fighting subversives.

Lastly, using arguments from game theory, Gorbaneff and Jcome (2000), and Salazar and Castillo (2001) have defined subversion as an out of the law rational economic activity, in which the players involved in the conflict use their strategies to maximize their payoff functions subject to constraints determined by the conflict itself.

To the best of my knowledge, the approach of differential games and activity analysis to study the conflict in Colombia has yet to be undertaken.

The following section is intended to briefly describe the conflict in Colombia, focusing on how each agent has been participating in it.

4   The Colombian Conflict

According to the General Report of the Historical Memory Group (GMH 2013), the civil conflict in Colombia can be divided into four periods: [6] In the period between 1958 and 1982, Colombia experienced the transition from political violence to subversive violence. The po-

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[6]From 1946-1958 the violence in Colombia was mainly politically motivated. The two principal political parties fought for controlling the country's political system.

litical projection and territorial expansion of guerrillas, and the emergence of paramilitaries,[7] characterized the period 1982-1996. 1996-2005 is known as the peak period in terms of violence, and the period between 2005 and 2012 was characterized by strong attacks perpetrated by the Colombian government against the guerrillas to the point that guerrillas were weakened.

As mentioned above, the first period (1958-1982) was characterized by the transition from bipartisan violence between the traditional parties (Conservatives and Liberals) to subversive violence marked by the proliferation of leftist guerrillas. In order to decrease the level of violence the two parties agreed in 1958 to rotate the power every four years; this agreement was known as the National Front, which continued until 1974. This was an attempt to give equal political participation to both conservatives and liberals. Although it was intended to foster equal participation, some armed splinter groups formed inside of the political parties. The members of these groups had different interests and levels of organization and felt that they did not have enough political representation (Palacios 2006; GMH 2013). Some of these groups, inspired by the Cuban revolution and Chinese/Russian communism, became what Colombians know nowadays as the "guerrillas". [8]

As reported by the GMH (2013), the Colombian government-supported by the U.S government agencies, implemented strategies to constrain the spread of communism. These strategies were a combination of socioeconomic reforms (i.e., Alliance for Progress policy and the creation of the World Coffee Organization) and military repression (Palacios 2006). The political and legal exclusion that the National Front motivated many groups to oppose the government. In addition to political motivations, land distribution was the other key element that boosted the consolidation of the various guerrilla groups.[9]

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[7]Many events took place during this period, some of the most important in the dynamic of the conflict are: the 1991 Colombian new constitution, the emergence of private security companies called CONVIVIR, the influence of the drug cartels in the political, economic and social life of Colombia, and the fact that the illegal drugs interdiction efforts shifted toward the Andean region.

[8]Most of the guerrilla groups emerged around the same period (1964-1970).

[9]Some peasants were claiming rights to the rural lands in which they were working which belonged to big

9

In the second period (1982-1996), the guerrilla groups occupied more territory and structured themselves in a more sophisticated way. During their VII conference, the Colombian Revolutionary Armed Forces (FARC for its initials in Spanish) decided to use aggressive tactics, which involve expanding to new rural areas by using coercive force. They created new groups to cover more regions and increased their number of armed attacks (GMH 2013). Even though the president of Colombia, Belisario Betancur (1982-1986), offered to negotiate with the FARC, the elites of Colombian society, the command of the Colombian army, and the heads of big companies opposed this proposition.[10]

The elites' lack of confidence regarding how the government was handling the conflict with the guerrillas, and the decision of the guerrilla to occupy more rural zones, contributed to the emergence and expansion of paramilitary groups dedicated to protect the interests of the elites. In 1968 the Colombian government passed Law 48 which legitimized the creation of paramilitary groups. Thus, the paramilitaries emerged as a legal groups whose main purpose was to help the Colombian army combat guerrillas. However, by the end of the 1980s, the paramilitaries were declared illegal as a consequence of a series of violent events.[11]

In addition to the active presence of the guerrillas and paramilitaries in the internal conflict, drug trafficking was fueling it, becoming an integral part of the conflict during this time. Now without the legal support of the government, the relationship between the drug cartels and the paramilitaries was even more apparent. On the one hand, the paramilitaries needed financial aid to continue military activity. While on the other hand, the drug cartels needed the protection of their lands, drug-laboratories, and the routes inside the country to export the production of illegal goods. This relationship between the paramilitaries and the drug

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farmers. The peasants (campesinos) asked the government to redistribute the land more equally.

[10]The elites were afraid because an insertion of the guerrillas into the political arena would imply the loss of the power that they held until that moment (Salazar and Castillo, 2001).

[11]In 1989, paramilitaries conducted a massacre known as La Masacre de la Rochela, which was the last straw for the Colombian government. As a result, the government eliminated Law 48 using decrees 813 and 814 (1989) which penalized the promotion, funding, support and creation of paramilitary groups (GMH 2013). This marked the end of the paramilitaries as legal groups, but not the end of their collaboration with the Colombian armed forces.

cartels was one of the first signs of the involvement of drug trafficking within the conflict. Similarly, drug trafficking became a contributor to the land problem in Colombia (GMH 2013). Drug cartels need for land to plant coca fields created a war for the possession of territory.[12]

The peak of the conflict in terms of the magnitude of violent attacks developed in the third period (1996-2005). According to the GMH (2013), this period was marked by the simultaneous expansion of the guerrillas and the paramilitaries, the war against drug trafficking, and a change in the organization of the drug cartels. Although territorial control was still one of the main objectives among the different armed actors, the reasons why they fought changed (see Salazar and Castillo 2001). Popular perceptions of the leftist guerrillas -as defenders of social demands- transformed into images of vandalism and common delinquency. All illegal armed groups intimidated, killed, and forcibly displaced people as a way to install fear among the civil population. The level of the conflict during this period reached such a magnitude that Colombia was ranked second to Sudan in terms of internally displaced persons according to the GMH (2013).[13]

The fourth period (2005-2012) witnessed a strong offensive launched by the Colombian state against the leftist guerrillas. It is clear that the government weakened but did not eliminate the guerrilla groups. Regarding the process of negotiation with paramilitary groups to get their demobilization, the government got partial results. During 2003-2004, many paramilitary groups demobilized, while others did not. Those paramilitary groups that did not demobilize helped create a new era of extra-judicial armed groups called *"bandas crim-*

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[12]According to the GMH (2013) by the end of the 1980s and the beginning of the 1990s the owners of the illegal drug businesses bought lands in around 409 municipalities in Colombia, which is almost half of Colombia's national territory.

[13]The massive displacement of the population from different regions in Colombia, especially toward the main populated cities affected the labor market and the welfare of this part of the population. The Colombian labor market suffered negative impacts on wages and employment opportunities (Ibáñez 2009), and the victims of forced displacement faced difficulties to generate income, significant drops in consumption, and significant losses in welfare (Ibáñez and Moya 2010; Ibáñez and Vélez 2008; Ibáñez 2009).

11

inales". These new groups wanted to continue receiving benefits from illegal mining and coca cultivation, processing and transportation. Thus, the phenomenon of paramilitarism continued as scattered new groups.

Although the Colombian government tried to reduce guerrillas to their minimum armed capacity and to do peace agreements with the paramilitaries, two things were clearly happening. One, guerrillas became adjusted to the new culture of low intensity perpetual warfare, and continued being active in the conflict (See Salazar, and Castillo 2001). Two, paramilitary groups which did not sign the peace agreement continued carrying out military attacks. In addition, the illegal drugs' market continued to expanded and the leaders of the drug cartels continued monopolizing access to arable territory, making the problem of the distribution of land worse.

In 2010 Juan Manuel Santos was elected and replaced Alvaro Uribe as the current president. Santos' job has been marked by a tension among the legislative, judicial and executive powers due to corruption scandals (the "parapolitics" and those related to the influence of the Odebrecht scandal[14] in some governmental decisions) and the necessity of restarting the process of a peace agreement with the Guerrillas, and those paramilitaries groups which did not sign the agreement during Uribe's presidential period (2002-2010).

This section has described the conflict and the main agents who are part of it. The objective of the next section is twofold. First, it describes the main assets[15] involved in the conflict and why these assets are important in the understanding of the conflict. Second, it explains how the activities conducted by the agents previously described affect these assets. The importance of this and the following section is that they help us to characterize the game

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[14]Odebrecht is a Brazilian construction company which became an international giant using bribery to obtain contracts. It has destabilized governments across the region, including the March 2018 collapse of the Peruvian government. In Colombia, prosecutors are investigating whether or not President Santos' 2014 campaign received improper donations from Odebrecht.

[15]In this paper the assets are the number of hectares under coca cultivation, the levels of unrest and insecurity due to the conflict, and the level of local and foreign investment. These are variables which depend on the activities undertaken by the agents involved in the conflict.

that we want to develop using elements that are inherent to the conflict.

5   The main variables in the Colombian conflict

The Colombian government, guerrillas, paramilitaries, drug cartels and the U.S government are the main agents involved in the country's armed conflict. Additionally, my description allowed me to define some of the main assets which are affected by the dynamic of the conflict. These assets are the number of hectares under coca cultivation and the routes to transport the final product; the level of local and foreign investment, and the level of internal security and tranquility. The evolution of these assets in a conflict context is marked by the activities conducted by the agents that participate in it. In addition to describing these assets and their importance in the conflict, in this section I describe how agents' activities affect their evolution.

The number of hectares under coca cultivation can give us a useful measure of the size of the illegal drug market in Colombia. As mentioned before, cartels have influenced the conflict through several mechanisms, such as, financially supporting illegal armed groups which protect the coca crops. Furthermore, these armed groups protect the labs in which the drug is produced and the routes through which the drug is transported internally to then be sent to other countries. Analyzing the evolution of this illegal market is crucial to understand the conflict. The war for the control of the routes and the land suitable to the cultivation of coca involves the participation of the Colombian government, U.S government, and illegal groups.[16] From one side, these two governments have made alliances to conduct activities

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[16]According to one of the main Colombian newspapers "El Tiempo (April 23 of 2017)" since at least last year, the city of Tumaco (a city located in the south-west of Colombia in the Department of Nariño) has became the epicenter of a war among four criminal groups which represent up to 300 armed men, who fight ceaselessly to get and maintain control of lands that constitute the largest extension of illegal crops in Colombia. The amount of coca in the zone is of a such magnitude that Tumaco is considered as the new "capital" of coca in Colombia. In the words of an intelligence officer belonging to the *Dirección Central de Policía Judicial e Inteligencia DIJIN,* "Nowadays Tumaco is the main port of drug exportation. 315 tons of

intended to curb the coca supply. From other side, the illegal armed groups receive financial support from drug cartels to develop activities that favor the illegal markets.

The strong relationship between drug production and illegal armed groups can be explained by the confluence of interest. Illegal armed groups need resources to conduct military operations and producers need protection for their business, constituting a relation in which both parts benefit each other. As stated by Holmes et al (2006), "current instability in Colombia derives from the interaction and resulting synergies stemming from two distinct tendencies: the development of an underground criminal drug economy and the growth of armed challenges to the state's authority". This relation between drugs and violence is strongly supported by the profitability of the drug business. It is the high rate of return which maintains this perverse symbiotic relationship, and allows the owners to bribe authorities at many levels, making the problem even more difficult to solve.

According to Sanin (2008), even though guerrillas and paramilitaries have long been involved in drug trafficking, in the case of guerrillas their relations with drug traffickers are highly bureaucratic, and the commander of each front is financially and politically accountable for his or her actions. In the case of the paramilitaries, that relationship is mostly based on a network of personal interactions, with the expectation of individual enrichment for all parties. In many paramilitary units one of the best rewards is to give the fighter access to the taxing of coca and poppy crops. While drug trafficking is not the nucleus of the Colombian conflict, nowadays, drug cartels are a fundamental agent in it, and for this reason we are considering the hectares under coca cultivation and the routes to transport the final product as one of the assets in our model.

The evolution of this asset can be negatively affected by the actions developed by the soldiers sent to the field. Soldiers are sent to develop tasks intended to control territories, where

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coca per year leave from Tumaco, that is equivalent to 80% of the country's production". This officer noted, that this municipality is a living paradox: it registers one of the highest poverty indexes in the region, while at the same time it grows 16,690 hectares of coca. Groups who are present in this zone include paramilitaries, criminal bands, the guerrilla group ELN, and drug cartels.

there are coca crops or where the soil is suitable to grow them. Along with the military activities, policies of eradication and interdiction affect how much land is devoted to the coca cultivation, the places where illegal drug is processed, and the routes through which it is internally transported(See Mejia and Restrepo 2013, and Mejía et al 2017).

This asset can be positively affected by the Drug Cartels' actions seeking to make illegal business flourish. This includes, alliances with other countries' drug cartels and the use of new technologies that yield more coca per hectare cultivated. Similarly, guerrillas' and paramilitaries' operations conducted to protect and extend the coca crops and the transportation routes contribute positively to the prosperity of the asset under analysis.

The level of local and foreign investment in Colombia is another asset affected by the internal conflict. This is an important economic indicator because it shows the evolution of the economy and the confidence that local and foreign entrepreneurs have in the country. Activities contributing positively to this variable are those related to security conditions and the political stability of the country. In that sense, it seems plausible that sending soldiers to these regions under control or potentially controlled by insurgent groups constitutes an activity that may affect investment positively once the government takes effective control over that territory. [17] Another activity that positively affects the investment in Colombia is the support of the U.S through providing money or in kind assistant to the Colombian government to fight the drug cartels and subversion as a whole.

Regional security leads to more investment. Cooperation between the Colombian government and the international community to fight subversion promises to weaken the violence and corruption which are key factors undermining legality. Therefore, a strong public policy discouraging both illegality and corruption will certainly generate a much better environment

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[17] Even though the objective of sending soldiers to "recover" territories under the domination of the subversives is to bring security to the civilians, when a territory is dominated by subversive groups, sending soldiers to conflict regions did not bring tranquility and security right away. Establishing certain levels of security takes time as it is necessary to first recover control of the territory in dispute. Tranquility and security cannot be obtained without complete control of the region in dispute.

for capital investments.

Camacho and Rodriguez (2013) find that in zones controlled by the subversives, entrepreneurs have been extorted to the point that some of them have decided to close their companies. This creates a decrease in the level of investment and the subsequent short-run effects on the labor market, such as supply shocks and unemployment. Camacho and Rodriguez note that there are several channels through which the conflict can interfere in the productive and commercial activities of a business. One of them is that workers are simply afraid of being killed. Another is the change in the operational costs of companies, meaning that the extorted firms have to incorporate in their costs the monthly amount that they have to pay to the subversives. Additionally, if the conflict makes people move away from their territory, some of the companies in conflict zones lose demand, and do not have incentives to increase their investments. Another interesting effect is that as loans are based on the riskiness of the borrower, firms located in zones of conflict may face difficulties accessing credit that allows them to make investments.

In addition to the factors mentioned above, confidence in the country to make investments is not based on security conditions alone. The prosperity of a business also requires a stable economic and political environment. Therefore, aspects such as transparency in the policies that govern the municipalities in which the entrepreneurs want to establish a company are of vital importance for local and foreign investment. As for the political environment in Colombia, Acemoglu et al. (2009) describe how insurgent groups influenced elections and public policies both locally and nationally, creating an unattractive environment for investment. Specifically, Acemoglu et al. state that: "In Colombia, a third of the legislature in 2002 and 2006 may have been elected in elections heavily influenced by armed paramilitary groups." As mentioned previously, if the objectives of the subversives are aligned with those of the people in public offices the problem becomes even worse. Once their goals legitimate become closer to illegality than they are to legal investment, a toxic atmosphere dissuades investors. Under this scenario, legal firms have to displace illegal businesses or to coexist with them which implies competition for resources with businesses that generate a disproportionate

16

amount of benefits.

Finally, activities developed by the Colombian government intended to support educational projects which make the population better prepared to participate in the labor market contribute positively to generate confidence, and make Colombia a country suitable for investments

In close connection with the asset described before is the level of internal security and tranquility which we have also mentioned as one of the state variables or assets in our model. Security and tranquility is a global issue. Yet, in a country under conflict it is a topic of immediate concern. One of the many reasons for concern about the level of security in Colombia is that it is critical for attaining local and foreign investment, which may imply better macroeconomic outputs such as economic growth and the reduction in unemployment rate. Additionally, security creates a stable environment in which the civil population, together with public and private institutions, can strengthen the social fabric.

As noted in my description of the conflict, security conditions in Colombia were of concern during all the years of conflict, and becoming worse during the period 1994-2012 when the conflict reached its highest levels. In this period the number of kidnapings, massacres, and extortions were extremely high[18]. Crimes were conducted in a frame of dispute for strategic territories that gave the subversive groups the strength to continue to be militarily active in the conflict [19].

It is important to note that along with the lack of security experienced in Colombia due to the internal war between the subversives and the Colombian army, the drug cartel's war (specifically the war between Madellin's and Cali's cartel) have marked a long period of violence and insecurity in Colombia. By the end of the 1980s and through the 1990s a cruel

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[18]See table A3 in the appendix

[19]Paramilitaries and guerrillas act according to their benefits, most of the time, regardless of the population's preferences (Salazar and Castillo 2001). The objective of military attacks is to take control of a territory and obtain political dominance, enabling subversives to have the economic control over the resources of the region in dispute.

17

battle raged between Madellin's and Cali's cartel sowing the terror in Colombia. That was the period in which car bombs, kidnapings, and selective killings were the main topics in Colombia's newspapers, radio and television.

Study of the conflict necessarily involves the analysis of the security levels which clearly have been transformed throughout the armed confrontation. The policy of democratic security implemented under the presidential term of Alvaro Uribe Velez made the issue of security a key element given its influence in the social, economic and political development of the country.

During armed conflict, security and tranquility are affected when an actor conducts actions intended to gain control over of a territory dominated by another group. It is widely documented that levels of security and tranquility decrease when there is more than one group trying to occupy a territory for the purpose of taking control over its resources (Angrist and Kugler 2005, Salazar and Castillo 2001, Núñez and Montoya 2014).

Tranquility is directly affected by military activities conducted by the Colombian state in regions dominated by armed groups operating outside of the law.[20] This situation applies to all disputes between all groups. For example, if paramilitaries want to dominate a region of vital importance to them, but guerrillas also have interests in the area, this will decrease the levels of security in that region.

A representative situation of the elements aforementioned is the current fight in Nariño[21], where there are at least four groups involved in an ongoing dispute of its rural territory, which is known by having a big part of land devoted to the cultivation of coca [22].

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[20]We are assuming that levels of violence will increase while the territory is in dispute, but when either the Colombian government or the subversive group takes control of the land, the level of security would increase.

[21]Nariño is a department which borders Ecuador and is located in the South West part of Colombia.

[22] We want to emphasize that even though rebel groups have several sources of funding, the fact that the subversives receive funds from the drug cartels is important to the construction of the game because it creates a bridge between our four internal players. Through the war against the illegal drugs, the U.S government, which is our foreign player, is intervening also in the armed conflict against paramilitaries and guerrillas.

It has been well documented that in municipalities in which armed illegal groups make mutual non-aggression agreements the security and levels of peace increase. According to Nuñez and Montoya (2014), in the department of Arauca [23] between 2006 to 2010 the levels of confrontation between the ELN and FARC to get territorial control resulted in an increase of violence which involved forced displacement, homicides, battles, and planting of IED (Improvised Explosive Devices). By, September 2010, both groups reached an agreement to diminish the armed confrontation. With this agreement emerged a manual called *Normas Unitarias de Comportamiento y Convivencia* (Unitary Norms of Behavior and Coexistence). This manual made explicit the rules of coexistence, punishments and fines that the groups will impose on those who do not fulfill the agreement.

What groups dominate what territory is not the only factor that affects security and tranquility. Colombian government policies oriented to improve the economic opportunities of the population, which include alliances with the private sector, financial and technical support to peasants, and better access to schooling and health care for those living in marginal zones, also contribute to increase indexes of security.

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[23]Arauca is a department located in the East part of Colombia on the border with Venezuela.

6 The Model

The last two sections help us to gain a better understanding of the Colombian conflict and to define the basic elements of the game that we want to describe. We formulate the problem as a dynamic model in which the players are the Colombian government, guerrillas, paramilitaries, drug cartels, and the U.S government. As described above, the players' interaction occurs through the effect of all activities [24] conducted by players on all assets. As in every game, each player has its own payoff function reflecting its assessment of the assets in it.

Assets are denoted by the vector $X \in I \subseteq E^3$. The evolution of these assets is described by the following set of differential equations:

$dx_i/dt = L_i(Z, X, t)$

Where $L_i(Z, X, t)$ is a function representing the effect of activities on asset i when the stock of assets is X. In this system of three equations the levels Z of each activity are our control variables. This function $L_i(Z, X, t)$ makes it clear the effect of the level of an activity conducted by a player on the stock of assets in the game.

From the previous description, we have a system of three ODE (ordinary differential equations) describing the state of the conflict. These equations explain in a simplified way the dynamic relationship between the three assets and the activities or actions taken by every player. Thus, we have the interaction between players through the effect of their activities on the assets as it was previously described.

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[24]The activities in this game are: sending soldiers to the field, investment in projects of social development, improving or strengthening judicial and legislative laws and institutions, eradication of illegal crops, drug interdiction, peaceful conflict resolution, protection of coca crops and drug transportation routes, monetary funding of the Colombian government, in kind/ military assistance, nonmilitary assistance, extortions, massacres, and kidnapings for ransom, enrollment of civilians in illegal groups, forcible displacement of population, and destruction of public infrastructure.

5.1 Payoff Functions

As stated by Salazar and Castillo 2001: the Colombian conflict is mainly a territorial and military dispute among armed organizations to control civilians' behavior, their economic resources, and the whole national territory. In addition, as this conflict has been unusually long, in order to reach their objectives, agents involved in it have to adjust their strategies to the changing circumstances of the country.

This section describes the objectives of the agents by using the notion of payoff functions. Along with the definition of every player's payoff function, a brief explanation of how changes in the assets and some activities affect the payoff functions is provided[25]. This can give us an insight into how the players are related to each other, not only through the dynamic system but in terms of their payoff functions.

Colombian government's payoff function

The main objective of the Colombian government should be to recover the control of regions that today are dominated by subversive groups and the drug cartels [26] Therefore, the Government's objective function is:

$$U^1 = S^1[t_1, X(t_1)] + \int_{t_0}^{t_1} F^1(Z, X, t)dt$$

Where F^1 is an index reflecting the level of socio-political and economic control that the Colombian government has on the country. The elements contributing to measure this indicator are for example: the number of politically motivated assassinations, number of people

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[25] As in the case of the explanation of how activities affect assets, here we are mentioning just the main assets and activities affecting the payoff functions.

[26] In particular, the objective of taking control of these regions should be to improve the quality of life of their citizens. For example, that could be done by improving the security and tranquility conditions (see the document, *Política de Defensa y Seguridad Democrática* (Policy of Defense and Democratic Security), providing more and better job opportunities, and giving equal access to schools, and health services for everybody.

21

killed by illegal groups, the number of regions with public good provision (paved routes, water and energy services, notaries, and public hospitals), number of police stations or military bases actually operating in zones which are affected by the conflict or zones that could be potentially affected by the conflict, percentage of coca crops eradicated, number of attacks perpetrated by illegal groups to the civilians, and number of regions with normal election processes. Additionally, the payoff function contains the term $S^1[t_1, X(t_1)]$ which for the purpose of this research denotes the level of democratic governance. $S^1[t_1, X(t_1)]$ measures the "value of Colombia as a democratic country" at time t_1, when the set of assets is $X(t_1)$. $S^1[t_1, X(t_1)]$ indicates how well Colombia is performing as a country under the rule of law. This could give us a measure of how attractive Colombia is for local and foreign investments and international trade. Regarding this term notice that, first it is related to F^1 because it is assumed that a country where the monopoly of the violence is held by the government that was elected in a democratic way is easy to govern, and second this is a measure of how well Colombia is perceived by the rest of the world in terms of its socio-political performance. It seems to be clear that countries as Chile and Uruguay are better perceived in terms of democratic governance than Colombia, and certainly this issue matters when a country wants to negotiate, for example, with local and foreign investors [27].

This payoff function is negatively affected by the increase in the coca leaf and the improvement in the methods to produce, transport, and commercialize cocaine. This basically denotes the strength of the drug cartels making investments to improve the productivity of illegal businesses related to the illicit drug market. Similarly, the growth of paramilitaries' and guerrillas' income negatively impacts the objective of the Colombian government. As the income of the subversives increases it enables them to recruit people, to dominate regions, to buy armaments, and to be better prepared to fight the Colombian state.

Additionally, the increasing number of people under poverty, and the rising inequality index increase the population vulnerable to rebel groups recruitment[28]. This could be the case

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[27]Variables constituting the democratic governance indicator can be seen in the World Bank's data set called worldwide governance indicators

[28]Vulnerable populations are people living in regions with poor utility services, no paved roads, and deficient

either because individuals see these subversive groups as an opportunity to get a job, or because they are forcibly recruited (Isaza and Campos, 2005). In any case, this negatively affects the government's payoff function.

On the other hand, a positive effect on the government's payoff function occurs when the Colombian government fights paramilitaries and guerrillas who have influenced political elections at local and national levels (see, for example, Acemoglu et al. 2013, and Acemoglu and Robinson 2012). The transparency in both the election process of people occupying public offices and the way in which they govern regions generates an environment of public faith in democracy which ultimately brings benefits to the country as a whole. Similarly, the support of the U.S government through monetary or in-kind aid positively affects the Colombian government's payoff.

Guerrillas' payoff function

Through all the years of the Colombian conflict, guerrillas have politically and economically controlled part of the country's territories with the end to impose their authority on civil society. Ever, since the beginning of the conflict, the guerrillas' activities have been directed to getting political recognition, and taking control of the Colombian state [29] (see for example, the general report of the Historical Memory Group HMG, and Salazar and Castillo 2001). Therefore, the guerrillas' payoff function is:

$$U^2 = S^2[t_1, X(t_1)] + \int_{t_0}^{t_1} F^2(Z, X, t)dt$$

The function $F^2(Z, X, t)$ denotes how much political and economic power guerrillas are getting [30]. It seems that guerrilla groups are aware that the transformation they say they want

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health institutions, and suffer human rights abuses with impunity.

[29]This is how guerrillas frame their ideas of public interest.

[30]That power can be reflected by the number of territories controlled by the guerrillas, the quality and efficacy of armed fronts that they constitute through the years, the intensity and the amount of attacks against the Colombian government and paramilitaries, the money that they receive from kidnappings, racketeering, and their participation in illegal activities, such as illegal mining and drug trafficking. All of these elements

23

is possible through the participation in the political arena, to be able to make decisions that probably have a direct impact on the population. An example of the desire for political participation that the guerrilla groups have is the M19 group. This used to be a guerrilla group that was demobilized in 1990, and since then they have held public offices. Two of the most prominent individuals of this organization, Gustavo Petro [31] and Antonio Navarro Wolff, have been participating in politics after the M19 was demobilized. Gustavo Petro was the mayor of the Colombian capital city, Bogotá, from 2012 to 2015. Navarro Wolff was the governor of Nariño (2008-2011) and the mayor of Pasto (1994-1997). Due to his achievements as mayor, he was named as the best Colombian mayor in 1998. They both became Colombian senators later in their political career.

The term $S^2[t_1, X(t_1)]$ in the guerrillas' payoff function is measuring the value of the guerrillas as a subversive organization at time t_1 when the set of assets is $X(t_1)$. Clearly, this term is going to depend on variables like the security and tranquility in the country, the levels of local an foreign investment and the behavior of the illegal market which are determinants factors of this conflict.

The guerrillas' payoff function is positively affected by the increase of their budget because this increases their ability to cover a bigger proportion of Colombian territory and exert control over its population. This increases opportunities for guerrillas to have people ready to recruit (See Isaza and Campos (2007), Natalia Springer (2012), and Amnista International (2008)). Additionally, the expansion of coca crops and illegal markets favor the budget of the guerrillas, and consequently it has a positive impact on their payoff function [32].

On the other hand, an increase in the government's and paramilitaries' budget and in the in-kind or monetary support from the U.S government to the Colombian state negatively

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reflect their stability as subversive organizations.

[31]Gustavo Petro is candidate to the Colombian presidency in 2018. He belongs to the party "Movimiento Progresistas"

[32]Even though at the beginning of the conflict guerrillas did not have a relationship with the drug cartels, or at least this was not their main objective when they emerged, today the guerrillas get funding from the illegal drug market.

24

affects the guerrillas' payoff function.

Paramilitaries' payoff function

The paramilitaries' main objective is to give protection to big land owners in zones attacked by guerrillas[33]. Paramilitaries take advantage of their relationship with the elite and politicians in zones under their control to dominate and subdue the population (See Acemoglu et al 2013, and Echandia 2013). In that sense, paramilitary groups are maximizing a profit function derived from their activity as self proclaimed "security organizations" which protects the interests of big land owners, cattle ranchers, and drug traffickers. Therefore, their payoff function is:

$$U^3 = S^3[t_1, X(t_1)] + \int_{t_0}^{t_1} F^3(Z, X, t)dt$$

Considering paramilitaries as illegal "security organizations" the term $F^3(Z, X, t)$ is the instantaneous profit obtained by this illegal organizations through the activities in which they provide "security services" [34]. The instantaneous profit function $F^3(Z, X, t)$ is the revenue minus the costs obtained by these groups through their activity as illegal armed groups [35]. In this specific case the revenue is the money obtained from the activities developed by paramilitary groups which will depend on the number of individuals or rich families protected or the size of lands under their domain. However, the costs are those associated with the war.

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[33]This was their objective in their origins (See the second chapter of the general report of the HMG).

[34]Services provided by paramilitaries include threatening and expelling people from their territories to favor individuals interested in running illegal businesses or protecting big land owners from the attacks planned by guerrillas groups. Additionally, according to Human Rights Watch and Amnesty International, paramilitaries are groups that together with the Colombian government are accused of killing innocent people with the argument that they belonged to the guerrilla groups. This is well known as the scandal of false positives.

[35]We can think about F^3 as $P \times m(Z, X, t) - w \times l(Z, X, t) - r \times k(Z, X, t)$ where m is the number of agents that paramilitaries protect or the territories under their control, l is the number of people enrolled in this group and k is the capital used by these groups to conduct their activities. As it is usual w and r denote the price of the labor and capital used by these groups to run their businesses.

These costs are the salaries paid to the soldiers enrolled in paramilitary groups, plus the price times the amount of capital used by these groups in the armed conflict, which in this case could be weapons, vehicles, communication devices, computers, cellphones etc. - all those elements used by these groups in order to be active in the conflict.

The term $S^3[t_1, X(t_1)]$ in the payoff function is the value of paramilitaries as "security companies" at time t_1 when the level of assets is $X(t_1)$. With the objective to obtain control of as many regions in Colombia, paramilitaries have created a reputation as illegal armed groups. That reputation has a value which depends on the level of the assets in dispute in the time t_1.

The paramilitaries' payoff is affected positively by the increase in the number of illegal crops and the prosperity of the drug and contraband markets. As some of the paramilitary groups have been supported financially by the drug cartels, the prosperity of their illegality increases paramilitaries' profit. Similarly, deteriorated security and economic conditions increase both the land owners' need for protection and the willingness of vulnerable people to join a group that guarantees security regardless of its legal status (Amnistía Internacional 2008, Salazar and Castillo 2001).

As it stated in the previous section, paramilitaries' profit is positively affected by their sway in political elections. After the candidate they support wins, many of the policies are adjusted to favor paramilitary groups and their clients.[36]

Finally, as guerrillas are the main subversive groups opposing paramilitaries, an increase in the guerrillas' budget, means more resources to attack paramilitaries. As such, paramilitaries have to spend more resources to protect themselves from military attack. Hence, the expansion of guerrilla groups negatively affects paramilitaries' payoff function.

Drug cartels' payoff function

In spite of the many objectives that drug cartels can pursue through their illegal activities, we

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[36]According to Sevillano and Lopez (2008), by 2000, 40% of the Senate was controlled by the paramilitaries, and many municipalities had Mayors influenced by Paramilitaries.

are assuming that the overriding objective of this player is to increase its profit obtained from the production of illegal drugs. As a consequence, their payoff is a profit function defined by:

$$U^4 = S^4[t_1, X(t_1)] + \int_{t_0}^{t_1} F^4(Z, X, t)dt$$

Where F^4 is an instantaneous profit function. This profit function is the difference between revenues and costs. Notice that the key element for the cocaine production is coca leaf. Since coca is considered crops for illicit use, the whole process since the cultivation of coca plants involves two kinds of costs. One is production cost that every firm producing goods or services has to include in its productive process. The second kind of costs are these associated with the illegal market in which they are involved. Producers of cocaine have to hire private security to protect routes of transportation, crops and the laboratories to process the final product. To trade cocaine, producers have to avoid authorities or bribe them which implies additional costs [37]. These are just a couple of illegal activities associated with the production of illegal drugs. Regarding the term $S^4[t_1, X(t_1)]$, this is the value of the illegal drug firms at time t_1, when the set of assets are $X(t_1)$.

The drug cartels' profits are positively affected by the increase in the number of coca crops and their productivity, as well as a control of the routes to facilitate the distribution of illegal drugs. This positive effect is reinforced by the increase in the budget of those rebel groups which receive funding from drug cartels. By having more resources, these groups are better prepared to help cartels run their businesses.

However, drug cartels' profits are negatively affected by the anti-drug programs led by the

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[37]Assume that the production of cocaine is defined by a function $Q = Af(l, k)$ where l is labor and k is capital. Our model assume also that the amount of drugs produced depends on the number of hectares under coca cultivation $Q = \rho x_1$ where x_1 is the number of hectares with leaf cultivation. Additionally we have $c_1 = w_1 \times l_1 + r \times k$ and $c_2 = w_2 \times l_2$ where w_1 is the wage paid to the labor in the production and w_2 is the money paid in bribes by the cartels or the money used to hire private armed groups. Then, the total cost is $c_1 + c_2$ meaning that in addition to the production costs the drug cartels incur in costs of being producers of an illegal good.

27

Colombian government and supported by the U.S. government (see GAO reports on anti-drug programs). These agreements increase the Colombian government's budget, and as a result the government has more and better resources to fight against drug cartels.

The U.S government's payoff function

The U.S government is maybe the most polemical player because of its influence on Colombia's social, political, and economic issues. However, for the purpose of this research, let us assume that the primary U.S. government objective is to prevent the flow of illegal drugs into the United States and to diminish the power of the drug cartels. Therefore, the U.S government's payoff function is the utility derived from its drug intervention [38].

$$U^5 = S^5[t_1, X(t_1)] + \int_{t_0}^{t_1} F^5(Z, X, t)dt$$

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[38] According to the Memorandum on Certification for Major Illicit Drug Producing and Drug Transit Countries from February 26, 1998: "...Although the Government of Colombia (GOC) has made important progress in some areas this year, the U.S Government (USG) cannot certify Colombia as fully cooperating with the United States on drug control, or as having taken adequate steps on its own to meet the goals and objectives of the 1988 UN Drug Convention. Poor government performance in the extradition debate, lack of a concentrated effort to combat official narcotics-related corruption and still lagging enforcement of strong counternarcotics laws all argue against certification. However, the vital national interests of the United States requires that U.S. assistance to Colombia be provided. The continuing dominance of Colombian cartels in the cocaine industry, their growing role in the heroin trade and the growing role of the guerrillas in shielding and protecting illicit drug production make the challenges in Colombia greater than ever before. To meet these challenges, we need to work even more closely with the GOC to expand joint eradication efforts in new coca growing areas in southern Colombia and in opium cultivation zones, to enhance interdiction, and to strengthen law enforcement. The GOC would not likely approve such an expanded program if denied certification for a third straight time. We have a unique opportunity with significant US-supplied assets deployed and the commitment of the Colombian National Police (CNP) and elements of the armed forces to strong efforts in these areas. However, they will need increased resources and training to perform these tasks adequately. Strong leadership must come from the Colombian government to reform and defend essential democratic institutions, such as the country's judiciary. The coming elections may provide opportunities for further cooperation... The threats to U.S. vital national interests posed by a bar on assistance outweigh the risks posed by Colombia's inadequate counternarcotics performance".

Where, $F^5(Z, X, t)$ measures the instantaneous value of an indicator of effectiveness in the war against illegal drugs along $t \in [t_0, t_1]$. The elements contributing to measure this indicator are the amount of illegal drugs interdicted, the number of drug lords sent to jail, and the outcomes reported by the Colombian government about the war against the market of illegal drugs [39]. The term $S^5[t_1, X(t_1)]$ is the value of the U.S as a "counternarcotics agency" at time t_1, when the set of assets are $X(t_1)$. To better understand $S^5[t_1, X(t_1)]$, think about the U.S government as a company that fights the market of illegal drugs. This firm at time t_1 would have certain value as an anti-narcotic company, this is what we denote by $S^5[t_1, X(t_1)]$. Notice that the term S^5 depends on the outcomes obtained by "the company" through the years in which it was fighting the illegal market, but additionally its value depends on the abilities developed in the business to fight drug cartels, the capital accumulated and the structure consolidated as a company that fights against these kinds of illegal markets.

In this sense, the activities conducted by the U.S government have as their target the illegal drug market [40]. This payoff function is positively affected by the increase in the Colombian efforts to fight drug cartels and subversive groups, the improvement in the life conditions of the Colombian citizens and increased transparency in the political environment. The increase in the number of coca crops and the improvement in the productivity of the illegal drugs' industry have a negative impact on the U.S payoff function (See for example GAO reports, Rojas 2013, and Mejia and Restrepo 2015). Additionally, notice that if the poverty and inequality indexes in certain regions of Colombia get worse, the local population could be easy prey for incorporation into illegal organizations. This definitely would have a negative impact on the objective of the U.S government.

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[39] This includes the amount of hectares of coca crops eradicated, the number of drug cartels' leaders captured, and the amount of illegal drugs interdicted.

[40] See the reports of the United States General Accounting Office (GAO) about the war against the traffic of illegal drugs in Colombia.

5.2 Concept of solution

In the present study we use the Pareto solution concept (see Evans 1922, El-Hodiri 1971, and Schmitendorf and Moriarty 1976) which is a vector maximum concept. The vector can be scalarized using:

$$\max_{Z} \sum_{p=1}^{5} \alpha_p U^p[X, Z, t] \tag{1}$$

subject to: $dx_i/dt = L_i(Z, X, t)$

Where $\alpha_p \in [0, 1]$, with $\sum_{p=1}^{5} \alpha_p = 1$

For simplicity, we re-write the problem to solve as:

$$\max_{Z} \quad \sum_p \alpha_p [S^p(t_1, X(t_1)) + \int_{t_0}^{t_1} F^p(X, Z, t)d\tau]$$

$$\sum_p \alpha_p = 1 \qquad \text{and} \qquad \alpha_p \geq 0 \qquad p = 1, 2, ..., 5$$

$$\text{s.t.} \qquad \dot{x}_i = L_i(X, Z, t)$$

$$h_k(X, Z, t) \geq 0 \tag{2}$$

$$\psi_\theta(t_0, t_1, X(t_0), X(t_1) \geq 0$$

$$G = \lambda_0 \sum_p (S_0^p + S_1^p) + \sum_\theta \gamma_\theta \psi_\theta$$

$$x_{i0} = x_i(t_0) \qquad \text{and} \qquad x_{i1} = x_i(t_1)$$

30

Assuming that functions F, L, and h are continuously differentiable, and if (Z^*, X^*) is a solution of the problem as depicted above, then there exists a vector $(\lambda, \mu) \neq 0$, such that the first order necessary conditions for our problem are as follows:

1. $\mu_k \geq 0$, and $\mu_k h_k = 0$

2. Euler-Lagrange

   2.1 $\dot{\lambda}_m = -\sum_p \alpha_p F^p_{x_m} - \sum_i \lambda_i L_{i_{x_m}} - \sum_k \mu_k h_{k_{x_m}}$
   where $H = \lambda_0 \sum_p \alpha_p F^p + \sum_i \lambda_i L_i + \sum_k \mu_k h_k$

   2.2 $\frac{\partial H}{\partial z_j} = \sum_p \alpha_p F^p_{z_j} + \sum_i \lambda_i L_{i_{z_j}} + \sum_k \mu_k h_{k_{z_j}} \leq 0$

3. $dH/dt = H_t$

4. Transversality conditions

   4.1 $\hat{G}_{t_0} - \hat{H}|_{t=t_0} = 0$

   4.2 $\hat{G}_{t_1} + \hat{H}|_{t=t_1} = 0$

   4.3 $\hat{G}_{x_i 0} - \lambda_i(\hat{t}_0) = 0$

   4.4 $\hat{G}_{x_i 1} - \lambda_i(\hat{t}_1) = 0$

7   Simplified models of the conflict

This section has as its main objective to describe three simple cases which can yield insight about the behavior of the model as a whole. First, we will assume that there are two agents, the Colombian government (player 1) and the drug cartels (player 2). There are two assets: the number of hectares under coca cultivation, x_1 and levels of unrest and insecurity x_2. Every agent is conducting one activity. These are: the eradication of coca leaf which is an activity led by the Colombian government, z_1, and protection and expansion of coca crops which is an activity led by the drug cartels, z_2. After describing the model under this circumstance we will add the guerrillas as a new agent (player 3). We assume that guerrillas

will develop one activity, which is to cooperate with drug cartels in the illegal market as their armed wing, z_3. From this activity guerrillas receive income which adds more resources to their budget. The third part of this section explores the idea of the legalization of cocaine. At this point, we illustrate what would happen in the model if both the Colombian and the U.S.A governments allow the production, distribution, and consumption of cocaine. In this model we allow the guerrillas to develop two activities: the first is racketeering on the new legal cocaine industry, $\hat{z}_3$. Guerrillas' second activity consists of perpetrating attacks against the Colombian government, z_4. This activity has the objective of making the Colombian government more vulnerable in economic and political terms. We also allow a second activity for the government which consists of military responses to guerrillas' attacks, z_5. Given that under a hypothetical legalization of cocaine, the Colombian government has to support the legal cultivation and processing of coca leaf for cocaine as it has to do with any legal industry, the activity z_1 is replaced by activity $\hat{z}_1$ which is an activity developed by the Colombian government in order to protect and give support to the cocaine industry. Therefore, we will analyze the legalization of cocaine in a country that faces an internal armed conflict. Notice that in a legalization framework subversive groups have to offset their budget through other legal or illegal activity given that they are not going to receive a direct income from the cocaine market.

7.1   The Colombian government and the drug cartels.

During the period of intense war against illegal drugs, drug cartels wanted to destabilize the Colombian government to better run their business, but also to avoid risks like extradition to the U.S. As noted by Guaqueta (2005), "increasingly, Colombian drug traffickers resorted to corruption and violence to protect the illegal industry and persuade government officials to block extradition to the U.S. and instead grant them a bargained amnesty. Members of the Medellín cartel assassinated government officials, judges, and journalists. Drug traffickers fostered training schools of hit men and ordered bomb attacks that terrorized Bogotá, Cali, and Medellín for most of the 1980s until 1992".

We turn now to the first model in which we deal with two agents, the Colombian government (player 1) and the drug cartels (player 2). As argued in the previous section, the objective is to maximize the scalarized vector:

$$\max_{z_1, z_2} \quad \alpha_1 \left[S^1(1, x(1)) + \int_0^1 F^1(t, x_1, x_2, z_1, z_2) dt \right] + \alpha_2 \left[S^2(1, x(1)) + \int_0^1 F^2(t, x_1, x_2, z_1, z_2) dt \right]$$

$$\text{where} \quad \alpha_1 + \alpha_2 = 1, \alpha_1 \geq 0, \alpha_2 \geq 0$$

$$\textbf{s.t:}$$

$$\dot{x}_1 = z_2 - z_1$$

$$\dot{x}_2 = V(x_1) + k$$

$$x_1(0) = \psi, x_1(1) = a\psi$$

$$x_2(0) = \gamma, x_2(1) = b\gamma$$

$$\text{where} \quad 0 < a < 1, 0 < b < 1$$
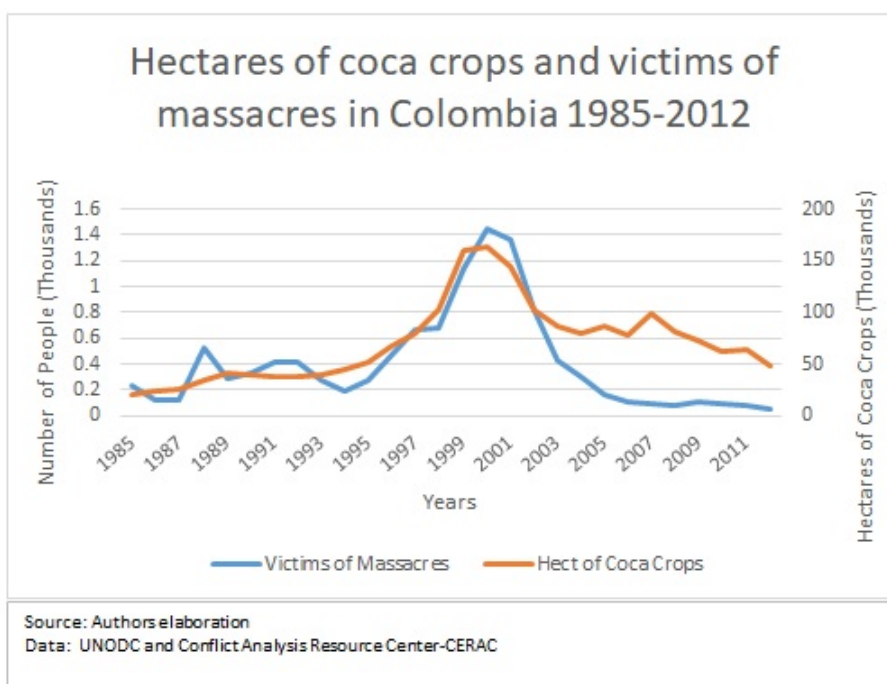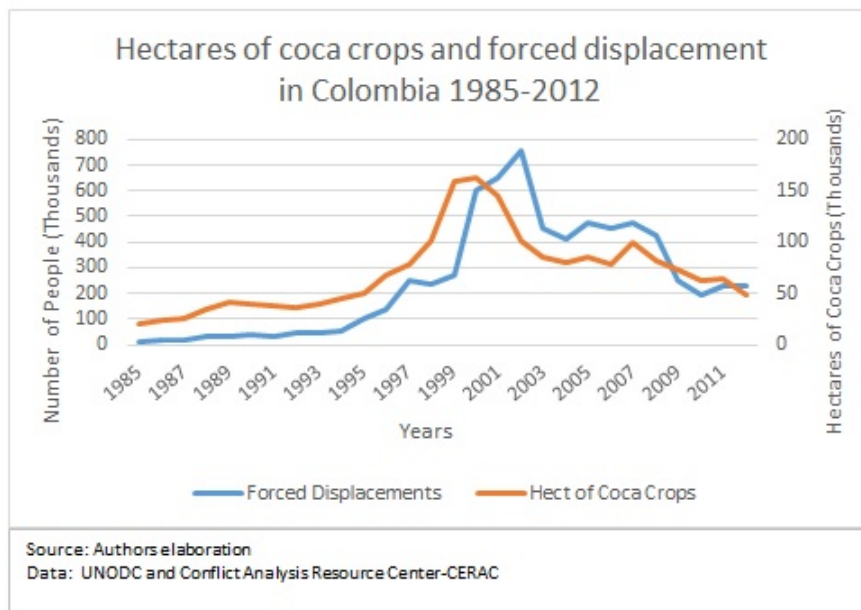
$$\gamma > 0, \psi > 0$$

(3)

Before writing the Hamiltonian of this problem and its first order conditions let us explain some of the equations and variables of this dynamic problem. x_1 is the number of hectares under coca cultivation and x_2 represents an index measuring the level of insecurity and violence in the country [41]. Defining $\dot{x}_2 = V(x_1) + k$ we are acknowledging that the war against illegal drugs has an impact on the levels of insecurity and violence in Colombia, but we are also saying that in a country under internal armed conflict there are other sources of insecurity and violence that we define as a positive constant k. That is why even if $V(x_1) = 0$ there exists certain levels of insecurity in the country related to the armed conflict. Increments in the number of areas under coca cultivation would increase the levels of unrest and insecurity. The model reflects this relationship through the equation $\dot{x}_2 = V(x_1) + k$ in which we assume that the derivative of the function $V(x_1)$ with respect to x_1 is positive.

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[41] As noted, this index measures things like selective death, kidnappings, massacres, victims of land-mines and forced displacement among others indicators of violence and insecurity.

33

The variable $\dot{x}_1$ is simply saying that the variation in the number of hectares under coca cultivation depends on the efforts made by drug cartels to protect and to expand those territories with coca leaf production, minus the efforts that the Colombian government does to decrease the number of such territories through coca leaf eradication and interdiction of cocaine. In this model more hectares under coca cultivation means more territories controlled by the drug cartels which negatively affects the Colombian government's payoff function, $S^1(1, x(1)) + \int_0^1 F^1(t, x_1, x_2, z_1, z_2)dt$, but positively affects the drug cartels' payoff function, $S^2(1, x(1)) + \int_0^1 F^2(t, x_1, x_2, z_1, z_2)dt$.

The initial and final conditions imposed on this simplified model reflect the situation between 2001 and 2012, where according to the United Nations Office on Drugs and Crime (UNODC) the hectares under coca cultivation dropped from 145,000 to 48,000. Regarding $x_2(1)$ the graphs below display that two of the main indexes of violence have also decreased from 2001 to 2012 [42]. Through these graphs we are not implying that there exists a causal relationship between the evolution of these variables. However, it is interesting to note the strong correlation among coca cultivation (as an agricultural activity) and forced displacements and the victims of massacres which are all indicators of violence based on land disputes.

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[42] Even though we are interested now in the period 2001-2012, the graphs show the evolution of coca crops, victims of massacres, and forced displacements from 1985 to 2012.

Hectares of coca crops and forced displacement in Colombia 1985-2012

Number of People (Thousands): 800, 700, 600, 500, 400, 300, 200, 100, 0

Hectares of Coca Crops (Thousands): 200, 150, 100, 50, 0

Years: 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011

— Forced Displacements   — Hect of Coca Crops

Source: Authors elaboration
Data: UNODC and Conflict Analysis Resource Center-CERAC

Hectares of coca crops and victims of massacres in Colombia 1985-2012

Number of People (Thousands): 1.6, 1.4, 1.2, 1, 0.8, 0.6, 0.4, 0.2, 0

Hectares of Coca Crops (Thousands): 200, 150, 100, 50, 0

Years: 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011

— Victims of Massacres   — Hect of Coca Crops

Source: Authors elaboration
Data: UNODC and Conflict Analysis Resource Center-CERAC

After explaining the variables and equations involved in our first model let us write the

35

Hamiltonian:

$$H(x_1, x_2, z_1, z_2, t) = \alpha_1 F^1(x_1, x_2, z_1, z_2, t) + \alpha_2 F^2(x_1, x_2, z_1, z_2, t) + \lambda_1(z_2 - z_1) + \lambda_2(V(x_1) + k)$$

The first order conditions (f.o.c.) are:

(1) $\alpha_1 F^1_{x_1} + \alpha_2 F^2_{x_1} + V_{x_1}\lambda_2 = -\dot{\lambda_1}$

(2) $\alpha_1 F^1_{x_2} + \alpha_2 F^2_{x_2} = -\dot{\lambda_2}$

(3) $\alpha_1 F^1_{z_1} + \alpha_2 F^2_{z_1} - \lambda_1 \leq 0$

(4) $\alpha_1 F^1_{z_2} + \alpha_2 F^2_{z_2} + \lambda_1 \leq 0$

(5) $H_t = \frac{\partial H}{\partial t}$

In equations (1) and (2), λ_1 and λ_2 represent the marginal change in the value function when x_1 and x_2 change respectively. In the case of λ_1 we can say that this is the shadow price of a hectare of land under coca cultivation. In the case of λ_2 this is the cost of a change in the levels of violence.

Regarding the signs of $F^1_{x_1}$ and $F^2_{x_1}$ in the equations above, as mentioned in the previous section, an increase in the number of coca crops negatively affects the Colombian government's payoff function, while it positively affects drug cartels' payoff function. Therefore, $F^1_{x_1} < 0$ and $F^2_{x_1} > 0$. In addition, an increase in the level of unrest and insecurity makes the Colombian government more instable and a more instable government is less capable of controlling the drugs market and other kind of illegal businesses. Therefore, increasing levels of insecurity positively affect drug cartels' payoff, while it negatively affects the Colombian government payoff. Then, $F^1_{x_2} < 0$ and $F^2_{x_2} > 0$.

Let us assume that this problem has an interior solution, meaning $Hz_1^* = Hz_2^* = 0$ which implies $z_1^* > 0$ and $z_2^* > 0$. From equation (3) and (4) in the f.o.c we have:

$$\alpha_1 F^1_{z_1} + \alpha_2 F^2_{z_1} = -(\alpha_1 F^1_{z_2} + \alpha_2 F^2_{z_2})$$

Rearranging this equality we obtain $\alpha_1 F^1_{z_1} + \alpha_2 F^2_{z_2} = -(\alpha_1 F^1_{z_2} + \alpha_2 F^2_{z_1})$. This is saying that to have an interior solution the marginal instantaneous benefits generated by z_1 and z_2 must

36

be equal to the marginal costs imposed by z_1 and z_2 on every player. At this point it is important to note that this model takes into consideration the externalities generated by the actions of each player. These externalities would not be taken into account if we solve this problem using the Nash equilibrium as our solution concept. In a Nash equilibrium solution each player takes each others activity as given, so the externalities which we are denoting as important in the Colombian conflict would disappear. Instead of that, we are saying that if in the optimum marginal benefits are equal to marginal costs, then activity levels are positive.

In addition of having the equality between marginal benefits and marginal costs, it is important to mention that the initial and final conditions for x_1 and x_2 preclude the possibility of having an interior solution in which $z_1 = z_2 > 0$. This is not possible because then we would have $\dot{x}_1 = 0$, meaning that x_1 is constant which is not true because the value of that variable when $t = 0$ is different from its value when $t = 1$. The same argument applies for a corner solution in which situation $H_{z_1^*} < 0$ and $H_{z_2^*} < 0$. In that case $z_1^* = z_2^* = 0$, and we would face the same issue of having $\dot{x}_1 = 0$ which is not possible given the initial and final conditions of our model.

Even though the situations described above are not allowed to be part of a solution we want to emphasize that changing the final condition for x_1, or the differential equation $\dot{x}_1$ [43] to allow for a corner solution, $z_1^* = z_2^* = 0$ to exist, it would generate a constant path for x_1. It is interesting to note that a corner solution would imply $\alpha_1 F_{z_1}^1 + \alpha_2 F_{z_2}^2 < -(\alpha_1 F_{z_2}^1 + \alpha_2 F_{z_1}^2)$ meaning that if marginal costs are greater than marginal benefits of conducting z_1 and z_2 the optimal level of activities are $z_1^* = z_2^* = 0$. This would represent a situation in which continuing the conflict means that everybody in the margin is losing more than they are winning and this provides an opportunity to reflect and create alternative approaches to solve the conflict.

There are four important aspects to highlight in the first simplified model: the variation of

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[43] For example, we could write $\dot{x}_1 = z_2 - z_1 + \Omega$ with $\Omega > 0$, this allows us to have a corner solution and an interior solution with $z_1 = z_2 > 0$. However, for our purposes we are interested in a problem where $\dot{x}_1 = z_2 - z_1$.

the land under coca cultivation is dependent on the efforts made for each player according their interests. The amount of land under coca leaf cultivation which generates a dispute between these two agents is affecting the levels of insecurity and violence. Moreover, positive levels of z_1^* and z_2^* are supported by the equality between marginal benefits and marginal costs. This is similar to the case of a firm's profit maximization in which it produces until reaching the point that makes marginal revenues equal to marginal costs. Lower values of a and b imply a bigger z_1, leading to a reduction in both x_1 and x_2. Finally, the initial and final conditions of this model preclude both the possibility to have an interior solution with $z_1 = z_2 > 0$, and to have a corner solution with $z_1 = z_2 = 0$.

Although the boundary conditions imposed on our state variables exclude the possibility of having a corner solution, this does not prevent us from saying that, if a corner solution were allowed, it would reflect a situation in which the marginal costs are greater than the marginal instantaneous benefits of conducting activities z_1 and z_2. This finding is important because it reflects the rationality of the acts carried out by the agents in this conflict who are not willing to take an action that is against their own interests.

7.2 The Colombian government, drug cartels and subversive groups.

Let us now add guerrillas (player 3) to the previous model. In this model we assume that guerrillas conduct one activity denoted z_3, which is cooperation with the drug cartels to effectively run the illegal drug market. Thus, more hectares under coca cultivation means more territories controlled by the drug cartels and the subversive groups that cooperate with them, which negatively impacts the Colombian government's payoff function, but would positively affect drug cartels' and guerrillas' payoff functions. The rest of the model remains the same. We have three agents, the Colombian government, drug cartels, and guerrilla groups, each one of them conducting specific activities to maximize their own interests, which will be reflected in their payoff functions, and in the externalities that their actions impose on the other agents participating in the conflict. This model is defined by the following

equations:

$$\max_{z_1,z_2,z_3} \quad \sum_{i=1}^{3} \alpha_i \left[S^i(1, x(1)) + \int_0^1 F^i(t, x_1, x_2, z_1, z_2, z_3) dt \right]$$

where $\quad \sum_{i=1}^{3} \alpha_i = 1, \alpha_1 \geq 0, \alpha_2 \geq 0, \alpha_3 \geq 0$

s.t:

$$\dot{x_1} = z_2 + z_3 - z_1 \tag{4}$$
$$\dot{x_2} = V(x_1) + k$$
$$x_1(0) = \psi, x_1(1) = a\psi$$
$$x_2(0) = \gamma, x_2(1) = b\gamma$$

where $\quad\quad\quad 0 < a < 1, 0 < b < 1$

$$G = \lambda_0[S^1(1, x(1)) + S^2(1, x(1))] + x(t_1)$$

In this new model of the conflict we are taking into consideration that guerrillas have an indirect effect in the levels of unrest and insecurity through the activity z_3 which affects $\dot{x_1}$, whose variable is affecting $\dot{x_2}$. Guerrilla groups are part of the illegal drug market and through it they are negatively affecting the levels of unrest and violence. This relationship between subversive groups and drug cartels makes the business of illegal drugs stronger and provides monetary resources to the subversives to continue fighting the Colombian government. This positively affects guerrillas' payoff function, but negatively affects the Colombian government's payoff function.

The Hamiltonian of this problem is:

$$\sum_{i=1}^{3} \alpha_i \left[F^i(t, x, z_1, z_2, z_3) dt \right] + \lambda_1(z_2 + z_3 - z_1) + \lambda_2(V(x_1) + k)$$

and the first order conditions are:

(1) $\sum_{i=1}^{3} \alpha_i \left[F_{x_1}^i(t, x, z_1, z_2, z_3) \right] + V_{x_1} \lambda_2 = -\dot{\lambda_1}$

(2) $\sum_{i=1}^{3} \alpha_i \left[F_{x_2}^i(t, x, z_1, z_2, z_3) \right] = -\dot{\lambda_2}$

39

(3) $\sum_{i=1}^{3} \alpha_i \left[F_{z_1}^i (t, x, z_1, z_2, z_3) \right] - \lambda_1 \leq 0$

(4) $\sum_{i=1}^{3} \alpha_i \left[F_{z_2}^i (t, x, z_1, z_2, z_3) \right] + \lambda_1 \leq 0$

(5) $\sum_{i=1}^{3} \alpha_i \left[F_{z_3}^i (t, x, z_1, z_2, z_3) \right] + \lambda_1 \leq 0$

(7) $H_t = \frac{\partial H}{\partial t}$

In this model it is important to note that the initial and final conditions for x_1 and x_2, preclude the possibility to have a corner solution in which $z_1^* = z_2^* = z_3^* = 0$. This is not possible due to the same reasoning following in the previous simplified model. We then assume that this model has an interior solution, meaning $Hz_1^* = Hz_2^* = Hz_3^* = 0$ which implies $z_1^* > 0$, $z_2^* > 0$, and $z_3^* > 0$ [44]. Equations (3) to (5) show us that to have an interior solution the marginal instantaneous benefits generated by z_1, z_2 and z_3 must be equal to the marginal costs imposed by these activities on every player.

7.3 Legalization of production and consumption of cocaine as one option to explore in this conflict.

The analysis conducted so far has shown that the problem of the trafficking of illegal drugs in Colombia has involved all the players in the Colombian conflict. Guáqueta (2005) refers to the 1971 treaty as the first phase of cooperation between the U.S and Colombia. At that time, drugs and drug trafficking were declared a problem and placed on the diplomatic agenda. Since then, the governments of both countries have developed strategies to fight the market of illegal drugs. Trafficking of illegal drugs worsened the armed conflict in Colombia because as it was mentioned before in this document, drug traffickers use corruption and violence to protect their illegal industry. In addition, it is now clear that subversive groups, such as guerrillas and paramilitaries, use the proceeds coming from the illegal drug industry to finance

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[44]Notice that we have excluded the possibility of having a $z_j = 0$ because this leads us to a contradiction with the initial and final conditions for x_1.

their wars against the Colombian government. The leaders of the drug cartels fight against the government to persuade its members to abolish extradition to the U.S[45] and at the same time, these cartels, finance subversive groups which are fighting the Colombian government. Guáqueta (2005) mention that " guerrilla groups had begun raising funds through illegal "taxes" charged to coca-growing peasants and drug laboratory owners operating in their zones of influence. Their greater economic capacity slowly allowed for the expansion of troops." In a similar way paramilitary groups have participated in the business of illegal drugs. Like the guerrillas, they have grown steadily thanks to the financial resources coming from illegal activities like drug trafficking, kidnappings for ransom and extortions.

Even though guerrillas and paramilitaries obtain resources from illegal activities other than trafficking drugs, drugs related incomes have become the largest part of their earnings. In that sense the business of illegal drugs imposes a security threat because of the money that they provide to subversive groups. Thus, the cooperation offered by the U.S government to fight drugs in Colombia is affecting the overall conflict. In 1999 the governments of the two countries signed an initiative, called Plan Colombia, to reduce the cultivation, processing, and distribution of narcotics. Through this agreement the U.S government gave monetary and in-kind assistance to the Colombian government. Due to the relationship established between drug cartels and subversive groups, and the intensification of the war on terrorism after 2001, the U.S government also justified monetary and in-kind assistance to combat illegal armed groups[46]. According to Guáqueta (2005), in October 2001 guerrillas and paramilitaries were included in the U.S list of international terrorists. The strategy of cooperation between U.S.A and Colombia has two main objectives: first, to reduce the production and trafficking of illegal drugs (mainly cocaine) by 50 percent withing a period of six years, and second, to improve security conditions in Colombia by recovering control over large areas of the country that were in the hands of illegal armed groups (see Mejia, D. 2016).

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[45]In this context extradition occurs when a Colombian trafficker is charged with a crime in the U.S and the U.S government asks the Colombian authorities to move that person to the U.S to be accused in trial.

[46]Here we see the emergence of the discursive importance of the concept of narcoterrorism, promoted by the Bush administration

Regarding the levels of security and tranquility in Colombia, it is well documented that the illegal drug market brings an increase in violent acts. Organizations in this market protect their businesses and their properties mainly through violence since they cannot claim protection from the judicial system and the Colombian police. In Colombia, violence has steadily increased along with the growth of the cocaine market (Mejá and Restrepo 2013 a, and Angrist and Kugler 2005). There are multiple examples of territorial disputes among different illegal armed groups to dominate strategic zones with the end of cultivating coca, and then produce and transport the cocaine to its final destination. This part of the conflict takes place in regions suitable for growing coca, or regions which are near the main ports, such as Urabá, Valle del Cauca, Nariño, and Catatumbo. Even after signing the peace agreement with the FARC, Colombia faces high levels of violence in some municipalities in these regions mentioned above, but specially in a municipality called Tumaco (a municipality of Nariño). One among many reasons why there exists such high levels of violence in Tumaco is the opposition of multiple illegal groups to coca eradication programs. In Tumaco there are violent confrontations among dissident groups of the guerrilla and paramilitary groups, criminal bands, drug lords, and the Colombian government to get control over the resources in that municipality.

It is clear that both Colombia and the U.S.A have invested a lot of resources on the war against drugs. In addition to the monetary resources invested in this war, more than 57,000 Colombians are estimated to have been killed between 1994 and 2008 as a consequence of the illicit drug markets and resulting confrontations between drug trafficking organizations and the Colombian government during the war on drugs (See Mejia 2016). However, Colombia still is one of the main producers of illegal drugs.

According to Mejía (2016), the efforts made by both Colombian and the U.S government to curb the supply of cocaine through eradication and interdiction have resulted in decreasing the net cocaine supply. However, the retail price of cocaine in the USA has increased. Thus, the cooperation between the two countries has a net result in the reduction in cocaine supply, so there are less drugs on streets. However, if the price increases more than the supply decreases

42

one can think that the counter-narcotic war is making the profitability of this business grow, which is not a desirable outcome for many reasons. First, drug cartels have more resources to hire illegal armed groups to protect their business. As a consequence, these groups get more money to fight the Colombian government. Second, the level of violence needed to control these zones suitable to produce coca and the corridors to transport the final goods increases due to the high profitability of the business. Finally, the drug cartels get more power to bribe people in order to avoid being persecuted, and to control more territories in a political and economic fashion. All these things together make it more difficult to think about a possible end to the conflict.

After decades of Colombian and USA governments' fighting against the market of illegal drugs, some academics have drawn the conclusion that the outcomes of the repressive strategy are ambiguous and at some point the prohibition of production and consumption of drugs gets the opposite effect of this for what counter-narcotic policies were created for, bestowing unusual profitability on the drug trade. Under this scenario, the Colombian government has to face stronger subversive groups and wealthier and more vigorous drug cartels which through the years have been more involved in the socio-political life of Colombia. If neutralizing terrorist groups and ending internal conflicts is the principal objective in the international agenda and drugs constitute one of the main financial sources for subversive groups, this is the time to look at narcotics policies and the drugs themselves in a different way.

It seems like the character of the illegal drug trade is one of the factors bringing high profitability to this industry, as well as high levels of violence (see Mejía and Restrepo 2013 a). In the Colombian case, all of this brings support to the illegal armed groups which are fighting the Colombian government to achieve political-economic power. An attempt to simultaneously legalize narcotics in Colombia and the USA could be explored as a new strategy to deal with Colombia's civil strife. Among many effects that this policy could bring, at least three of them emerge as the most relevant for this research: first, the funds of illegal armed groups may shrink, second a legal and a highly profitable industry would attract more firms to the market which can be translated into lower internal and external price of cocaine, and

43

third, the Colombian government can collect taxes from the new legalized industry.

With the previous discussion in mind, let us now think about a hypothetical legal drug market. The role of the agents in this conflict would change if the U.S and Colombian governments simultaneously legalize the production and distribution of cocaine. For example, drug cartels would not be interested any more in attacking the Colombian government in order to protect their business, and the Colombian government would have no interest in dismantling drug cartels. On the contrary, as a new legal industry the Colombian government would be interested in protecting the coca market to benefit from the taxes of that industry. However, under legalization, the drug cartels would not need the protection of subversive groups to run their business, and they would lose their main source of monetary income. In the new expression of the model we assume that the legal coca industry is affected by the attacks of subversive groups. That is, the Colombian government protects the coca industry because it is now a legal industry from which the government obtains taxes. However, as subversives know the high profitability of the coca business, they want to continue getting benefits from it which negatively affects this hypothetical legal industry through racketeering. We write that affectation as a reduction on x_1 which is the main component of cocaine. This model also reflects that the dispute between the government and the subversives affects the levels of violence and security.

The equations describing the model under legalization are as follows:

$$\max_{\hat{z_1}, z_2, \hat{z_3}, z_4} \quad \sum_{i=1}^{3} \alpha_i \left[S^i(1, x(1)) + \int_0^1 F^i(t, x_1, x_2, \hat{z_1}, z_2, \hat{z_3}, z_4) dt \right]$$

$$\text{where} \quad \sum_{i=1}^{3} \alpha_i = 1, \alpha_1 \geq 0, \alpha_2 \geq 0, \alpha_3 \geq 0$$

s.t:

$$\dot{x_1} = \hat{z_1} + z_2 - \hat{z_3} - \eta x_2 \tag{5}$$

$$\dot{x_2} = \frac{z_4 + z_5}{z_5^2} + k$$

$$\text{where:} \qquad \eta > 0, \text{and} \qquad k > 0$$

$$x_1(0) = \psi, x_1(1) = c\psi$$

$$x_2(0) = \gamma, x_2(1) = b\gamma$$

$$\text{where:} \qquad 1 < c < l, 0 < b < 1$$

Taking into consideration that the objective of this research is not to eliminate guerrillas but trying to provide ways to solve the conflict, we have to acknowledge that insecurity is a consequence of the conflict, and not a consequence of the existence of the guerrillas per-se. In order to acknowledge this fact, before describing the first order conditions of the problem, let us see how the idea of legalization imposes a new structure on the model elaborated above. $\hat{z_1}$ is the support giving by the Colombian government to the new legal coca industry and $\hat{z_3}$ is the racketeering the subversive groups impose upon the owners of coca firms in oder to have the monetary resources to continue fighting the Colombian government.

Regarding the term ηx_2 in the equation for $\dot{x_1}$, we want to make it clear that under legalization cocaine firms, as well as many other legal firms, could be targeted by criminal organizations that perpetrate violent acts. Accordingly, x_2 is negatively affecting x_1 which is the state variable denoting the number of hectares under coca cultivation and we assume that a negative effect on the inputs of cocaine is somehow negatively affecting the coca industry.

The equation describing the evolution of the levels of insecurity, $\dot{x_2}$, is showing that the attacks conducted by subversive groups against the Colombian government, z_4, will increase $\dot{x_2}$. Similarly, the military response conducted by the Colombian government to the subversives'

attacks have the unintended effect of increasing the levels of insecurity because the cross fire between subversives and the Colombian army makes people flee their lands losing their assets due to the fear of being a victim of combat. It is also well documented that many people fled their natal territories even before combat starts as precautionary measures. As stated above, it is not the presence of a subversive group per-se which causes insecurity and fear, but the dispute between two or more groups which increase the levels of insecurity. It is well documented (See Salazar and Castillo 2001) that in certain regions completely ruled by one group (no matter if the group dominating is legal or illegal) civilians feel some sort of peace and order, but this false sensation of tranquility often ends when political and economic power is in dispute by two or more groups. We are not trying to argue here that a nation can be in the hands of illegal groups with the condition that their rules bring some sort of "order" and "peace". What we are pointing out is that even when legal institutions fight illegal ones to recover the monopoly of violent power(Max Weber), that transition period generates insecurity while the legal forces recovers control in that disputed territory. This last argument is reflected in the denominator of the first term of equation $\dot{x}_2$. The dispute between subversives and the Colombian government both contribute to having a bigger x_2. However, the fact that in the denominator we included z_5^2 indicates that when z_5 gets bigger the whole term $\frac{z_4+z_5}{z_5^2}$ gets smaller, contributing less to x_2. So, z_5 generates a collateral effect positively contributing to x_2 through z_5 in the numerator, but it also contributes to get x_2 down since it appears as z_5^2 in the denominator of that expression. The constant term k in that equation is denoting other elements contributing to the levels of insecurity that we consider here as exogenous to our model.

The Hamiltonian of this problem is:

$$\sum_{i=1}^{3} \alpha_i \left[F^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4)dt \right] + \lambda_1(\hat{z}_1 + z_2 - \hat{z}_3 - \eta x_2) + \lambda_2(\frac{z_4 + z_5}{z_5} + k)$$

and the first order conditions are:

(1) $\sum_{i=1}^{3} \alpha_i \left[F_{x_1}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] = -\dot{\lambda}_1$

46

(2) $\sum\limits_{i=1}^{3} \alpha_i \left[F_{x_2}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] - \eta \lambda_1 = -\dot{\lambda_2}$

(3) $\sum\limits_{i=1}^{3} \alpha_i \left[F_{\hat{z}_1}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] + \lambda_1 \leq 0$

(4) $\sum\limits_{i=1}^{3} \alpha_i \left[F_{z_2}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] + \lambda_1 \leq 0$

(5) $\sum\limits_{i=1}^{3} \alpha_i \left[F_{\hat{z}_3}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] - \lambda_1 \leq 0$

(6) $\sum\limits_{i=1}^{3} \alpha_i \left[F_{z_4}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] + \lambda_2 z_5^{-2} \leq 0$

(7) $\sum\limits_{i=1}^{3} \alpha_i \left[F_{z_5}^i(t, x_1, x_2, \hat{z}_1, z_2, \hat{z}_3, z_4, z_5) \right] - \lambda_2(2z_5^{-3} z_4 + z_5^{-2}) \leq 0$

(8) $H_t = \frac{\partial H}{\partial t}$

λ_2 in equation (2) it showing the effect of a change in x_2 on the optimum. That is the marginal variation in the optimal from $t = 0$ to $t = 1$ generated by a change in x_2 in t. So λ_2 is a measure of how a change in the environment of unrest and insecurity affects the optimum. The co-state variable λ_1 is the shadow price of the land under coca cultivation which depends on the effect of a change in x_1 on the weighted instantaneous benefits of all agents involved in the armed conflict.

As mentioned before, some things have changed in this model with respect to the previous two models described in this section. In the model we now have a legal cocaine market which the Colombian government supports. So activity $\hat{z}_1$ is an activity promoting the coca industry. Drug cartels can now enforce their contracts through the Colombian courts. We thus have actions conducted by the Colombian government and the drug cartels which favor the cultivation of coca plants.

Subversives do not have the direct financial source from the traffickers in this new model, where $\hat{z}_3$ is the racketeering activity conducted by subversive groups against drug cartels. This activity would negatively affect the coca industry so we reflected that as a negative variation in x_1. Subversive groups continue the war against the government attacking State

47

offices and infrastructure to make the government more vulnerable. The activity against the Colombian government is denoted by z_4 and this appears in the equation that defines the variation of x_2. These attacks negatively affect the levels of security and tranquility, and low levels of security affect the local level of investment. We denote this effect on the cocaine industry as $-\eta x_2$ in the equation defining the variation of x_1.

Additionally, we need to take into consideration that under legalization $F_{\hat{z}_1}^2 > 0$ because the activities conducted by the government and its institutions are intended to protect the new industry. Under a scenario of legalization we also have $F_{z_2}^1 > 0$ because activities conducted by cocaine firms to make their business grow imply more income for the government through taxes, more employment and less violence if the government exerts its monopoly over coercive violence. All of these elements positively affect the Colombian government's payoff function.

Regarding the activities conducted by the subversive groups under the legalization scenario, notice that $F_{\hat{z}_3}^3 \geq 0$ as it was $F_{z_3}^3$, but now the activity $\hat{z}_3$ is not an activity of cooperation with the drug cartels. Instead we assume that subversives extort firms devoted to the production and commercialization of cocaine. As the relationship between drug cartels and subversives have changed it has an impact on $F_{\hat{z}_3}^2$ and $F_{z_4}^2$. Before the legalization of cocaine our model assumed that the action conducted by subversives to destabilize the Colombian government positively affected the drug cartels' payoff function because a weaker government makes it easier for an illegal organization to run its business. However, under a legalization framework a weaker government does not give any guarantee to any productive business enterprise. Therefore, under a scenario of legalization, $\hat{z}_3$ and z_4 negatively affect the payoff function of the new legal industry of cocaine. With a legal market $F_{\hat{z}_3}^2 < 0$ and $F_{z_4}^2 < 0$.

As in the models previously analyzed in this section, here there is no room for a corner solution[47]. Then, let us assume that we have an interior solution meaning $H_{\hat{z}_1}^* = H_{z_2}^* = H_{\hat{z}_3}^* = H_{z_4}^* = H_{z_5}^* = 0$. From equations (3) and (5) the interior solution implies that the weighted marginal benefit and costs of activities z_1 and z_3 are equal between each other. On the LHS of the equation below, we have the sum of the costs that activities $\hat{z}_1$ and $\hat{z}_3$ impose

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[47]The reason is that the construction of variable $\dot{x}_2$ does not allow z_5 to be equal to zero.

on the agents involved in the conflict, while on the RHS there is the sum of the marginal benefits that these activities generate.

$$-(\alpha_1 F^1_{\hat{z}_3} + \alpha_2 F^2_{\hat{z}_3} + \alpha_3 F^3_{\hat{z}_1}) = \alpha_1 F^1_{\hat{z}_1} + \alpha_2 F^2_{\hat{z}_1} + \alpha_3 F^3_{\hat{z}_3}$$

The same is true for activities z_2 and $\hat{z}_3$ when we compare equations (4) and (5). In the equation below, we have equality between marginal costs and benefits generated by these two activities.

$$-(\alpha_1 F_{\hat{z}_3^1} + \alpha_2 F_{\hat{z}_3^2} + \alpha_3 F^3_{\hat{z}_2}) = \alpha_1 F^1_{z_2} + \alpha_2 F^2_{z_2} + \alpha_3 F^3_{\hat{z}_3}$$

With respect to equations (6) and (7), as we can see below, the interior solution imposes the equality between marginal costs and benefits of activities z_4, and z_5. However, we now have the expression $(\frac{2z_4}{z_5} + 1)$ affecting that equality. Notice that in this case increments on activity z_4 impose costs on the Colombian government and cocaine firms' expand. The expression $(\frac{2z_4}{z_5} + 1)$ is to some extent weighting the externalities of that activity on these two agents. On the RHS, the expression $(\frac{2z_4}{z_5} + 1)$ is affecting the change in the instantaneous benefits of the subversive group. Overall, the interior solution requires instantaneous marginal benefits and costs to be equal.

$$-[(\frac{2z_4}{z_5} + 1)(\alpha_1 F^1_{z_4} + \alpha_2 F^2_{z_4}) + \alpha_3 F^3_{z_5}] = \alpha_1 F^1_{z_5} + \alpha_2 F^2_{z_5} + [(\frac{2z_4}{z_5} + 1)\alpha_3 F^3_{z_4}$$

It is interesting to notice how if, for example, we have an interior solution in which $\hat{z}_1 + z_2 = \hat{z}_3$, meaning that the activities conducted by the government and the new entrepreneurs just counterbalance the racketeering activity $\hat{z}_3$. This is not enough to protect the new legal cocaine business when a country is facing an internal conflict because the term ηx_2 is still an element that negatively affects x_1. This situation allows us to think about two issues framed inside of the context of the Colombian conflict. First, the situation we have described is similar to the situation faced by the firms located in regions where the conflict reached high

49

levels of intensity. According to Camacho and Rodríguez (2013), during the high intensity period of the Colombian conflict many firms exited the market due to the lack of security undermining any incentives to invest. Second, under a conflict context which started based on ideological reasons and turned into a conflict based on economic interests, the existence of natural resources which generate high profit always motivates in fighting. It does not matter how many peace accords Colombia has signed; there will be new or old groups outside of the rule of law, ready to occupy the room left by those who signed the accord.

7.4   A brief comment on a hypothetical legalization

We want to make it clear that for the purpose of this research we assumed that the judicial and moral issues of a hypothetical legalization are somehow solved, so we incorporated the legalization in our simple scalarized model to see how it would look like. However, it is clear that in the judicial arena the legalization would bring many issues to solve. Issues mainly related to policies of justice and reparation of victims of selective deaths, kidnappings, or any kind of violent acts generated by the illegal drug cartels and their allies.

Another important issue to take into account is that through all the years of violence a huge number of people were forcibly displaced from their lands due to disputes over strategic zones for the produce and transport of illegal drugs, or because their territories are rich in natural resources or strategic politically speaking. Such issues certainly have to be considered. We are not suggesting that the process of legalization is as easy as declaring drugs legal today and then tomorrow a legal industry of cocaine would emerge as one of the activities that counts for the computation of the GDP. We are well aware that making this product legal have many implications which are not just political and economic, but also moral. However, these issues are well out of the scope of this research and should be considered under a different research approach and method.

8 Conclusions

The conflict described in this document is one of the longest internal conflicts in the world. The involvement of the market of illegal drugs has made this internal clash worse. At the outset the conflict was based on opposite political ideologies. Political parties in dispute for the socio-political power were the main actors. However, with the expansion of the illegal market of drugs the subversive groups involved found a strong source of financial support. As a consequence, the internal war grew in terms of the number of agents that actively participated in it, while the intensity of the armed combat and the magnitude and number of violent acts expanded. Due to the multiplicity and opposite objectives that every group of players pursues, the conflict is not an easy problem to solve. The drug cartels want to get the maximum profit from their illegal activity; the Colombian government wants to recover its control of the whole country which implies reducing the power of groups outside of the law and destroying drug cartels; guerrillas want to obtain the political power in Colombia; paramilitary groups proclaim themselves as groups fighting against the guerrillas and in favor of people who are victims of the guerrillas; while the U.S government provides money and in-kind assistance to the Colombian government to support it in its war against the subversive groups and the drug cartels.

The concept of solution of our dynamic model takes into consideration the costs imposed by every player on their own payoff function and on others through the affectation of their payoff functions. Using three basic specifications of the general dynamic model, we found that an equilibrium with an interior solution implies that agents develop activities until the level in which the sum of the marginal costs (externalities) imposed by the activities on others is equal to the sum of the marginal benefits generated by these activities on the agents that conduct them. Furthermore, a corner solution in which the level of activities conducted by every agent is zero implies that the sum of marginal costs (externalities) imposed by the activities is greater than the sum of marginal benefits generated by executing these activities.

We also found that under a context of internal conflict the legalization of the drug market for

51

cocaine could negatively affect the drug cartel's profits. However, the internal levels of unrest and insecurity could not significantly change. This is due to the dispute among subversives for other resources and financial sources beyond those provided by cooperation with cartels. If subversive groups have been taking the money coming from the drug trafficking as their main source of financial support, then under a legalization scenario they have to offset the negative effect on their budget through conducting another illegal activity. Under a situation of internal conflict, racketeering on legal firms could continue and the hypothetical legal industry of cocaine could be part of those industries affected by that illegal activity.

The models presented in this paper illustrate how the involvement of armed groups functioning outside the rule of law in the market of illegal drugs makes it difficult for the Colombian government to implement strategies to control the trafficking without controlling subversive groups. According to the media in regions such as Urabá (which borders Panamá), Catatumbo (which borders Venezuela), and Nariño (which borders Ecuador), the problem of drug trafficking continues due to disputes between dissident groups of the demobilized FARC and groups of delinquents that want to control the rent of the cocaine business. Under a framework of internal conflict in which the Colombian government is dealing with the presence of several subversive groups (guerrillas, paramilitaries, criminal groups) while at the same time fighting to curb drug trafficking, it is difficult to think that legalization per-se could bring a solution to this seemingly intractable conflict. It is necessary to support a policy of legalization with actions that make the government more visible in vulnerable areas, otherwise what seems to be an alternative to contribute to the reduction of the armed conflict would end up having an opposite effect given the presence of new groups operating outside of the law could make the situation worse.

Using a duopoly model, we will show in the paper's appendix that prohibition increases the price of illegal drugs, since prohibition raises both the production costs associated with labor and capital, and those costs associated with illegality like bribing people, hiring security companies, and implementing mechanisms out of the law to execute contracts[48].

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[48]We do not include costs avoided by black market suppliers such as taxes, environmental and health

Future research using the dynamic model includes collecting data relevant to doing numerical simulations using scenarios such as peace negotiations with paramilitaries and guerrillas, or a framework in which the Colombian government is in an alliance with a group outside of the law to fight, for example, guerrilla groups.

Appendix

A duopoly model of legalization effects on prices, quantities, and profits

We will consider a simple duopoly model to see what would happen with prices, quantities and costs of running a cocaine firm under a legalization framework. Even though this is not closely related to the models that we have previously described, it will give us a good perspective of the situation related to Colombian drug cartels in the late 1980s and during the 1990s. There are at least two reasons for using a duopoly model. First, during the period described above the strongest drug cartels in Colombia were Medellin's and Cali's cartels. These two cartels had the control of the illegal drug market in Colombia. Second, we do not use a competitive model or something close to it because in this market the producers have market power, meaning that they can influence the price of the good that they sell.

Assume that we have two firms (Medellin's and Cali's cartels) that produce an homogeneous illegal good (cocaine) and they compete in quantities. Let us denote the quantities produced by firm one and two as q_1 and q_2 respectively. Assume that these firms face a demand curve which is decreasing and linear in the interval $[0, \frac{\hat{a}}{b}]$. We are going to analyze first a situation in which under illegality these firms are facing costs functions that incorporate the costs of being illegal. We also assume that all the production is sold.

Assuming that none of the cartels are dismantled by the Colombian authorities, let the inverse demand function be [49]:

policies, and advertisements which are costs usually incurred by the legal industries (see Miron, 2003).

[49]If the cartels are dismantled the production would be $Q = 0$.

$$P(Q) = \begin{cases} \hat{a} - bQ, & \text{if } \hat{a} \geq bQ \\ 0, & \text{if } bQ \geq \hat{a} \end{cases}$$

In the previous conditional equation $b > 0$ and $Q = q_1 + q_2$

The costs functions are defined as: $C_i(q_i) = (c + \alpha)q_i$, where $c > 0$, $\alpha > 0$, and $c + \alpha < \hat{a}$, and $i = 1, 2$.

In these costs functions, $(c+\alpha)$ is the marginal cost due to the use of labor and capital which we define as c, and the marginal costs associated to the illegality, α. According to Miron (2003) labor and capital costs are higher in the cocaine industry than they are in a legal industry, meaning that the constant c is probably greater in an illegal market than in a legal market. The marginal costs α is reflecting the money that drug cartels have to spend to bribe people, such as police officers, mayors, governors, judges etc, and the money that they use to hire private security companies (these companies are usually guerrillas, paramilitaries or other kind of groups functioning outside of the law) to protect their business given that they cannot go to the Colombian legal system to enforce their contracts. As noted by Basov et al (2001): "Production of a black market good can be thought of as the production of two goods, the commodity itself and evasion, meaning all the activities undertaken to avoid the sanctions associated with violating prohibition." Producers in the black market develop the ability to know which kind of officers are more corrupt, and which routes are more suitable to transport the drug without being discovered. All these are activities related to the characteristic of the illegality of this market. Additionally, in the case of Colombia the symbiotic relationship between the drug lords and the groups operating outside of the law has emerged as a powerful alliance to destabilize the Colombian government, which makes it easy for the cartels to run their business and for the subversive groups to take power in many rural zones in Colombia.

Notice that the costs functions are particularly interesting because they are affected by the illegality in two senses, one that has to be directly with the productive process and other

specifically related to the mechanism implemented to avoid being captured by the Colombian authorities. However, no matter how big the efforts are to avoid being captured this possibility exists. For simplicity sake we are assuming here that there are just two possible outcomes: the trafficker is captured or he is not captured. If the capture takes place, the business is destroyed, but if not, the trafficker runs his business as any entrepreneur does even though he has the overhead costs of running an illegal firm.

Assuming that the cartels have succeeded avoiding being dismantled or destroyed by the Colombian authorities, the profit function for firm 1 is:

$$\Pi_1(q_1, q_2) = q_1[\hat{a} - b(q_1 + q_2) - (c + \alpha)]$$

The objective of each illegal firm is to find the quantity that maximizes the profit function π. Assuming that our solution is one in which $q_1 \in (0, \frac{\hat{a}}{b})$ the first order condition for the maximization problem of firm 1 is:

$$\frac{\partial \pi_1}{\partial q_1} = \hat{a} - 2(b)q_1 - bq_2 - (c + \alpha) = 0$$

Solving this equation for q_1 we get: $q_1 = \frac{1}{(2b)}[\hat{a} - bq_2 - (c + \alpha)]$. This is the optimal response of firm 1 to the quantities produced by the firm 2. By symmetry the reaction function of firm 2 is: $q_2 = \frac{1}{(2b)}[\hat{a} - bq_1 - (c + \alpha)]$

Solving the system constituted by these two reaction curves we have: $q_1 = \frac{(\hat{a} - c - \alpha)}{3b}$ and $q_2 = \frac{(\hat{a} - c - \alpha)}{3b}$. After solving for q_1 and q_2 we find the price $p = \frac{\hat{a} + 2(c + \alpha)}{3}$. Now we can compute the profit of both cartels which are: $\pi_1 = \frac{[\hat{a} - (c + \alpha)]^2}{9b}$, and $\pi_2 = \frac{[\hat{a} - (c + \alpha)]^2}{9b}$.

Now assume that the Colombian government and the U.S government legalize the production and consumption of cocaine. The model representing this situation is:

$$P(Q) = \begin{cases} a - bQ, & \text{if } a \geq bQ \\ 0, & \text{if } bQ \geq a \end{cases}$$

The costs functions are defined as: $C_i(q_i) = cq_i$ where $c > 0$, and $c < a$. Now there is not α, in the costs functions. Additionally, as we are considering a scenario of legalization, the punishment for running a cocaine firm disappears meaning that there is not a risk of being captured and dismantled.

Working through the first order conditions of this model, the quantities, the price and the profits in equilibrium are: $q_i = \frac{a-c}{3b}$, $p = \frac{a+2c}{3}$, and $\pi_i = \frac{(a-c)^2}{9b}$. This would be the situation if after legalization there are just two firms in the market. However, given that we are under a legalization scenario there is no reason to be afraid from the punishment of producing cocaine. Therefore, the barrier created by the punishment which was probably preventing some firms to enter in this market would disappear. It would then be probable that many firms enter into the market. In that case the quantities, price and profits in equilibrium would be: $q_i = \frac{(a-c)}{(n+1)b}$, $p = \frac{a+nc}{n+1}$ and $\pi_i = \frac{(a-c)^2}{(n+1)^2b}$.

From the previous results it is clear that the price of the illegal drug is greater than it is under legalization. Regarding the profits the conclusion will depend on the difference between $\hat{a} - c - \alpha$ and $a - c$. If we assume that $\hat{a} - c - \alpha > a - c$ then we can argue that profits are smaller under legalization. However, it is interesting to note that even if $a = \hat{a}$ the price under legalization is lower than it is under an illegal scenario.

Even though this is a simple Cournot model, it helps us to reinforce what was said in Miron (2003), a research paper that compares the price of legal cocaine in the U.S and Europe, the legal cocaine in the U.S was more expensive than in Europe because there was just one company legally authorized to import coca leaf into the U.S for analytic, scientific and research purposes. Clearly, without the barrier that illegality imposes there might be many entrepreneurs interested in making investment in an industry that promises generous return rates. More firms competing in which is now a legal industry might make the price of cocaine

go down.

Now suppose that we are in a country where the drug is legally produced and consumed, but that country is facing an internal armed conflict in which there are different armed actors like guerrillas, paramilitaries, and criminal groups fighting to control specific rural zones. Under this situation of internal conflict it is probable that zones where the Colombian government does not fully guarantee security to the firms, attacks from subversive groups would continue and this could be the case faced by the new legal cocaine industry. The model would be:

$$P(Q) = \begin{cases} a - bQ, & \text{if } a \geq bQ \\ 0, & \text{if } bQ \geq a \end{cases}$$

The costs functions are : $C_i(q_i) = cq_i + (1-\delta)\theta$ where θ measures the level of the extortion (or as it is called in Colombia "vacuna") made by the subversive group on firms legally producing cocaine [50], and $0 \leq \delta \leq 1$ is the control that the Colombian government has on the region in which the new industry operates. $\delta = 0$ means zero control, while $\delta = 1$ means full control. Notice that we are modifying the costs function in a way that the control or lack of control exerted by the Colombian government is reflected in the computation of the profits of the firms that are now working in the legal cocaine industry. Therefore, the quantities produced and the price do not change with respect to those that we described above when we assumed legalization without paying attention to the possible behavior of subversive groups after legalization. However, now the profits of the cartels are affected by the amount of money that they have to give to the armed illegal groups if $\delta \neq 1$.

After computing the first order conditions to get price and quantities in equilibrium, the profit functions are: $\pi_i = \frac{(a-c)^2}{9b} - (1-\delta)\theta$ for $i = 1, 2$. These functions are showing that if the control of the Colombian government is zero, this negatively affects profit margins.

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[50]For simplicity let us assume that the level of extortion is fixed. We can extent the model with an expression like: $C_i(q_i) = cq_i + (1-\delta)\theta q_i$, where the level of extortion changes depending of how big is the firm in terms of the quantity produced. However, to keep things simple, we have assumed that the second term of the cost function works as a fixed cost.

However, as the control starts going to one, the profits are getting close to those that we have described above. One important thing to take into account is that the size of the profit is not only dependent on the skills of the entrepreneur, but it also depends on the amount of money claimed by the subversive group and how strong is the Colombian government to exert its monopoly over violence in favor of the firms legally constituted in the country.

Now to link the Cournot model and the dynamic models previously under study, notice that when we analyze the duopoly under illegality, subversive groups obtain incomes from participation in the illegal market. They made part of the αq_i in the cost function. Nonetheless, under a scenario of legalization they are not getting anything from the coca industry since the term αq_i does not exist any more. Subversive groups now get their resources from racketeering, kidnappings for ransom, and from attacking the Colombian government. Therefore, two things emerge here as noteworthy. First, as the conflict in Colombia is not a war motivated by political ideology but rather a war for obtaining economic and political power, the legalization itself would not enhance the levels of security in a conflict environment because those groups operating outside of the law would find new ways to access illegal economic resources to continue being active in the conflict. Second, under a legalization scenario the costs associated with illegality disappear and the price of cocaine drops as observed by Miron (2003). However, based on our simplified model the fact that the profits obtained from the cocaine industry possibly exceeds those obtained in other industries would attract more firms to the market, but would also attract the attention of delinquents that want to enjoy the benefits associated with this industry. Additionally, it would be interesting to analyze the role played by the regulation of the new industry. It is clear that an illegal firm does not pay taxes, and it is not restricted by any governmental regulation. However, when cocaine firms become legal they have to participate in a market that surely will impose certain rules on them. All these elements related to regulation, including taxes and other normative rules, such as environmental, safety and health regulations will affect not only the costs but the profits obtained in the new industry.

Part II

9 Introduction to Part II

This paper assesses the economic impact of the high intensity conflict in Colombia for the period 1995-2014. After decades of conflict, and years of negotiation, rebels and government finally reached an agreement to end fifty years of war (NYT 2016). However, this upcoming post-conflict situation requires a better understanding on the economic legacies of civil conflict, shedding light on possible recovery strategies, and pointing out a case of study for current or upcoming post-conflict situations in different regions.

The constant state of violence in Colombia represents a threat for the political and economic institutions, affecting firms decisions to stay or to exit the market (Camacho and Rodríguez 2013), that added to the massive forced displacement of civil population toward big urban areas, impacted local investments and created obstacles for foreign investments. On the other hand, despite these adverse conditions, political and economic institutions did not suffer major transformations, and democracy remains the form of government (Chacón, Robinson, and Torvik 2011); moreover, for some years within this period of violence, Colombia experienced positive income shocks and reduced poverty levels in urban areas according to official data (World Bank 2017). This context and the recent peace agreements with two of the major illegal armed groups, allow us to inquire about the economic impacts of the armed conflict in Colombia. In particular: did the conflict affect the unemployment rate in Colombia?

Several studies assess the socio-economic impact of conflict in Colombia. Some of them show the incidence of violent actors on the decision process in policy making (Acemoglu, Robinson, and Santos 2013; Chacón, Robinson, and Torvik 2011), and the impact of conflict on political elections, and democratic processes. In particular, Acemoglu et al. (2013) using electoral data by region and legislative data, find a strong relation between right wing illegal armed groups, and electoral outcomes in determined regions in Colombia. Other empirical studies examine the impact of conflict on health outcomes (Camacho 2008), its consequences on

59

forcibly displaced households (Ibáñez and Vélez 2008; Ibáñez and Moya 2010; Ibáñez and Vélez 2008; Ibáñez 2009); and its incidence on firms exit decisions (Camacho and Rodríguez 2013; Rozo 2016). These studies show the welfare losses due to the forced displacement phenomena, provide evidence regarding policy instruments for preventing displacement, and determine the impact of conflict on firm exits from the market.

Similarly, unemployment in Colombia is an issue analyzed under several approaches. Some authors estimate the effect of non-salary cost on the unemployment rate (Sánchez, Duque, and Ruíz 2009; Bernal and Cardenas 2004), the impact of the economic cycle (Núñez and Bernal 1997), and the gap between the supply and demand of high quality workers (Núñez and Sanchez 1999; Cárdenas and Bernal 1999). Even though most of these studies relate the increase on the unemployment rate strictly to macroeconomic conditions, we encounter a correlation between the intensification of the Colombian conflict in the 1990s decade, and this increase in the unemployment rate for the same period (figure 3).

Some other works examine the relationship between the labor market and forced displacement in Colombia (Ibáñez and Moya 2010; Ibáñez and Vélez 2008; Ibáñez 2009; Calderón-Mejía and Ibáñez 2016); however, only one of them, specifically, estimates the impact of forced displacement on wages in Colombia (Calderón-Mejía and Ibáñez 2016). Using instrumental variables to assess the effect of these migrations on the urban labor market, the authors find that this phenomenon reduces wages for urban unskilled workers who compete for jobs with the arriving population. Our study aligns with the examination of Calderón-Mejía and Ibáñez (2016), and contributes to this literature analyzing the unemployment rate using a methodology that allows estimating this effect by comparing with a counterfactual, following Abadie and Gardeazabal (2003).

To estimate the effect of the high intensity conflict on the unemployment rate, we approach the problem from two similar methods. First we estimate a difference-in-differences model to establish the average treatment effect of the "high intensity conflict" in Colombia relative to similar countries within the region; and second, we construct a "synthetic Colombia" to estimate the effect of this treatment on the unemployment rate. A main problem is the

60

definition of a treated and untreated region within Colombia, due the geographic uniformity of the violent events and multiplicity of illegal armed groups (Figure 1). Because of this, we choose eight countries in South and Central America, with a relatively low or nonexistent conflict during the period of analysis, as control groups (donor countries).

The untreated countries we choose for the period of study are Argentina, Chile, Ecuador, Uruguay, Paraguay (South America), Costa Rica, Panama, and Honduras (Central America). Although all Latin American nations had guerrilla movements after 1960, few of them have a history of conflict with the length or intensity of the Colombian conflict. Other countries such as Mexico and Brazil share institutional characteristics with Colombia, in particular Mexico; but they are not comparable given their economic size relative to the Colombian economy.

Using the World Development Indicators data base available at the World Bank, we obtained information on economic variables (GDP per capita, investments, unemployment by sector, population, enrollment, and labor force among others) for all the potential control units and Colombia, between 1977-2014. We also consulted publicly available data from the Center for Social Studies at Universidad de los Andes - CEDE and the Conflict Analysis Resource Center - CERAC to explore measures on conflict and violence.

Considering 1995 as a break point for the treatment period we estimate our difference-in-differences (DID), and our synthetic control effects. For the DID, we find an increase in unemployment rate of 3.7 percentage points in our preferred estimation relative to the control group. Meanwhile, for the same variable, our synthetic control shows an increase of 4.9 percentage points relative to the synthetic Colombia. Both estimations represent at least one third of the average unemployment rate for the treatment period (1995-2014); however, the synthetic control suggests an effect larger than the first average effect estimated by DID. We test our DID results through three different standard tests, and for the synthetic control method we follow Abadie et al. (2010) implementing a placebo test to validate our results.

The rest of the paper is organized as follows. Section 1 introduces a detailed literature

61

review describing studies examining economic impacts of conflict worldwide and in Colombia. Section 2 offers a brief context on the Colombian conflict pointing out key elements for the period selection. Sections 3 and 4 present the empirical strategy for our analysis and the results obtained. Section 5 contains some conclusions and comments. An Appendix presents results from a series of robustness tests.

10 The Colombian Conflict and Economic Outcomes

For the past fifty years, Colombia has faced a constant threat to its institutional stability, as well as a situation of violence originated from different armed groups representing multiple ideologies, motivations, and tactics. From the mid-sixties communist guerrillas were formed with the remains of former bipartisan self-defense armies (GMH 2013; Palacios 2006; Dube and Vargas 2013), and later on the 1970s and 1980s, paramilitary groups and drug cartels arise, both motivated by the control and protection of private property and agricultural land, as well as the returns of the drug dealing (GMH 2013). Even though there was a constant state of violence, the political and economic institutions did not suffer major transformation within the country, and democracy has remained the form of government.

During the past twenty years the Colombian economy experienced a recovery boosted by high prices in commodities such as oil, coal and gold, as well as a persistent reduction in poverty levels in urban areas according to official data (World Bank 2017). Similarly, the state has negotiated peace agreements with two of the major illegal armed groups during the past fifteen years. Given this context, it is valid to question what was the impact of the armed conflict in Colombia on the labor market, and how the unemployment rate was affected by the persistence of violent events that derived forced displacement toward main urban areas, and obstacles to local and foreign investments.

Several studies have considered the impact of conflict on economic outcomes using different approaches. Most of them examine the impact of political conflict using cross-country level

data (Alesina et al. 1996; Alesina and Perotti 1996; Barro 1991; Mauro 1995; Venieris and Gupta 1986); finding a negative effect of conflict on investments, savings, and economic growth. Abadie and Gardeazabal (2003) ; Grier and Maynard (2016); and Horiuchi and Mayerson (2015) use a synthetic control to estimate the impact of political instability and conflict on economic outcomes.These works conclude that political instability has a negative impact on the economic performance of regions or firms.

Abadie and Gardeazabal (2003) assess the economic impact of conflict, using the terrorist conflict in the Basque Country as a case study. They find that, after the outbreak of terrorism, per capita GDP in the Basque Country decreased around 10 percentage points compared with the synthetic control region. Grier and Maynard (2016) find that political instability affected negatively economic growth while other indicators such as poverty, health and inequality improved, and Bove, Elia, and Smith (2016) find a negative but not significant effect of conflict on economic growth. To do so, this study compares its results with the results of a sample of "cases of studies" using synthetic controls to demonstrate the heterogeneous effects of conflict on economic performance.

Regarding the effect of conflict within specific countries on microeconomic level Shemyakina (2011), Chamarbagwala and Morán (2011), and Eccleston (2011), consider the impacts of conflict or exposure to terrorism on education outcomes (human capital accumulation). Eccleston (2011) finds that psychological stress due to exposure to terrorist events has negative impacts on early educational attainment and cognitive ability. Similarly, Chamarbagwala and Morán (2011), and Shemyakina (2011) find a strong negative impact of conflict on educational attainment and schooling, especially among vulnerable populations located on regions with high conflict intensity (Chamarbagwala and Morán 2011; Shemyakina 2011).

Specifically for Colombia and Bosnia Herzegovina, research assesses the impact of forced displacement on labor participation and welfare (Ibáñez and Moya 2010; Ibáñez and Vélez 2008; Kondylis 2010; Calderón-Mejía and Ibáñez 2016). Kondylis (2010) finds that displaced people in Bosnia are less likely to be working compared with those who stayed at the same place; her results reveal a differential effect on men whom experience high unemployment

63

rates, while displaced women are more likely to drop out the labor force. Similarly, Ibáñez and Moya (2010) examine the effect of forced displacement (caused by conflict) on households welfare after displacement; and Ibáñez and Vélez (2008) estimate the welfare losses due to forced displacement compared to a situation of traditional (unforced or voluntary) migration.

Lastly, we want to reference studies that analyze the impact of the conflict on politics, labor, and human capital specifically for Colombia. Acemoglu et al., (2013), consider the influence of irregular armies on policy decisions, in particular vote shares, finding a strong relation between paramilitaries and electoral outcomes in determined regions of Colombia. Ibáñez and Moya (2010), contribute to the literature of the conflict in Colombia assessing the vulnerability of households through information collected from a representative sample of forcibly displaced households in Colombia. These authors find that victims of forced displacement face difficulties in generate income and significant drops in consumption, revealing the limitation on the effectiveness on the public interventions. Similarly, Ibáñez and Vélez (2008) examine the causes of the forced displacement in Colombia, estimate the welfare losses and provide some evidence regarding policy instruments for preventing displacement.

These previous studies open the opportunity to ask: Did the extended violence in Colombia have an impact on the labor market? Although our analysis is strongly based on the methodology used by Abadie and Gardeazabal (2003), our study focused on the impacts on unemployment in Colombia, using as a control group a set of Latin American countries which constitutes a regional analysis rather than an analysis focused within Colombia.

11   Context: The Colombian Conflict

This document investigates on the impact of the armed conflict on the Colombian economy during the period 1977-2014.[51] Colombian armed conflict has lasted for more than a half of a century. It has had a multiplicity of internal actors (Colombian Government, Paramilitaries, Guerrillas, Drug Cartels, and the U.S government) which appeared in different moments, and played different roles in the conflict. Former bipartisan self-defense groups remains derived in the formation of communist guerrilla groups after 1964 claiming lack of political representation (Palacios 2006; GMH 2013). As a response to these communist groups, the national government did incentivize the formation of self-defense (paramilitary) groups as a counter-insurgency strategy. [52] Finally, during the decade of the 1980s, the boom in the drug trafficking activity became a part of the paramilitary activity and, therefore fueled the rise of violence in the country during the decade of the 1990s.

Table 1 in the appendix, presents data collected by the Group of Historical Memory[53], the Center for Conflict studies CERAC, and the Victims Unit in Colombia[54]. The violent activity, in terms of victims, was relatively low during the decade of 1980; the number of victims of landmines or unexplode ordinance was very low during this decade, its use increased after 1990, and it reached the peak in 2006. Other indicators of violence such as the number of kidnappings or the number of victims of massacres jumped up after 1988, right after the government declared as illegal any paramilitary activity within the country. Finally, although

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[51]According to the General Report of the Historical Memory Group (GMH) (2013), the civil conflict in Colombia can be divided into four periods. Our analysis includes the second (1982-1996) and third period (1996-2005).

[52]The lack of confidence of the elites in how the government was handling the conflict with the guerrillas, and the decision of the guerrillas to reach more rural zones, contributed to the emergence and expansion of paramilitary groups to protect the interests of the elites. The Colombian government passed the Law 48 of 1968 to legitimize the creation of these groups. In this sense, the paramilitaries were born as legal groups with the mission to help the Colombian army to fight guerrillas. These were declared illegal by the Ordinance 813/1989, but they continued operating until peace agreements in 2005.

[53]http://www.centrodememoriahistorica.gov.co/micrositios/informeGeneral/basesDatos.html

[54]https://cifras.unidadvictimas.gov.co/Home/Desplazamiento

the communist guerrillas did not expand or confront aggressively before the 1980s, they did occupy more territory, and structured themselves in a more sophisticated way.

The peak of the conflict in terms of magnitude of violent attacks occurred in the period 1996-2005. According to the GMH (2013) this period was marked by the simultaneous expansion of the guerrillas and the paramilitaries[55], the war against the drug trafficking, and the change in the organization of the drug cartels. The magnitude of violent events such as kidnappings, massacres, deaths, and landmine victims reached the highest point between years 1995-2002; and the forced displacement worsened between 2000 and 2008.

Although the territorial control was still one of the main objectives among the different armed actors, the reasons why they fought changed (Salazar and Castillo 2001). Popular perception of the leftist guerrillas as defenders of social demands transformed into an image of vandalism and common delinquency; in this sense, all illegal armed groups used intimidation, killings, and forced displacement of population as instruments to instill the fear among the civil population. Thus, the violent groups dominated the population through fear.

The level of the conflict in this period (1996-2005), reached such a big magnitude that according to the GMH (2013), Colombia was ranked second to Sudan in terms of forced displaced people. The massive displacement of the population from different regions in Colombia, especially toward the main populated cities affected the labor market and the welfare of this part of the population. The Colombian labor market suffered negative impacts on wages and employment opportunities (Ibáñez 2009), and the victims of forced displacement faced income losses, significant drops in consumption, and significant losses in welfare (Ibáñez and Moya 2010; Ibáñez and Vélez 2008; Ibáñez 2009). It took time for displaced people to adjust to a new environment.

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[55]Also during this period, through the decree 356 of 1994, the Colombian government allowed the emergence of new armed groups named Convivir (Private Surveillance Companies). These groups defined themselves as anti-subversive Political-Military groups, so they controlled strategic locations (municipalities) of the country and influenced politicians both at local and national level (Acemoglu, Robinson, and Santos 2013; Gutirrez 2010; Garay Salamanca and Salcedo-Albarán 2010).

At least four elements boosted the high intensity of the conflict in Colombia at this time (1994-2005). First, the 1991 Colombian constitution had the unintended effect of giving illegal armed groups the opportunity to control the resources of regions considered as strategic to continue fighting (see Gutiérrez, F. 2010). Second, changes in policies related to the war on drugs motivated a shift in the cultivation and production of coca from Peru and Bolivia to Colombia, bringing an upsurge in the price of coca leaf, and as consequence, a new source of revenue to fight for (Angrist, J. D., and Kugler, A. 2005; Mejía, D., and Restrepo, P. 2013b). Third, the new illegal group CONVIVIR emerged in 1994 (GMH 2013); this group was created to fight guerrillas in order to control places occupied by guerrilla groups. Lastly, during this period the FARC, the ELN and the AUC expanded their members and the territory in which they operated (Arias and Ibáñez. 2012). These four elements combined to generate a long period of massacres, extortions, selective deaths, and kidnappings.

These tactics of domination over the civil population affected the economic activity in general. The extortion had an impact on firms decision to stay or to exit the market (Camacho and Rodríguez 2013). Similarly, the level of regional influence and political control of some of these violent groups allowed them to take advantage of public resources, and not be prosecuted by the national authorities given the prominent mutualism among some illegal groups and politicians at the central level of government (Acemoglu, Robinson, and Santos 2013) . These conditions, plus the massive displacement of the civilian population toward big urban areas, impacted local investments, and created obstacles for foreign investment, as well as generated pressure on the country's production, and therefore on the rate of unemployment.

The violence in Colombia evolved, and took multiple shapes. Many factors contributed to the continuation of the conflict. This factors included the limitation of the political participation of some armed groups like the guerrillas, the beginning of drug trafficking, and its propagation around the country. The poor performance of Colombian institutions, and paradoxically, the decentralization opened an opportunity for the illegal armed actors to get involved in the political and economic life of local and regional governments taking control over some regions and their resources (Acemoglu, Robinson, and Santos 2013; Gutiérrez 2010; Garay

67

Salamanca and Salcedo-Albarán 2010). Although with different levels of impact, the armed conflict spread in one form of violence or another to the whole national territory, as it is shown in the figures from the Group of Historical Memory report (2013).
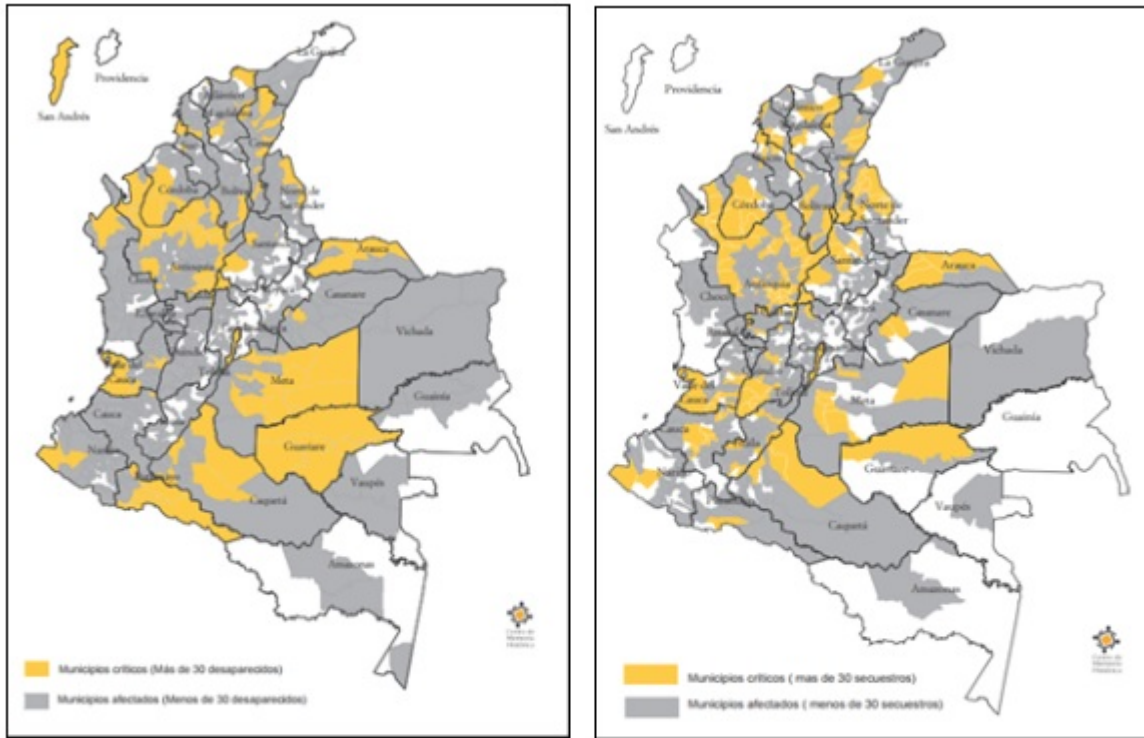

Figure 1
Source: Group of Historical Memory – Colombia. Report "Basta ya"
Left: Municipalities affected by forced disappearances
Right: Municipalities affected by kidnappings

12 Empirical Strategy

To study the impact of the conflict in the Colombian economy, we focus our analysis on the impact on the unemployment rate. For this we use two strategies. First, using countries in the Latin-American region, which have not been involved in a prolonged and intense armed conflict as Colombia, we construct a difference-in differences model; second, using the

synthetic control methodology and the same set of countries we construct a control region that resembles relevant economic characteristics of Colombia before the high level of Colombian armed conflict starts. For both approaches we think about Colombian conflict as a natural experiment in which, according to the previous description of the armed conflict, Colombia as a whole is the treated unit.

12.1   Sample Selection and Data

We propose to estimate a difference-in-differences model, and to create the Synthetic control using a set of countries that are related to Colombia in terms of institutional framework, income and even geographically. Although we follow the study proposed by Abadie and Gardeazabal (2003) in which they explore regions within Spain, our analysis cannot rely on the exploration of the different regions in Colombia. The geographic uniformity of the violent events and the multiplicity of illegal armed actors in Colombia are restrictions for the definition of an untreated (unaffected) "region" within Colombia by the conflict (e.g., Figure 1). As a result of this, we choose eight countries in South and Central America as potential control units.

These countries are not treated with a "high intensity conflict" for the period of study. Considering this, we pick a pool of countries formed by Argentina, Chile, Ecuador, Uruguay, Paraguay (South America), Costa Rica, Panama, and Honduras (Central America). Although all Latin American nations had guerrilla movements after 1960, few of them have a history of conflict with the length or intensity of the Colombian conflict. Most of the countries selected do not have any armed conflict for the analyzed period. Other countries such as Mexico and Brazil share institutional characteristics with Colombia, in particular Mexico[56]; but they are not comparable with Colombia given their economic size relative to the

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[56]Mexico has been suffered from an internal conflict related to the drug cartels. This has triggered a big wave of criminal violence implying events such as massacres, assassination of politician leaders, and regular citizens. The occurrence of these violent events, which include disputes for the political and economic control of some parts of the Mexican territory, excludes this country from our potential control group.

69

Colombian economy. Including countries with predictor values far different from the treated unit may generate problems with the estimation of the synthetic control, and the resulting weights of those countries are not going to be of help to the implementation of the synthetic control. Other countries such as Nicaragua, El Salvador and Peru are excluded since they faced high intense armed conflicts for the analysis period.

Similarly, we choose the pre-treatment and treatment based on two criteria. First, the availability of data for Colombia, and the control countries. Even though the Colombian conflict can be traced back from 1950, most of the information regarding the conflict in Colombia is available after 1980 (table 1); besides, the availability of data for Colombia, and many other Latin American countries is somehow complete or at least available after 1960. Second, the history of the Colombian armed conflict in the recent years that defines the peak of the conflict[57] after 1995 (GHM 2013) as noticed also in figure 2 and figure 3. Therefore, the pre-treatment period is 1977-1994, and the treatment period is 1995-2014.
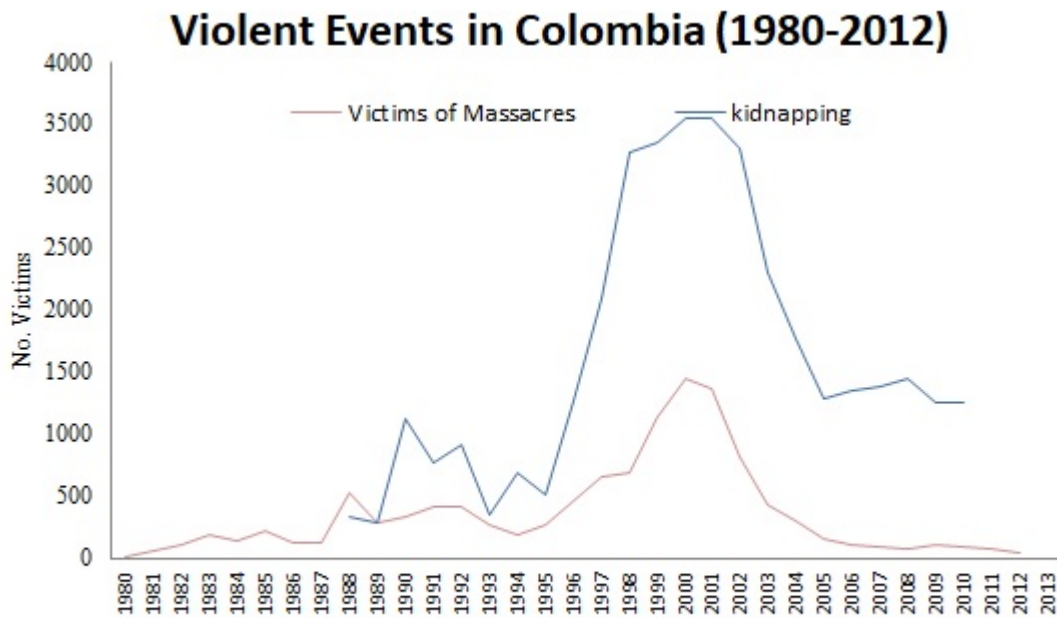

Figure 2

Source: Authors elaboration
Data: National Center of Historical Memory, Conflict Analysis Resource Center -CERAC

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[57]The period between 1995 and 2005 is marked by an increase in violence with drug cartels, guerrillas and paramilitaries being part of it.
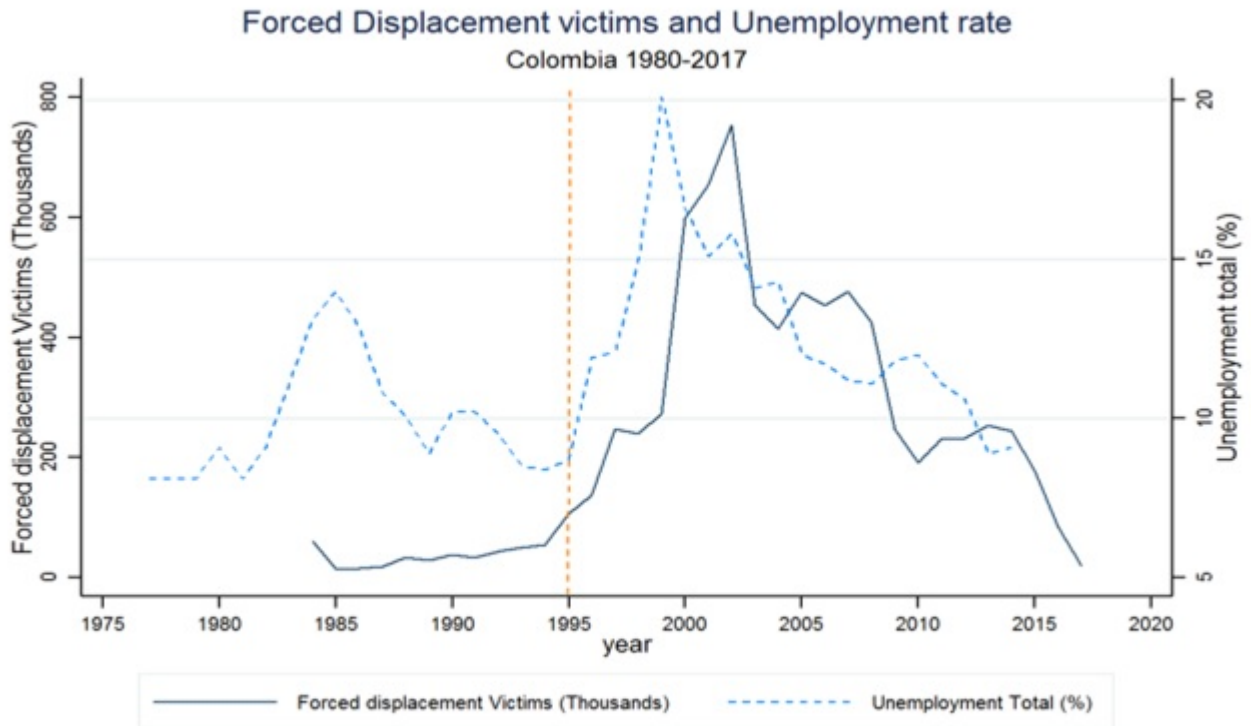
70

Forced Displacement victims and Unemployment rate
Colombia 1980-2017

Figure 3

To implement our strategies, we collected data for these countries from two major sources. From the World Development Indicators WDI platform established by the World Bank, we gather data for economic variables such as GDP, GDP per capita, unemployment rate, labor force, and Gross fixed formation of Capital; as well as other variables such as population, population density, and life expectancy at birth, land area, and gross enrollment for primary, secondary and tertiary education. From the International Labor Organization ILO, we gathered data on total employment and employment by sectors (agricultural, industry and services). Finally, we also consulted data on conflict variables (i.e., violent events) from the Group of Historical Memory GHM, the Conflict Analysis Research Center CERAC, and the Unit of Victims from the Vice-Presidency office in Colombia.

71

12.2   Difference-in-Differences

In our first approach we estimate a difference-in-differences (DID) model with the armed conflict as our natural experiment; Colombia as the treated unit, and a set of countries within the region[58] as the untreated or control units (these are countries in the region that have been not treated during the period under analysis). As it was mention before, our treatment period starts since 1995 and lasts until 2014. This period is characterized by the high levels of intensity of the conflict. Therefore, we have divided the whole period which goes from 1977 to 2014 into a pre-treatment period from 1977 to 1994 and a post-treatment period from 1995 to 2014.

In the case of the DID approach we have two groups indexed by treatment status T={1,0}. Where 0 indicates countries not receiving treatment, i.e. the control group, and 1 indicates the country receiving the treatment, i.e. the treatment group, which in our case is Colombia. Then, every country has two kinds of observations, one pre-treatment and one post-treatment. The outcome of our interest can be model through this equation:

$$Y_{it} = \alpha + \beta C_i + \gamma D_t + \delta(C_i \times D_t) + \theta X + \epsilon_{it} \tag{6}$$

Where α, β, γ, δ, and θ are unknown parameters, and ϵ_{it} is a random, unobserved "error" term which contains all determinants of Y_{it}, which our model omits. It is important to notice that, β is the treatment group specific effect, γ is the time trend common to control and treatment effect, and δ is the true effect of treatment. Therefore, our interest focuses on the assessment of δ, for unemployment as outcome variable.

The matrix X includes covariates such as the GDP per capita in constant 2010 US dollars, the gross fixed capital formation as a proportion of the GDP as a measure of investments, and general characteristics such as population density, life expectancy at birth, and gross enrollment in primary and secondary education.

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[58]Chile, Argentina, Ecuador, Uruguay, Paraguay, Costa Rica, Panam, Dominican Republic, and Honduras.

12.3 Synthetic Control

The second strategy which uses a combination of countries to construct a synthetic region resembling Colombia during the pre-treatment period relies heavily on the Synthetic Control approach proposed by Abadie and Gardeazabal (2003). They find that it would be problematic to assess the impact of the conflict in the Basque Country simply by a comparison between the Basque country and the rest of Spain during terrorism years, since this may not show the true impact and pre-terrorism differences between the Basque Country and the rest of Spain. Therefore, they approach this problem using a weighted combination of other Spanish regions with similar characteristics to the Basque Country before terrorism; they called this weighted average as a "Synthetic Basque Country" not affected by terrorism. In other words, this is an ideal counterfactual to examine the true impact of conflict.

13 Results

13.1 Difference-in-Differences and Synthetic Control for the Unemployment Rate.

13.1.1 Differences in Differences Analysis

Table 2 reflects the results for our DID estimation; presenting two sets of estimations. First we have the parsimonious model (columns 1-3); second, we include a set of covariates (columns 4-6). In each set, we show the unemployment rate aggregated (total), and disaggregated by gender. For both estimations, the parsimonious and including covariates, the DID coefficient reflects a positive estimated mean difference on the unemployment rate total, and the unemployment rates for females and males; interestingly, the inclusion of covariates reveals a positive expected mean change in the unemployment rate from before to after the onset of the "high intensity conflict" period among the control group. In other words, the more complete estimation shows a positive effect of time on the unemployment rate in the absence

73

of treatment.

Table 2. Differences in Differences unemployment rate

VARIABLES	(1) Unemployment Total	(2) Unemployment Female	(3) Unemployment Male	(4) Unemployment Total	(5) Unemployment Female	(6) Unemployment Male
Diff-in-Diff	3.229***	3.844***	3.039***	3.711***	3.218***	3.695***
	(1.081)	(1.272)	(0.961)	(0.899)	(1.073)	(0.822)
Time treatment	-0.474	-0.598	-1.011***	3.365***	2.557***	2.710***
	(0.342)	(0.402)	(0.304)	(0.490)	(0.584)	(0.448)
Controls				X	X	X
Constant	9.387***	12.466***	8.032***	45.892***	4.367	54.725***
	(0.235)	(0.277)	(0.209)	(6.141)	(7.329)	(5.620)
Observations	380	380	380	349	349	349
R-squared	0.024	0.025	0.042	0.427	0.397	0.405
Number of id	10	10	10	10	10	10

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In order to identify causal effects, the DID assumes that prior to the intervention, unemployment rates have identical trends in treatment and control countries. Then, after the intensification of the conflict (treatment), the DID estimates how unemployment rates change in the treatment (Colombia) compared to the control countries that did not suffer a "high intensity conflict". To test the common trend assumption we apply two standard falsification tests. Following Talosaga and Vink (2014), we try to estimate directly any difference in trends using the following regression model for the pre-treatment (if year is less than 1995):

$$Y_{it} = \alpha + \beta_1 trend + \beta_2(treatment \times trend) + \theta X + \epsilon_{it} \tag{7}$$

If the common trend assumption holds, the coefficient β_2 should be close to zero and not

74

statistically significant. The second test estimates the model using a "placebo" treatment. We re-estimate the DID for the pre-treatment period assuming that the treatment affected at an earlier date. In this case the DID coefficient should be not significant and close to zero. The first test confirms the common trend assumption for either the parsimonious case, or including covariates (see table A5. in the Appendix). For the second test we estimate two placebos (Table A6 and A7 in the Appendix), one assuming that the treatment started in 1985 (ten years earlier), and second assuming the treatment started in 1990. For the first placebo we find a not statistically significant DID coefficient for the parsimonious model, but this becomes significant[59] when including covariates. For the second placebo, neither the parsimonious nor the model with covariates reveals a significant DID coefficient.

Although we find an effect of the "high intensity conflict" on the unemployment rate in Colombia, as well as on the female and male unemployment rates; these mixed results for the falsification test, do not allow us to draw a conclusion. However, these results do signal the existence of an impact in Colombia with respect to other countries within the region caused by the presence of a "high intensity conflict." In order to establish a consistent conclusion, we rely on the synthetic control method propose by Abadie and Gardeazabal (2003) applied for the Colombian case.

13.1.2   Synthetic Control

The key question to evaluate the causal effect in which we are interested is how the unemployment has evolved in Colombia after 1994 in absence of the conflict. Certainly this question cannot be answered without the help of a counterfactual because we are not able to have both Colombia without and with conflict simultaneously. Therefore, we use the synthetic control method as a procedure to estimate that counterfactual.

Figure 4 below shows the trend of the unemployment in Colombia and the rest of countries in Latin-America.[60] As we can see the rest of Latin-America does not seem to be a suit-

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[59]It becomes significant at 10% significance level.

[60]The countries included are: Argentina, Bolivia, Brazil, Chile, Costa Rica, Ecuador El Salvador, Honduras,

able control group for our purposes. Although at the beginning of the pre-treatment period (1977-1994), unemployment rate in Colombia was slightly similar than the average unemployment rate for the rest of countries in the region, this difference was greater by 1985 when unemployment rate was about 5% greater in Colombia than the average for Latin America; and on average, unemployment rate for Colombia during the pre-treatment period was 14%; meanwhile the average unemployment for Latin America was 9%. Figure 4 suggests that, even before the beginning of the "high intensity conflict" period in Colombia, there is a gap between unemployment rate in Colombia and unemployment rate in the rest of Latin-America. As suggested by Abadie et al. (2010) and Abadie and Gardeazabal (2003) the synthetic control method help us to estimate a counterfactual for Colombia from a pool of donor countries for the period 1977-1994.
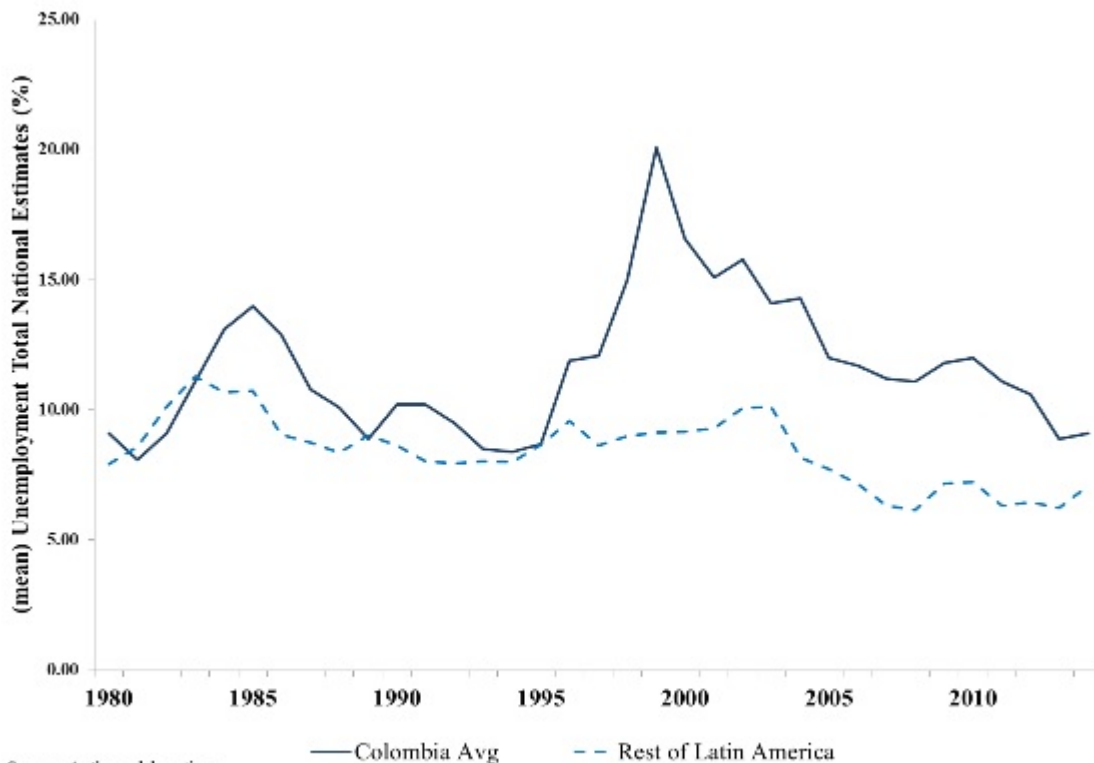
Source: Authors elaboration
Data: WDI-World Bank

Figure 4 Trend in Unemployment rate: Colombia vs the rest of donor countries.

Nicaragua Panama, Paraguay, Peru, Uruguay, Puerto Rico, and Venezuela RB.

76

Table 3 displays the results of our synthetic control in terms of pre-treatment characteristics between Colombia and the pool of donor countries. These results compare the means of the predictors of unemployment among Colombia, the synthetic Colombia and the average of the 8 donor countries, excluding from our donor pool those countries which do not meet the characteristics to be part of this. [61] We see that the average of countries that did not suffer a "high intensity conflict" after 1994 does not provide a good control group for Colombia. Economic predictors such as the GDP per capita or the investments (Gross fixed capital formation) adjust better for the Synthetic Colombia than the average of donor countries; a similar situation resembles with other predictors (i.e., life expectancy at birth, population density and gross enrollment in secondary education). Notice that it is important to have a donor pool of countries showing a high similarity with Colombia which is the country exposed to the treatment (high intensity conflict). In this sense, the synthetic Colombia accurately resembles the predictor values for the actual Colombia during the pre-treatment period. According to Abadie et al. (2010), this result assures that we have a counterfactual that falls within the convex hull of the data.

Table 3. Unemployment rate predictor means

	Treated	Synthetic	Average of control countries
GDP per Capita (constant 2010 US $)	3969.804	3912.071	4599.337
Gross Enrollment Primary (female and male)	108.0654	104.22	107.4469
Gross Enrollment Secondary (female and male)	47.27657	52.13944	54.34334
Life Expectancy at Birth (age)	67.11873	68.61149	69.56216
Population Density (ages 15-64 pop per km sq.)	16.40294	16.74575	14.94567
Gross Fixed Capital Formation (% of GDP)	17.14444	17.51391	18.88967

Note: All variables are averaged for 1977-1994 period

The weights of each control country in the synthetic Colombia are reported in Table 4. Unemployment rate in Colombia before the "high intensity conflict" period is best resembled by a combination of Panama, Uruguay and Honduras, which are the only countries within our

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[61]As we have explained in the empirical framework.

donor pool with positive weights. All other countries within the donor pool have a weight of zero for the synthetic Colombia.

Table 4. Country weights in the synthetic Colombia

Country	Weight
Chile	0.00
Costa Rica	0.00
Argentina	0.00
Ecuador	0.00
Panama	0.38
Paraguay	0.00
Uruguay	0.24
Honduras	0.38

Figure 5 shows the trend of the unemployment rate of Colombia and the synthetic Colombia for the period 1977-2014. We see that the synthetic Colombia presents a similar trajectory during the pre-treatment period. Altogether, this similarity and the similarity among the unemployment rate predictors reveal that the synthetic Colombia approximates the unemployment rate that would have occurred in Colombia in the absence of a "high intensity conflict" after 1994.

During the treatment period (1995-2014), there is a gap between unemployment rate for Colombia and unemployment rate for the synthetic Colombia. This divergence in figure 5 suggests that the high intensity of the conflict has increased unemployment rate in Colombia.The estimated effect of this treatment on unemployment rate is given by the difference between Colombia and the synthetic Colombia. On average, the "high intensity conflict" contributed with 4.9 percentage points of the unemployment rate for the treatment period; in other words, relative to the 12.8% average unemployment rate in Colombia for the period 1995-2014 our results suggest that the "high intensity conflict" explains more than one third of the unemployment rate.
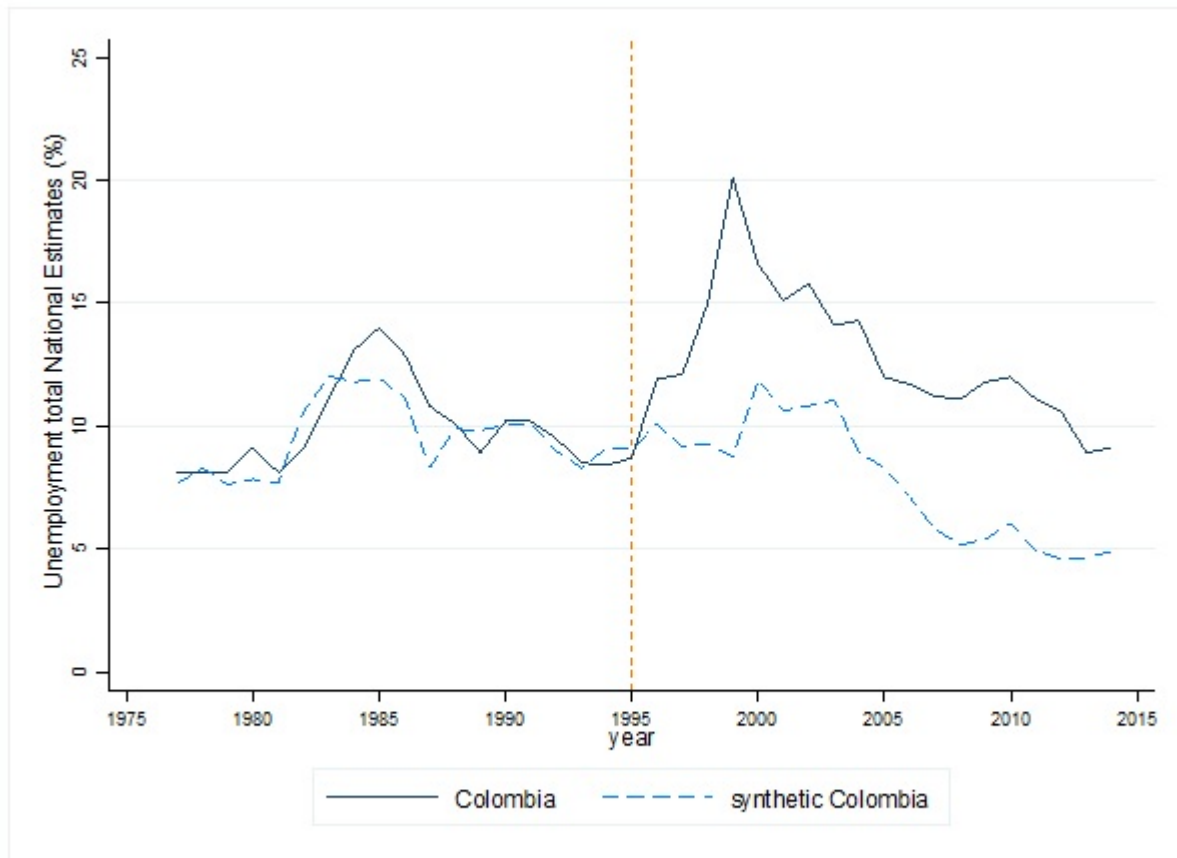
78

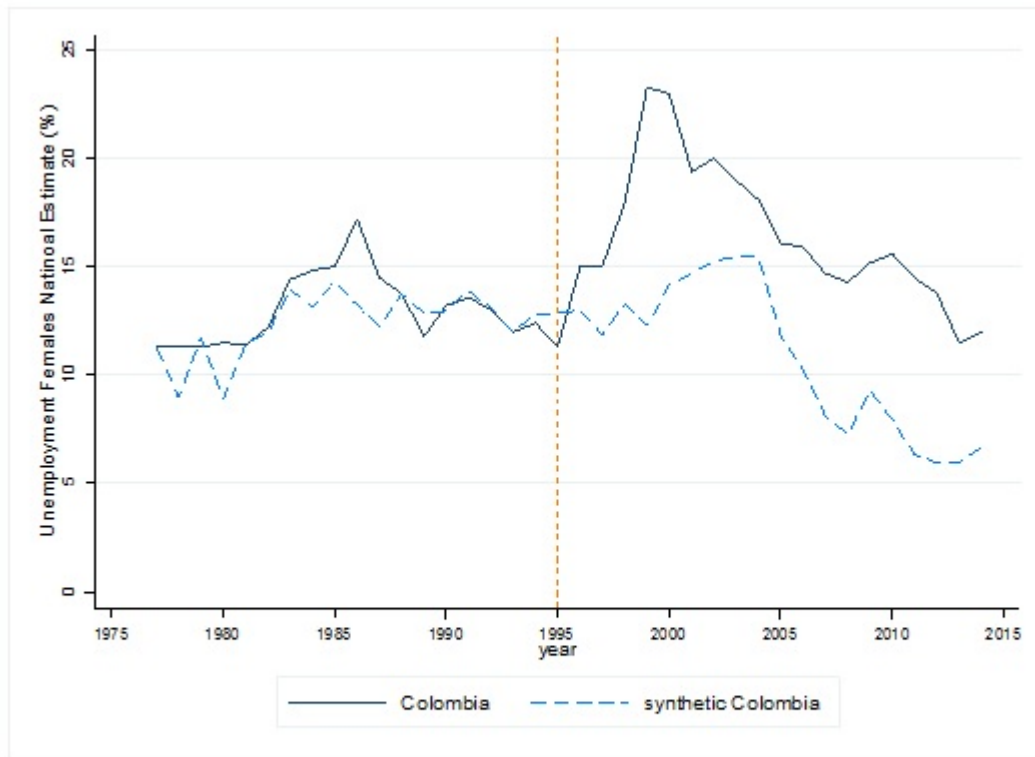Figure 5. **Trends in Unemployment rate: Colombia vs. Synthetic Colombia**

Figure 6 **Trends in Unemployment rate Female: Colombia vs. Synthetic Colombia**
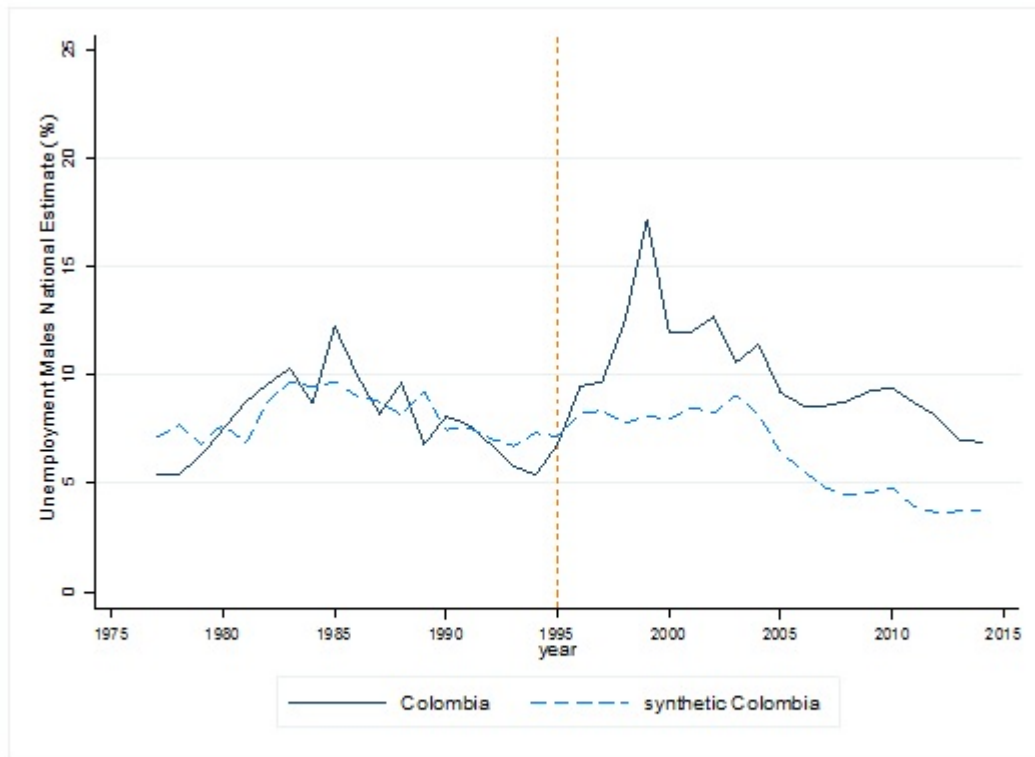
Figure 7 **Trends in Unemployment rate Male: Colombia vs. Synthetic Colombia**

13.1.3 Robustness of these results

a. placebo test

Even though the figures and the computations based on the divergence suggest that the conflict in Colombia has an effect on the variable of our interest, following Abadie et al. (2010) and Abadie and Gardeazabal (2003), we test whether our estimates have real significance or they are obtained by chance. In this sense, the questions we must respond is what would it happen with our results if we choose a random country besides Colombia? Using the non-treated countries within our donor pool, we apply the synthetic control during the sample period of our study. For each iteration, we reassign the "high intensity conflict" treatment to one of our 8 countries, and include Colombia within the set of donor countries. According to Abadie et al. (2010) the idea behind this placebo is that if the placebo creates gaps of similar

81

magnitude to the gap estimated in our main synthetic, then we can affirm that our results do not provide significant evidence of a positive effect of the treatment on unemployment rate in Colombia. On the opposite case, if the gap for Colombia is relatively larger than the ones estimated for the non-treated countries, we can say that our results provide significant evidence of a positive effect of the "high intensity conflict" on unemployment rates.

We do this for each one of the other eight countries, and then we compute the estimated effect associated with each of the placebo run, as well as the distribution of these effects. Thus, we can see where Colombia as the treated unit lies in the distribution; and based on a standard level of rejection we can conclude whether the effect is significant or not. Figure 6 shows the gap in the unemployment rate for the eight placebos, and Colombia. This figure also reveals that Argentina could have fit problems in the pretreatment period; however its mean squared prediction error (MSPE) is 12.1. Removing Argentina, we can see that the effect of the conflict on the unemployment rate in Colombia is the highest (figure 7).
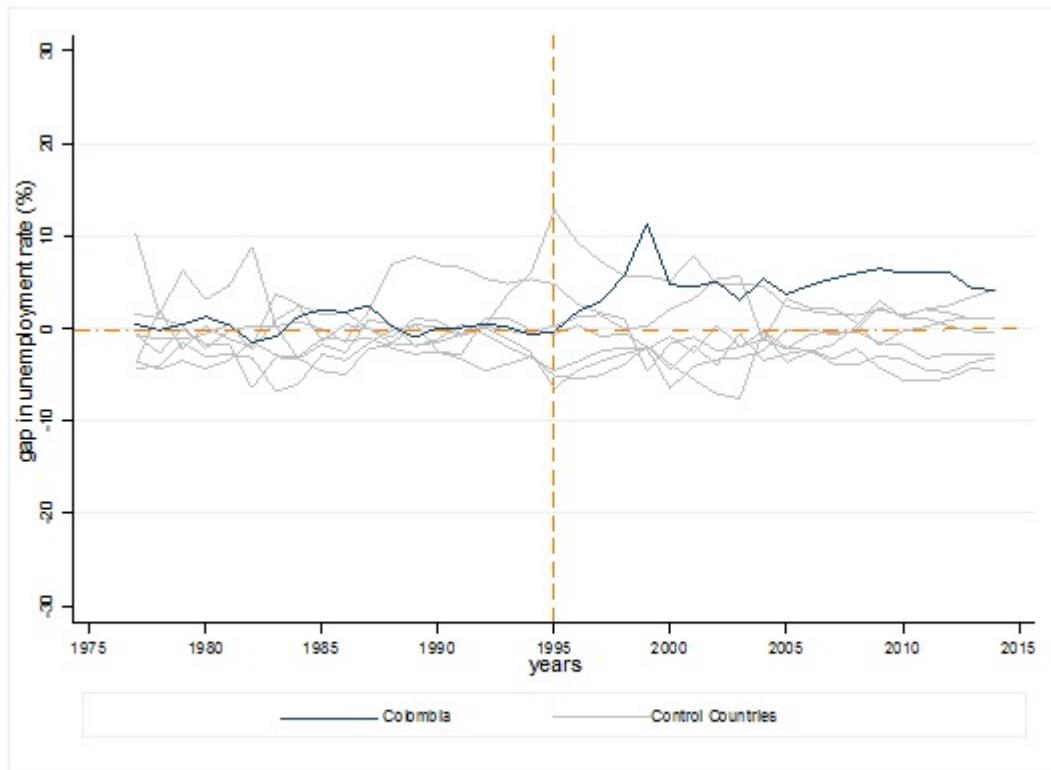
Figure 8. Unemployment rate gaps in Colombia and placebo gaps in all 8 control countries
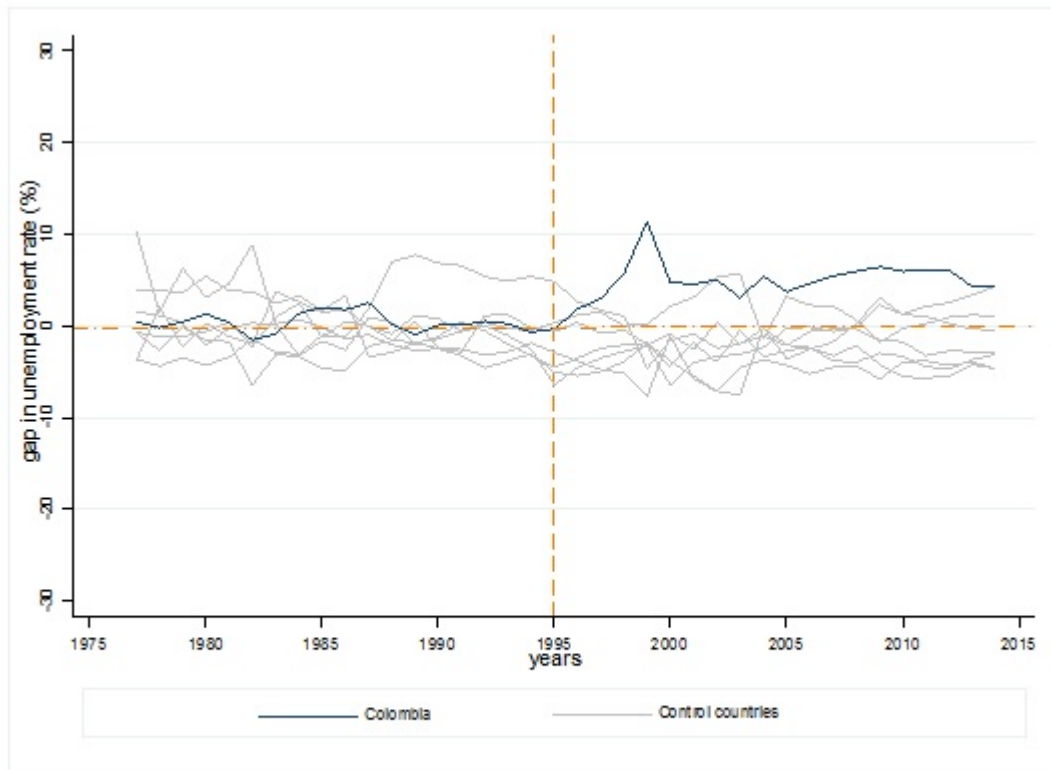
Figure 9. **Unemployment rate gaps in Colombia and placebo gaps without Argentina**

Even though these graphs give us an idea about how severe is the effect of the conflict comparatively with the placebos run, a more accurate way to evaluate the Colombian gap relative to the gaps obtained for the placebos is to analyze the distribution of the effects obtained after running iteratively a synthetic for every country. The idea is to calculate a post/pre-"high intensity conflict" MSPE ratio and constructs its distribution; based on that we assess the probability of having a value of the post/pre-"high intensity conflict" MSPE ratio as large as it is for Colombia. As it can be seen in the figure 8 the distributions of the post/pre conflict MSPE shows that the value of Colombia falls far from the values of the rest of the countries, meaning that our results are significant. The probability of observing a behavior similar to Colombia is one in nine.
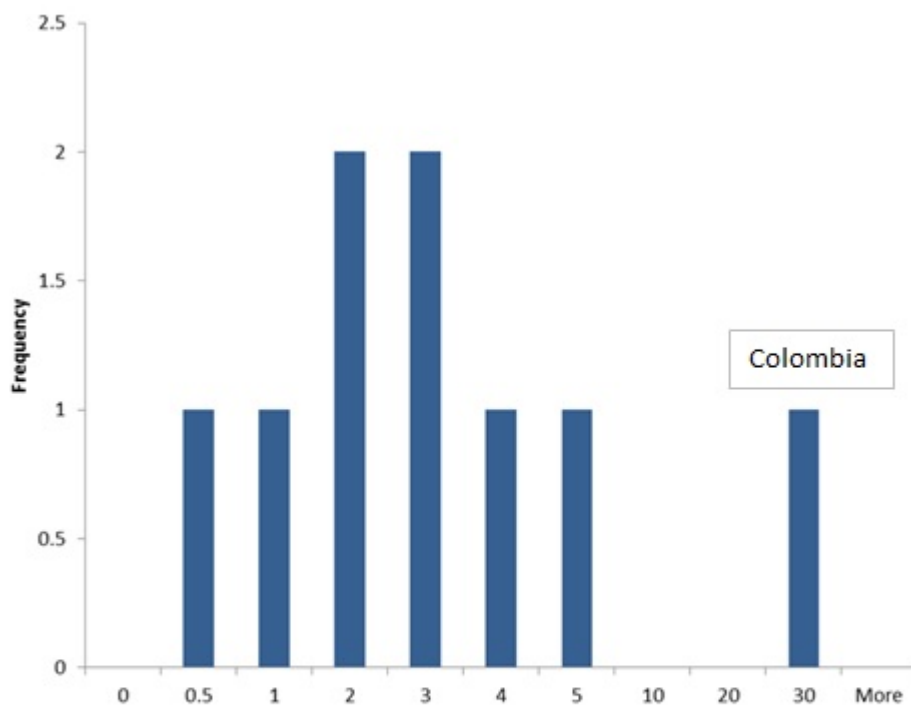
Figure 10 post/pre-"high intensity conflict" mean square prediction error

In addition to the analysis made above using the MSPE, our outcomes show that the average treatment effect for Colombia compared to its synthetic control is an increase of 5.4% in the unemployment rate. This value is presented in the graph below by the vertical line. That graph displays the cumulative distribution function of average treatment effects from systematically assigning treatment to each potential control country. The average treatment effect for Colombia is larger than the average treatment effect for all other countries, meaning that the effect of the high intensity of the Colombian conflict on unemployment rate is highly significant.

Figure 11 CDF Average Treatment Effect

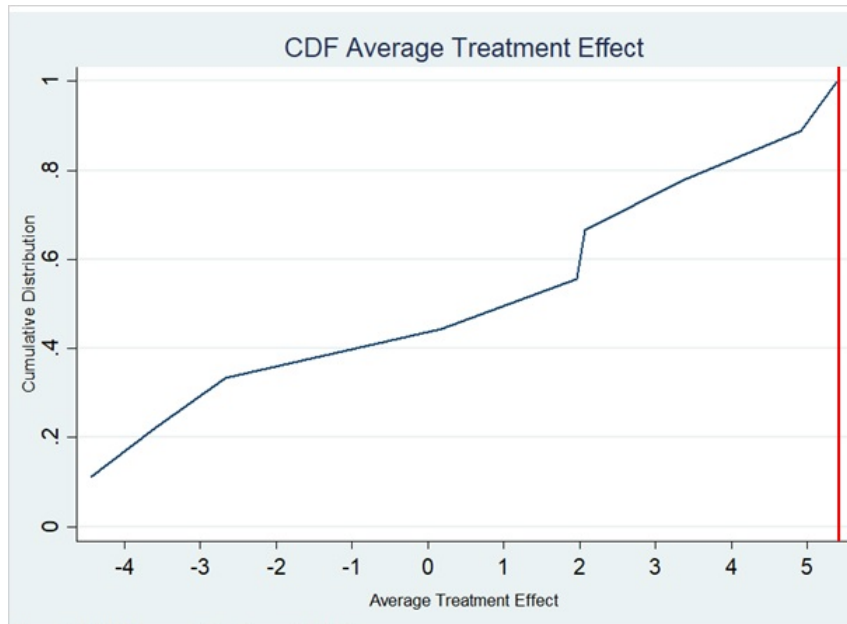Similar results are achieved when disaggregating the unemployment rate by gender. However, the effect on the female unemployment rate seems to be higher than the effect on the male unemployment. The results that we found here are consistent with other studies on the Colombian labor market that find a greater impact on unemployment within the female population (Nuñez and Bernal 1997; Sánchez, Duque, and Ruiz 2009); however, the studies here mentioned do not include the "high intensity of the conflict" within their analyses.

b. Synthetic control analysis including more countries in the donor pool

In the section called "sample selection and data" we have said that even though countries such as Mexico and Brazil share institutional characteristics with Colombia, they are not comparable with Colombia given their economic size relative to the Colombian economy. Therefore, including them in the donor pool will not contribute to the implementation of the synthetic given that their weights in the donor pool will probably be zero or close to it. In order to prove what we were saying in that section, we run the synthetic adding Brazil and Mexico to the list of countries that we use as controls. The results in table 6 show that the weights assigned to Mexico and Brazil are zero which confirms that these countries are not suitable to construct the synthetic Colombia. The countries that positively contribute to the

synthetic Colombia are Panama, Uruguay and Honduras with weights of .38, .25, and .37 respectively which are pretty much the same weights these countries got when we run the synthetic without Brazil and Mexico (See table 6).

Table 5. Unemployment rate predictor means	Treated	Synthetic	Average of control countries
GDP per Capita (constant 2010 US $)	3969.804	3948.489	5254.263
Gross Enrollment Primary (female and male)	108.0654	104.2746	109.8345
Gross Enrollment Secondary (female and male)	47.27657	52.39664	59.63335
Life Expectancy at Birth (age)	67.11873	68.65085	68.86283
Population Density (ages 15-64 pop per km sq.)	16.40294	16.67368	15.1299
Gross Fixed Capital Formation (% of GDP)	17.14444	17.48673	19.22486

Note: All variables are averaged for 1977-1994 period
These are the predictors including Mexico and Brazil.

Table 6. Country weights in the synthetic Colombia	
Country	Weight
Chile	0.00
Costa Rica	0.00
Argentina	0.00
Ecuador	0.00
Panama	0.38
Paraguay	0.00
Uruguay	0.25
Honduras	0.37
Mexico	0.00
Brazil	0.00

We have also run a synthetic including the rest of the countries in the regions [62]. The results in the table below show again Brazil and Mexico with weights zero in the donor pool. However, in addition to Panama, Uruguay and Honduras which had positive weights under our main specification, now Ecuador, El Salvador, and Bolivia positively contribute to the donor pool with weights of 0.03 , 0.01, and 0.08 respectively. However, it is important to notice two things. First, even though these weights are positive the biggest of them represents only eight percent. Second, el Salvador and Bolivia are two countries that faced similar conflicts than these faced by Colombia, then they should not be included as controls.

[62]We included all countries from which we obtained data to run the synthetic, meaning countries without many missing values.

Table 7. Unemployment rate predictor means

	Treated	Synthetic	Average of control countries
GDP per Capita (constant 2010 US $)	3969.804	3967.664	4928.259
Gross Enrollment Primary (female and male)	108.0654	104.8829	106.7154
Gross Enrollment Secondary (female and male)	47.27657	55.88285	57.19691
Life Expectancy at Birth (age)	67.11873	67.41781	66.21285
Population Density (ages 15-64 pop per km sq.)	16.40294	16.47227	21.77518
Gross Fixed Capital Formation (% of GDP)	17.14444	17.14305	19.06421

Note: All variables are averaged for 1977-1994 period
Predictors including all countries in the region.

Table 8. Country weights in the synthetic Colombia

Country	Weight
Chile	0.00
Costa Rica	0.00
Argentina	0.00
Ecuador	0.03
Panama	0.30
Paraguay	0.00
Uruguay	0.28
Honduras	0.29
Mexico	0.00
El Salvador	0.01
Brazil	0.00
Peru	0.00
Bolivia	0.08
Venezuela	0.00
Nicaragua	0.00

14 Conclusions

Analyzing the effects of the conflict in Colombia requires the consideration of multiple particularities including its duration, the multiplicity of armed actors involved, and the objectives of such armed actors. We overcome the lack of a counterfactual region within Colombia, by using a set of Latin American countries as a control group; and we estimated through two methodologies the effect of the "high intensity conflict" in Colombia on unemployment rate.

Our first approach using difference-in-differences revealed an effect on the unemployment rate. For the period 1995-2014, the DID estimated effect was about 3.7 percentage points with respect the control countries in our preferred specification (table 2, columns 4-6); and this magnitude replicated for the unemployment rate for females and males. However, these results only signaled the impact of the conflict; in order to estimate the true impact of the conflict we construct a synthetic Colombia as a counter factual.

Using the synthetic control method to analyze the period 1977-2014 we gathered few interesting conclusions. First, from our pool of donor countries only three countries obtained a positive weight: Panama, Uruguay and Honduras with weights of 0.379, 0.25 and 0.371 respectively. Second, the computation of the synthetic control allowed us to have an estimated impact of the conflict on the unemployment rate of 4.9 percentage points above the "Synthetic Colombia", which represents more than one third of the average unemployment rate for the "high intensity conflict" period (1995-2014) in Colombia. It is important to notice that there was a differentiated impact for females and males; consistent with other studies on the Colombian labor market (Nuñez and Bernal 1997; Sánchez, Duque, and Ruíz 2009), we found a greater effect among the female population for the "high intensity conflict" period than the male counterpart. Both, the DID estimated effect and the synthetic control estimate, represent at least roughly one third of the average unemployment rate for the post-treatment period. However, the synthetic control suggests an effect larger than our DID estimate.

The analysis conducted in this paper gives an idea of how the conflict is affecting one labor

variable as it is the unemployment rate, the next step could be to explore differentiated effects by schooling level and by economy sectors to identify which segments of the population and which part of the economy was more affected by the conflict. Similarly, this study opens two questions: first, a question regarding the mechanisms through which this "high intensity conflict" treatment has affected the unemployment rate; one hypothesis may reside in the pressure imposed on the labor market in urban areas due to the forced displacement phenomena; however we do not test such hypothesis in this document. Second, it is valid to ask if there was any effect on the GDP in Colombia given the impact on the unemployment rate; our first approach to the last question (which is not shown in this paper) do not reveals any conclusive results.

90

Appendix

a. Synthetic control method

This methodology considers the availability of J control "regions" different than the treated region, and a $(J \times 1)$ vector W of nonnegative weights summing to one. Each scalar in the W vector (i.e., w_j) represents the weight of region j in the synthetic control region. The main idea is to find a vector W in such a way that the synthetic control is the closest to the treated region before the beginning of the treatment period. Then, given a $(K \times 1)$ vector X_1 of pre-treatment values of K economics variables for the treated region, a $(K \times J)$ matrix X_0 containing the values of the same variables for the J possible control regions, and a diagonal matrix V with nonnegative components reflecting the relative importance of the different economic variables, a vector W^* of weights is chosen to minimize $(X_1 - X_0W)'V(X_1 - X_0W)$ subject to $w_i \geq 0$ and $w_j + + w_J = 1$. The objective is to approximate the outcome variable in the treated region Y_1 to the path this would have in the absence of the treatment, so this counterfactual outcome path is calculated as the outcome of the synthetic control region $Y_1^* = Y_0W^*$ (For more about synthetic control method see: Abadie and Gardeazabal 2003, and Abadie et al. 2010.).

b. Employment to population ratio

In this paper our main objective is to analyze the impact of the high intensity of the conflict in Colombia on the unemployment rate. However, now we want to study another measure of the Colombian labor market which is the employment to population ratio. The table below contains the results of a difference in differences model which is similar to the one that we have run for the unemployment rate, the only difference is that now the dependent variable is the employment to population ratio. Table A1 below shows that during the period 1995-2014 the effect of the conflict on the dependent variable for Colombia was approximately 0% (0.0000864) with respect the control countries.

Table A1. Differences in Differences Employment to population ratio		
	(1)	(2)
	Employment to	Employment to
	population ratio	population ratio
VARIABLES	Total	Total
did	0.0000864***	0.0000994***
	(0.0000259)	(0.0000254)
timetreat	0.0000565***	0.000112***
	(0.0000147)	(0.00000846)
controls	x	
_cons	-0.0003112	0.000241***
	(0.0001987)	(0.00000579)
R-squared	0.49	0.43
Observations	316	342

Standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1

We also run the synthetic for the employment to population ratio as our dependent variable. Tables A2 and A3 show the mean of each predictor used to construct the synthetic and the weight of every country in the donor pool respectively. As it can be seen, the synthetic values for the predictor are closer to the values of Colombia's predictors than the average values. However, in the figure 12 it is not clear that the year 1995, which is our cutoff point, defines a point in which Colombia and its synthetic diverge. The two lines were different even before our cutoff point. Therefore, in this case we cannot say that the high intensity of the conflict is the cause of any difference in employment to population ratio during the period 1995-2014.

Table A2. Employment to population ratio predictor means

	Treated	Synthetic	Average of control countries
GDP per Capita (constant 2010 US $)	3969.804	3970.623	4599.337
Gross Enrollment Primary (female and male)	108.0654	108.0721	107.4469
Gross Enrollment Secondary (female and male)	47.27657	47.28624	54.34334
Population Density (ages 15-64 pop per km sq.)	16.40294	16.40365	14.94567
Gross Fixed Capital Formation (% of GDP)	17.14444	19.03947	18.88967

Note: All variables are averaged for 1977-1994 period

Table A3. Country weights

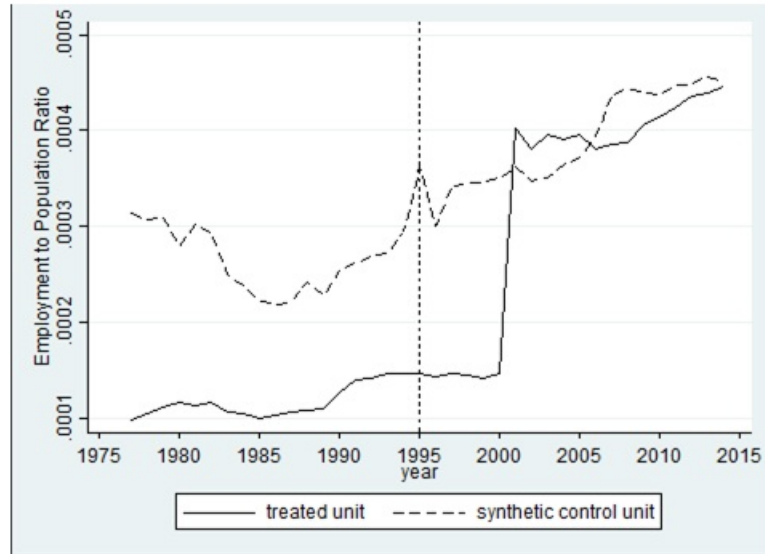| Country	Unit_Weight
Chile	0
Costa Rica	0.177
Argentina	0
Ecuador	0.205
Panama	0
Paraguay	0.233
Uruguay	0.225
Honduras	0.16

93

Figure 12 Trends in employment to population ratio total: Colombia vs Synthetic Colombia

According to the results that we have obtained here, we conclude that: either the employment to population ratio is not a good variable to explore the impact of the conflict on the Colombian labor market, or it is necessary to add more predictors to get a better adjustment in the pretreatment period in order to describe the behavior of that variable during our period of analysis.

c. Common trend assumption tests

The following tables show the results of the common trend assumption tests that we conducted for the difference in differences models where the dependent variable is the unemployment rate.

Table A5 Test for common trend assumption: test in pre-treatment period

VARIABLES	(1) Test Unemployment	(2) Test-controls Unemployment
Trend	-0.074	-0.009
	(0.078)	(0.089)
Test 1(Treatment X Trend)	0.119	0.035
	(0.135)	(0.073)
Covariates		X
Year Dummies	X	X
Constant	9.659***	54.587***
	(1.709)	(8.341)
Observations	180	168
Number of id	10	10

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6. Test for common trend assumption: Placebo treatment (t < 1985)

VARIABLES	(3) Placebo Unemployment	(4) Placebo-controls Unemployment
Time-treat (t<1985)	9.645***	53.668***
	(1.749)	(8.338)
Treatment	1.415	0.985
	(4.784)	(1.050)
DID	-1.887	-2.796*
	(1.459)	(1.567)
Covariates		X
Dummy year	X	X
Observations	180	168
Number of id	10	10

Standard errors in parentheses

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

Table A7 Test for common trend assumption: Placebo treatment (t < 1990)

VARIABLES	(5) Placebo 2 Unemployment	(6) Placebo 2-controls Unemployment
Timetreat3 (t < 1990)	1.091	56.056***
	(1.322)	(8.348)
Treatment	0.731	0.052
	(4.884)	(1.470)
DID	-0.215	-0.439
	(1.628)	(1.706)
Covariates		X
Dummy years	X	X
Constant	8.455***	
	(1.753)	
Observations	180	168
Number of id	10	10

Standard errors in parentheses

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

Table 1 Victims of violence in Colombia 1980-2014

Years	Selective Deaths	Forced Displacement	kidnapping	Victims of Massacres	Victims of Landmines
1980	NA	NA	279	10	0
1981	98	NA	92	62	0
1982	178	NA	114	106	1
1983	138	NA	124	193	0
1984	190	60,039	150	138	1
1985	180	13,835	346	229	0
1986	280	15,459	154	125	0
1987	60	19,099	132	125	0
1988	444	33,371	335	526	0
1989	390	29,735	280	290	0
1990	393	37,671	1122	328	22
1991	421	33,233	766	418	69
1992	461	43,935	912	419	151
1993	389	49,579	354	271	84
1994	491	54,066	691	187	85
1995	614	105,466	509	275	130
1996	565	137,364	1269	463	120
1997	811	246,950	2100	662	96
1998	439	239,354	3278	684	58
1999	682	272,792	3354	1134	54
2000	1291	598,026	3547	1441	137
2001	761	653,228	3545	1370	299
2002	1067	753,678	3306	815	634
2003	1495	453,126	2303	427	756
2004	1071	414,909	1773	303	890
2005	702	473,898	1283	160	1182
2006	399	454,267	1350	105	1235
2007	486	476,171	1384	89	978
2008	427	424,856	1455	78	857
2009	518	247,750	1252	106	747
2010	361	191,803	1252	87	552
2011	353	230,316	NA	80	549
2012	183	231,683	NA	45	502

Authors' elaboration

Sources: Group of Historic Memory – Colombia[1]; Victims Unit – President Office Colombia[2]; Center for Conflict Studies – CERAC.

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