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Sebastián Jaén, PhD (c), & Isaac Dyer, PhD  
Universidad Nacional de Colombia  
jsjaenp@unal.edu.co, idyner@unal.edu.co

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**Abstract**—The coca farming dynamics seems to partially follow the patterns of a long war against organized crime in Colombian. Since the early 80s, the cocaine market in the US and the rest of the world has been mainly supplied by Colombian cartels. Consequently, these illegal organizations have been targeted by Colombian and American law enforcement agencies. Our work argues that such policy has had a counter-intuitive effect which contributes to increases coca farming and reductions in cocaine prices. This paper hypothesizes that such situation was the consequence of the way that drug cartels were dismantled – thus the Colombian paradox. The consequences of the war against cartels may be assessed with the support of a dynamic theoretical framework and SD. Effective policy may consider alternative actions before dismantling drug cartels.

**Keywords**— Illegal Monopolies, Cocaine Market, Law Enforcement, Simulation.

**Resumen**— The coca farming dynamics seems to partially follow the patterns of a long war against organized crime in Colombian. Since the early 80s, the cocaine market in the US and the rest of the world has been mainly supplied by Colombian cartels. Consequently, these illegal organizations have been targeted by Colombian and American law enforcement agencies. Our work argues that such policy has had a counter-intuitive effect which contributes to increases coca farming and reductions in cocaine prices. This paper hypothesizes that such situation was the consequence of the way that drug cartels were dismantled – thus the Colombian paradox. The consequences of the war against cartels may be assessed with the support of a dynamic theoretical framework and SD. Effective policy may consider alternative actions before dismantling drug cartels.

**Palabras Clave**—Illegal Monopolies, Cocaine Market, Law Enforcement, Simulation.

## I. INTRODUCTION

The history of the world cocaine market, especially of the American market, has been tightly associated with the most renowned Colombian cartels during the last two decades. In the most recent years this association has been mainly with the guerrillas and paramilitary forces.

Most scholars in the field have focused their research exclusively on business costs, some on the associated business risk, and a small number on the industry's structure. Abundant literature addresses the American and Sicilian mafia cases (e.g., Rottemberg [1], Reuter [2], Fiorentini and Peltzman [3], and Fiorentini [4]<sup>1</sup> but the literature on the Latin American organized crime and specifically on Colombia is still limited.

Until 1993, the Peruvian and Bolivian farmers were the main coca farmers while this was just a marginal illicit crop in Colombia [5]. The Colombian cocaine boom started during the early 90s and “developed complex organizations which, in many cases, operated autonomously” [6]. It has been acknowledged that the Colombian drug trafficking activity “coincided with an accelerated demand-rise in the US, which started an unusual process of accumulation of enormous amounts of money in the hands of the few involved in this activity” [7]. Two big cartels were conformed (Medellin and Cali) and many other small ones operated across Colombian and Central America [6].

The growth and expansion of these criminal groups coincide with increases in homicide rates in Colombia. Continuous

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1. Additional literature is also relevant; however, authors consider that referenced books are the most relevant and compiled works within the pursued research line.

increases in violence and a terrorist threat shocked Colombians who become aware of their long connivance with the fast enrichment of illegal actors. Society and government reacted and got support from the US in terms of military training and technology [8].

In 1992-93 most members of the Medellín cartel were in jail or dead. The Colombian government then went ahead to fight the Cali cartel. In the mid 90s the two main members of the Cali cartel were taken to prison but immediately “the Norte del Valle cartel incorporated the Cali cartel’s routes and social networks” [9].

The Cali cartel played an important role as mediator between guerrillas and paramilitaries<sup>2</sup> [10]. Once this cartel was dismantled, small traffickers were co-opted by paramilitary groups who by 1996 had already controlled many remote and central regions in Colombia. The association that was established between traffickers and paramilitaries increase their possibilities for bribing and buying firearms but created frictions among them for market control. The guerrilla forces got also involved in the cocaine business. Given the rural nature of these groups, it is not an oddity that the new cartels’ focused on coca leaf production, gaining considerably knowledge to improve both profits and crops.

There were unexpected consequences in the war against cocaine trafficking. We developed a model aiming to evaluate and assess alternative policies against cartels, evaluating a dismantling strategy policy which could focus on either cartel leaders, or cartel members.

The paper is organized as follows: section two shows the evolution of coca crops and it argues that growth might be partially explain by the policy of dismantling big cartels. Section three indicates the cocaine supply chain and the role played by organized crime. Section four shows the model which let us evaluate former dismantling policies and infer about alternative dismantling strategies and their consequences. Section five discusses validation issues and conclusions.

## II. THE EVOLUTION OF COCA FARMING

Colombia has experienced two outbreaks of coca farming during the last twenty years. Figure 1, depicts the series of coca-leaf farming by two different sources (UNODC and INCRS).

2. Paramilitaries or self defence forces began as response against guerrillas’ extortion and theft during the early 80s. Not all their members can be associated to drug traffickers, in they beginning, many of them were rich countryside ranchers or big land owners dedicated to cattle industry [10].

The first outbreak starts in the early 80s subsequently heavily increasing the number of coca crops during almost ten years. After five years of apparent stagnation (1991-1995), in the mid 90s, coca farming reaches high levels until eradication policies reverts this tendency by 2000.

Stagnation period does not seem to be explained by any special eradication policy during those years as indicated in . An event that coincides with the stagnation period, perhaps the only one<sup>3</sup> directly linked to illicit drug trade, is the dismantling of the Medellín and Cali cartels<sup>4</sup>.

What happened during the period that the Medellín and Cali cartels were being dismantled (1991-1995)? As expected: stagnation, moderate fall, and initial slow recovery in coca farming. But following the dismantling of the Cali cartel (soon after the disappearance of the Medellín Cartel) something that seemed unexpected happened: a new outbreak occurred. Note that the patterns of coca farming are not very far from those that are crime related as the total inmates in Colombian prisons (Figure 2), and the Colombian homicide ratios (Figure 3) – there are though some differences in lags and tendency.

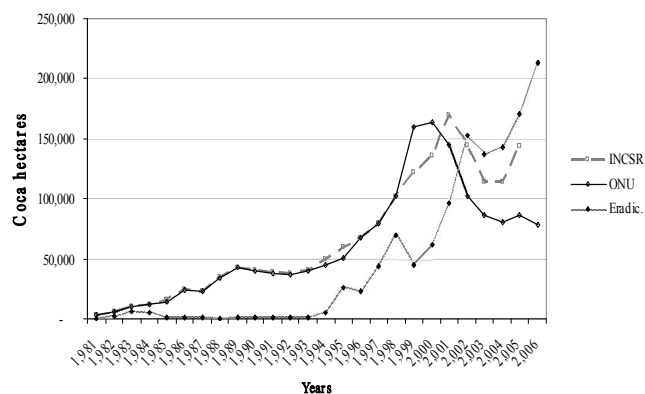


Figure 1. Coca farming and eradication. Sources: UNODC and INCSR several years.

- World Drug Report [11] shows an important leap in the Colombian poppy crops hectares by 1994, from 5,008 hectares in 1993, poppy crops reaches 15,091 hectares by 1994. But by 1995, poppy crops hectares come back to its usual margin of 5,216 hectares, reaching no more than 7,350 hectares during the next eleven years. There is no enough evidence that allows point out those sudden poppy crops increase did move illegal farmers from coca leaf crops to poppy crops. Both sources of coca crops signal a moderate increase during the 93-94 lap.
- Medellín cartel’s head was dead finishing 1993. Cali cartel main members were in prison in 1995.

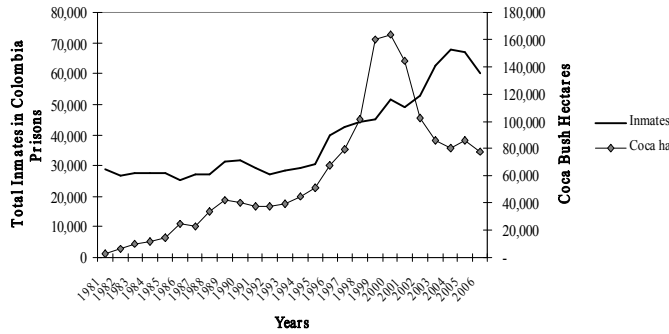


Figure 2. Coca Bush Hectares and Prison Population. Source: UNOCD, 2007, 2002; and INPEC<sup>5</sup> stats.

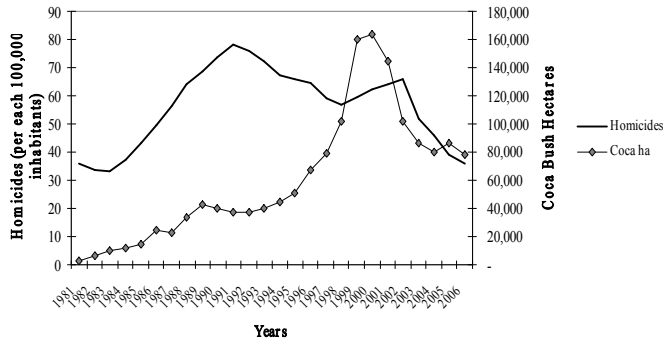


Figure 3. Colombian homicide ratios versus coca hectares. Source: Policia Nacional and UNOCD.

An important number of Colombian scholars in the field (e.g. [7]; [5], [6]; [10]) argue that the cartel dismantling policy gave way to a new generation of criminals. They indicate that the fall of the cartels promoted the surge of many small gangs, which were poor (and atomized) compared with the big cartels, vulnerable to police forces and other traffickers. What Colombian and foreign scholars do not acknowledge is that such a break-up into smaller divisions is the consequence of a cartel dismantling policy and the way that such cartels were dismantled. In other words, the fight against big criminal structures have contributed to split these into a number of smaller units, bringing more people into this illegal industry given that such policy have destroyed the costly entry barriers to this unlawful business.

Figure 4, depicts the Buchanan’s Defense of organized crime theory. The horizontal axis represents the resources devoted to law enforcement while the vertical axis the resources used by criminal activity. The C curve represents the criminal response to law enforcement; Z is the initial equilibrium under a criminal

monopoly;  $C_m$  represents the supply curve (criminal response) under monopolistic activities and  $Z_m$  a new equilibrium. Buchanan [12] states:

“Monopoly in the sale of ordinary goods and services is socially inefficient because it restricts output or supply. The monopolist uses restriction as the means to increase market price which, in turn, provides a possible source of monopoly profit. This elementary argument provides the foundation for collective or governmental efforts to enforce competition. If monopoly in the supply of “goods” is socially undesirable, monopoly in the supply of “bads” should be socially desirable, precisely because of the output restriction.” (p. 119).

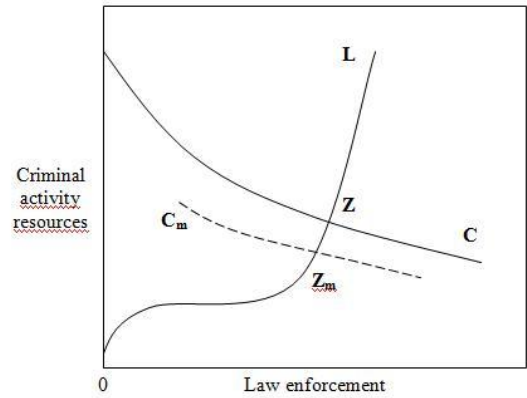


Figure 4. Criminal monopolies. Source: Buchanan [12].

When law enforcement focuses on monopolies, fragmentation and competition emerges. Figure 5, shows the monopoly equilibrium between price and quantity,  $P_M$  and  $Q_M$  respectively. A cartel dismantling policy would change the curve’s slope to a less inclined trajectory, and a new market equilibrium is reached at price  $P_F$  and quantity  $Q_F$  (F denotes a fragmented industry).

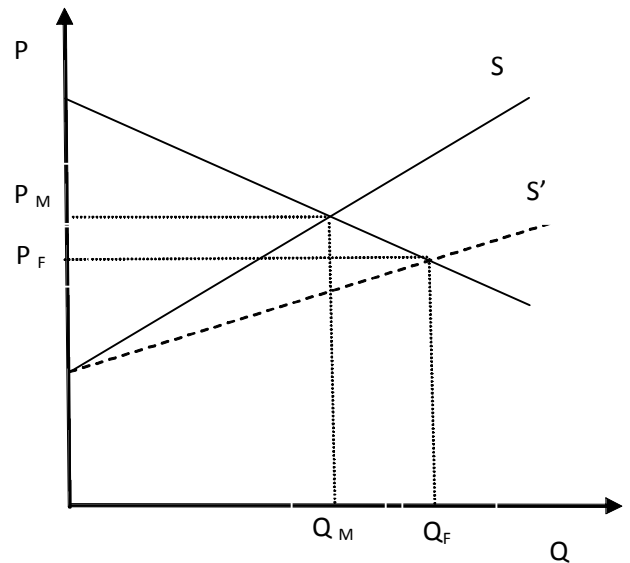


Figure 5. Drug price and supply after a cartel dismantling policy.

5. In spanish: Instituto Nacional Penitenciario de Colombia, National Penitentiary Institut from Colombia

III. A CONCENTRATE INDUSTRY

During the early days (about 1980s) the Colombian cocaine industry was characterized by its high degree of concentration and integration ([13], [5]). Coca base was imported from Bolivia or Peru, processed in remote laboratories and exported mainly to the US. Those activities were very expensive as there was a need to supplying remote laboratories with coca leaves and then transport cocaine powder by fast boats and airplanes to clandestine and legal airstrips and docks in the US.

During the period 1980-1995 cartels dominated cocaine trafficking as they dominated the available routes; only very few defy the big risk associated with the transportation business from South America to the US ([13]). There was a natural network monopoly where routes are fiercely owned and protected. Several route owners would generate negative externalities as the activity would turn more visible to the authorities - the best route is the safest one. Thus there exist several economic barriers in order to become a big route owner.

During the 80s and 90s coca prices declined: "It is difficult to account for the continued sharp decline until 1989 and the more modest declines in the 1990s", when supply and consumption seem to be constant [14]. However, as Figure 6 depicts, Colombian wholesale prices shows a modest increase at 1990s beginning, which coincides with the main Colombian cartels strategies for monopolizing the criminal drug industry.

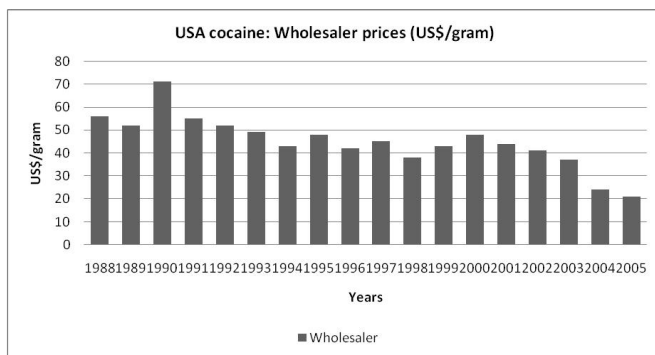


Figure 6. USA cocaine: Retailer and Wholesaler prices. Source Washington Office on Latin America (2004).

As cartels are broken into many small units along the production-distribution chain, the new units incorporate agents coming from the former cartels as well as newcomers into the business. Thus, it is possible to infer that a big firm dismantling policy would bring an interesting dynamic to the industry. This issue is discussed ahead and it is incorporated into our model structure.

IV. ILLEGAL FIRM SYSTEM AND DISMANTLING POLICY

4.1. ILLEGAL FIRM: BASIC STRUCTURE

The head of an illegal firm has under his command several functional areas and a large number of members. There is a well-defined barrier between members and heads. The Heads of the firm establishes a monopolistic and economic barrier (identified as the variable promotion barriers in the causal-loop diagram, Figure 7) which obstruct members to easily reach the Heads level. The monopolistic barrier works by force. Economic barriers influence the Capacity to hire, which establishes a well defined hierarchical structure.

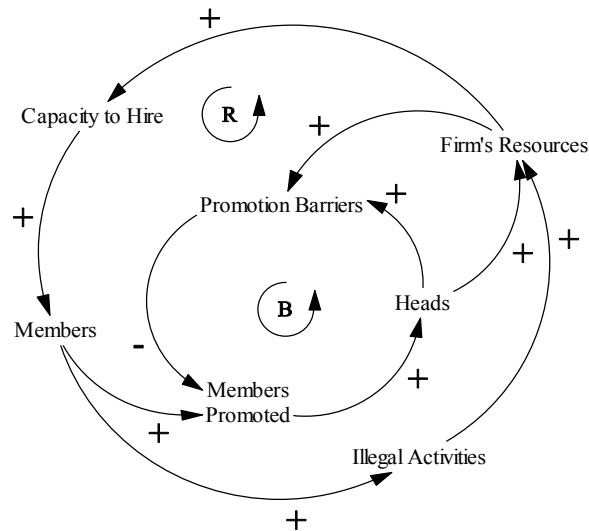


Figure 7. Criminal firm's basic causal-loop.

The model assumes that the illegal firm might reach its maximum capacity to generate funds depending on its illegal workforce. Several authors as Fiorentini and Peltzman [5], Krauthausen [13] and Thoumi [14], remark the main role of illegal firm size. Illegal firms need to establish their adequate size in order to gain strength, but at the same time, seeks to avoid insubordination.

Figure 8, indicates that illegal firms outsource some services (i.e. coca production, drug supply to end-customer and information services). In some cases as gangs grow very big rather than outsourcing these activities will include firm's divisions. However as previously discussed monopolist (cartels) have no incentives for market increase given the risky possibilities to filter information or loose operations control [13]. Our model suggests criminal firm enrolls the basic structure to conduct illegal task. Certain amount of people did not hire tray to preserve links with firm supplying criminal services rivaling with other outsource firms. Such rivaling brings a criminal services price decrease which brings economic benefits for firm.

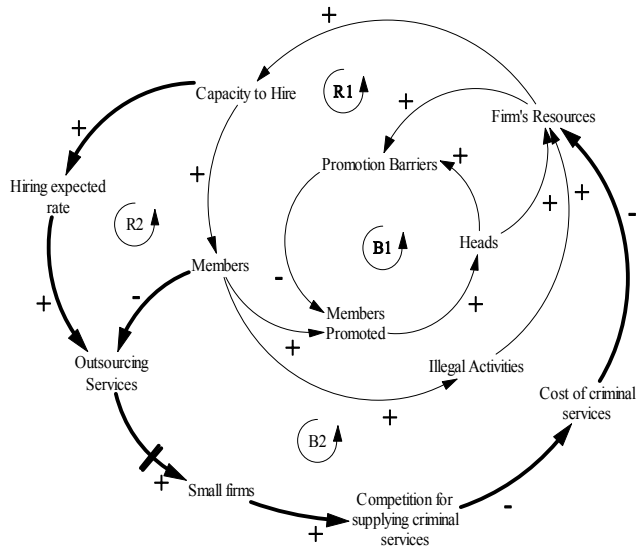


Figure 8. Illegal workforce and criminal services.

4.2. SIMULATION OF CASE-BASE SCENARIO

The simulation of the base-case scenario shows the evolution of the firm's initial configuration. It depicts a situation in which Firm's heads start raising: (i) hiring enough members and (ii) When firm reaches a determined size, out workforce establishes local suppliers of either coca base, or criminal services (iii). Low level suppliers can have its own reinforced increase given that it is at least a profitable activity with low barriers to entry. Firm's operations profitability (iv) would

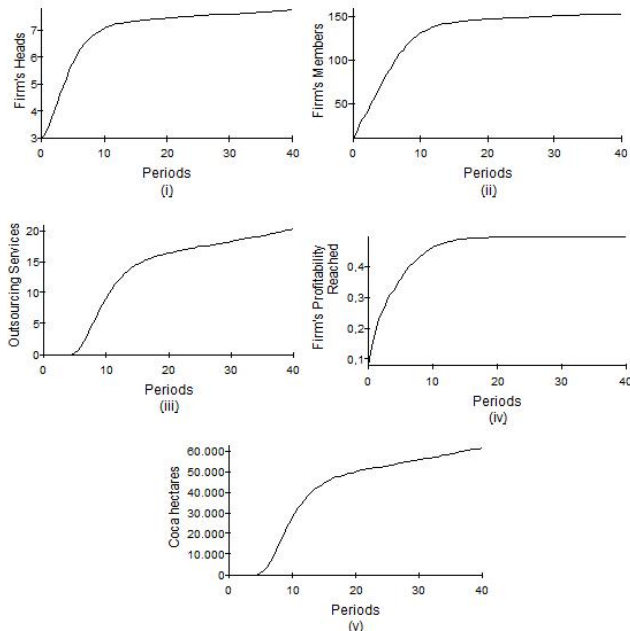


Figure 9. Base simulation: Firm initial configuration.

reach its maximum score (about 50% [15]), given the firm place into the market. As Outsourcing Services increases coca crops farming (v) increases as well.

Model establishes there exist a period of time in which variables' growth is more accelerated according to conformation phase. After this one stage, growth becomes slower given that firm starts to display its monopolizing efforts for controlling market.

4.3. CARTEL DISMANTLING POLICY

The first big Colombian criminal organization dismantled was the Medellin cartel. A bloody and long war against such group lasted almost ten years (1984-93) until efforts of Colombian and American law enforcement agencies<sup>6</sup> killed or imprisoned all cartel members. Our model replicates this policy using a probability of capture which triggers exit flows for both criminal categories (i.e. Heads and Members). Model assumes total impunity until policy is implemented as a switch function (period 15). It depicts the stocks and flow structure of law enforcement against cartels. To model such policy, law enforcement initially succeeds by eroding the firm's members and later striking bosses after some delay.

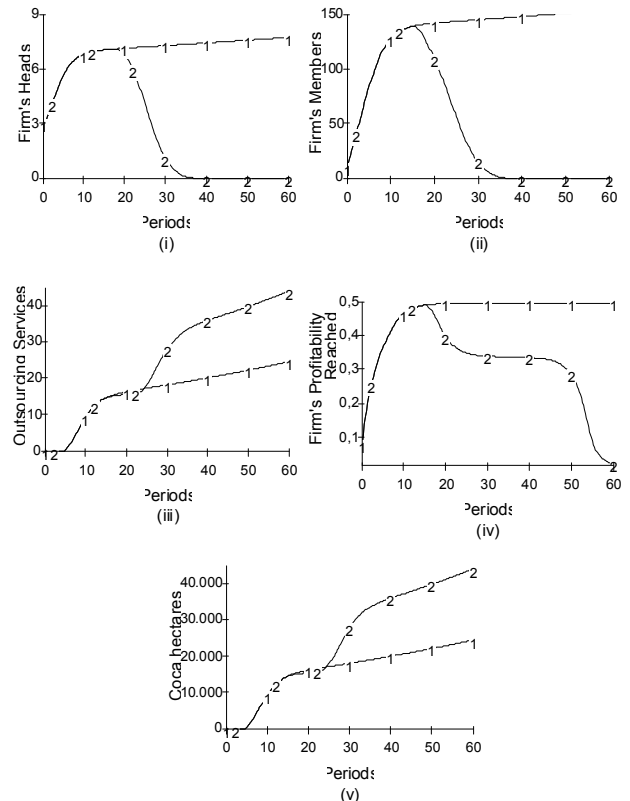


Figure 10. Similar policy to Medellin Cartel's dismantling policy.

6. Unofficial information argues the connivance and information support of illegal rival firms.

Figure 10, shows two trajectories: Number one (1) indicates the base-case scenario and number two (2) indicates the dismantling policy. Members and heads fall. Cartel resources fall as well as firm lacks its operative capacity. However, many of the low level criminal services (outsource services) take charge at lower costs, due to competition. As law enforcement persists members and heads disappear as well as profitability (iv).

A very interesting issue is that as outsourcing increases (iii) new entrants are needed due firm dismantling and hiring expectations. As firm dismantling policy prevails, avoiding recruitment, workforce migrates to smaller gangs that act as outsourcing firms of criminal services.

The new small firms fiercely rival among themselves to gain power as observed after the disappearance of the Medellin and Cali cartels. The attack on the Cali cartel was apparently successful as by 1995 their main head members were imprisoned (Duncan, [16]; Thoumi [13]). This was not a long and bloody war against this criminal group, simply the heads of the cartel disappear (only heads) as they were taken to prison. , illustrates the policy's impact: (i) heads fall, and (ii) members fall (had to look elsewhere for jobs). Members thus migrate away or establish their own firms. Such outbreak of new small firms renders criminal services at a very low cost.

Thoumi [15] describes very well the members' migration from big cartels (the most integrated) to small firms - small cartels or "cartelitos" (Duncan, [10]). Simulations show similar migration (Figure 11 (iii)). Next section discusses initial model evaluation and validation.

A tentative policy actually does not implemented would be focus law enforcement only on members as oppose as Cali cartel strategy which it was dismantled mainly in their heads. Figure 12, shows three main trajectories. The first one is the simulation of base-case. Second one, law enforcement against firm's members and heads, and third one, an exploratory policy of law enforcement on members only.

Short run results (until period 30) seem to reveal a promising behavior: Firm members decrease, Outsourcing Services level is lesser than base-case, and firm's profit shows a sharply fall. But after period 30, model turns such apparent beneficial behavior. Feed-back structure explains what it means. Absence of members encourages a high hiring rate. Hiring expected rate increases considerably because firm's heads need workforce to manage their activities. However, a persistent law enforcement policy against members decreases them until such point in which firm's profitability decreases avoiding affording both the workforce fees and hiring capacity. Hiring expected rate starts to decrease carrying workforce to outsourcing services. Competence among outsourcing rival firms allows a cost decrease and low barriers to enter. In this way, model generates new heads.

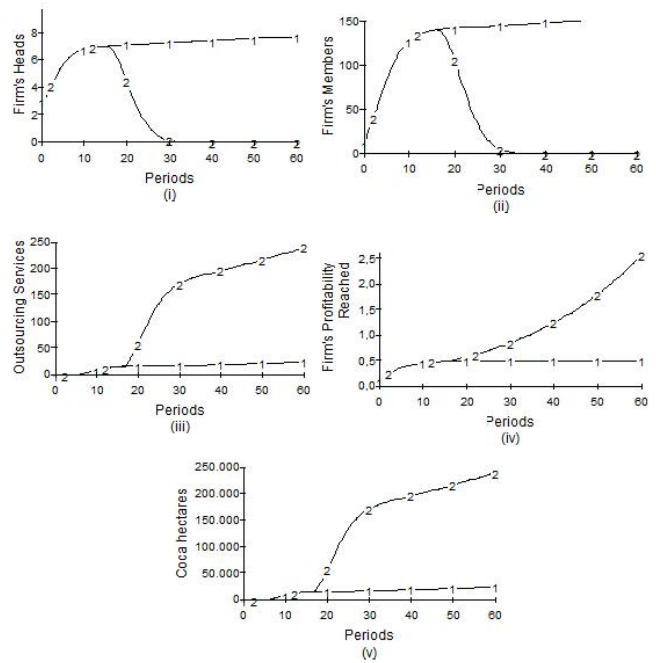


Figure 11. Similar policy to Cali Cartel's dismantling policy.

V. FINAL CONSIDERATIONS AND CONCLUSIONS

The purpose of the model is to explore the dynamics of criminal organizations and to assess alternative policy, aiming to reduce their impact on society. As observed, in general terms, the model reproduces the developed theoretical framework. However, is there a statistical evidence for this?

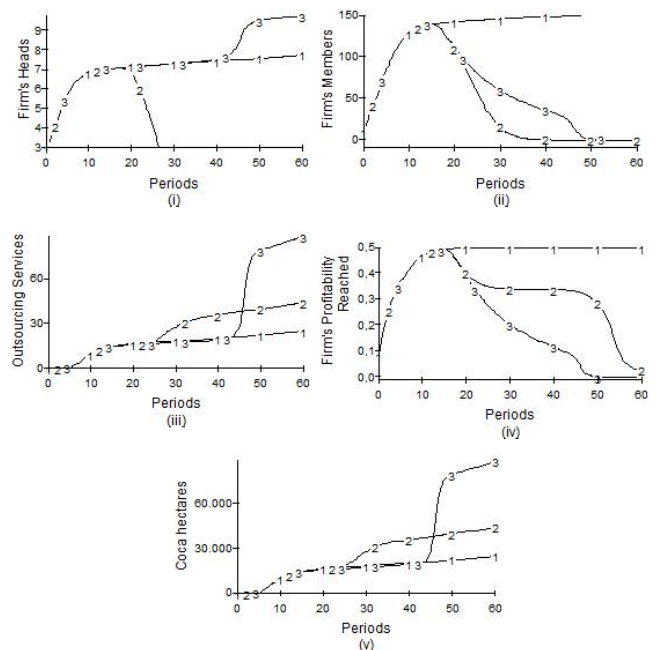
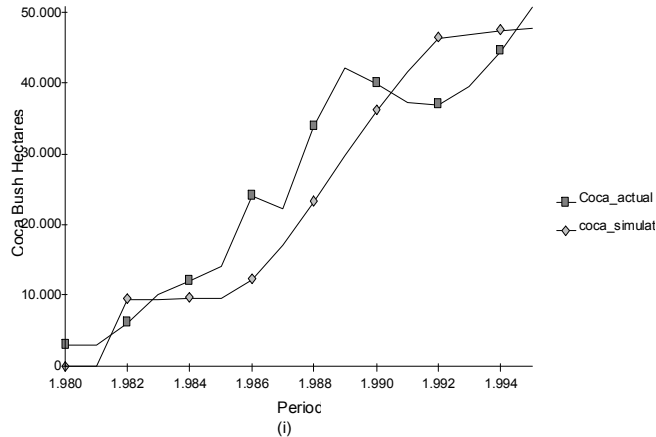


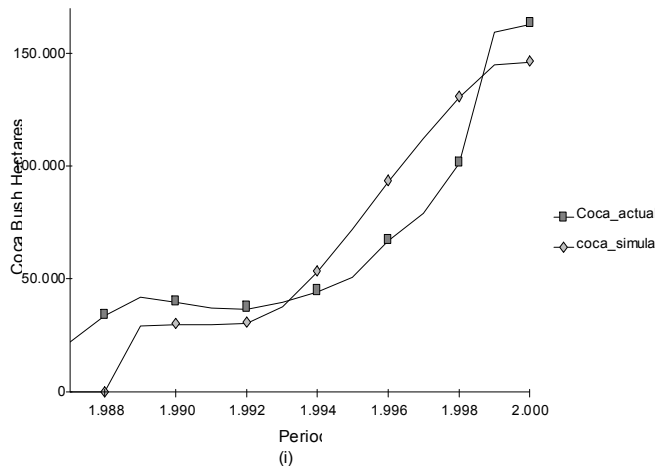
Figure 12. Law enforcement focused on members only.

Figures 13 and 14, show simulation results and reported coca plantations (hectares) during two important periods across the war against cartels. Both model results and real data show similar patterns: constant increase at the beginning and few periods of stagnation followed by several years of accelerated increase.



**Figure 13.** Simulated number of possible farmers and coca hectares stats until under Medellin cartel dismantling.

Analysing model under Cali cartel dismantling policy, we can see some basic coincidences (Figure 14). Both model and real data have some similar paths of behaviour: constant increase at the beginning and few periods of stagnation followed by several years of accelerated increase.



**Figure 14.** Simulated number of possible farmers and coca hectares stats until under Medellin cartel dismantling.

Although it is not enough for arguing that model is completely valid, at least we got confidence that our hypothesis would have sense and further research seems a promising task. Preliminary prototype gives us useful elements and cues in order to consider a more elaborated model. We need to consider

if more model detail will allow us gain learning about policies and its effect on system.

Former simulations allow us to evaluate the Buchanan theory and consider the impact of a cartel dismantling policy into the illegal drugs market. Our model allows us argue that a dismantling cartel policy does involve counter intuitive mechanisms who affect whole market especially for unleashing illegal workforce and generating a competitive market of criminal services.

Model shows as policies focussed on a sole part of the criminal firm involves side effects which benefits another echelon of supply chain. Although criminal antitrust strategy showed unexpected and undesired consequences, policy against heads, seems to be the most harmful strategy in order to face a criminal monopoly. Great push on law enforcement agencies forces it to concentrate efforts on criminal heads, and public opinion considers their fall like the crime end. Nonetheless, model reveals that it is more beneficial, at least in the short run focussing on members than heads. Such policy reveals to be the most expensive situation in which they could be placed.

We gained learning from a policy rebuilt and policy experimentation as law enforcement on only members hasn't been implemented against any Colombian know big criminal firm. Further research needs to be done in order to consider the homicide and inmate increase, and the best way to operate on market within carry it to best conditions for final consumers.

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