Balloon effects in coca crops in the Andean region
(1990-2009)

Los efectos globo en los cultivos de coca en la región andina (1990-2009)[*]

Os efeitos globo no cultivo de coca na região andina (1990-2009)

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Research article

Abstract

The aim of this article is to statistically examine the presence of *balloon effects* affecting coca crops in the geographical territory corresponding to the main producer countries of the Andean region (Colombia, Peru and Bolivia) during the period 1990-2009. The empirical methodology is focused on the specification and estimation of a model of simultaneous equations using the SUR method, which allows for the explanation of the behaviour of the hectares cultivated with coca plants based on a set of determinants. We conclude that there is empirical evidence supporting the presence of *balloon effects* in the Andean region during the period of inquiry.

Keywords: balloon effect, structural equations, illicit crops, SUR model, war on drugs.

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Resumen

El objetivo de este artículo es poner a prueba estadísticamente la presencia de *efectos globo* en los cultivos de coca en el territorio geográfico correspondiente a los principales países productores en la región andina (Colombia, Perú y Bolivia) durante el periodo 1990-2009. La metodología empírica se centra en la especificación y estimación de un modelo de ecuaciones simultáneas utilizando el método SUR, el cual permite explicar el comportamiento de las hectáreas cultivadas con coca en función de un conjunto de determinantes. Se concluye que hay evidencia empírica a favor de la presencia de *efectos globo* en la región andina a lo largo del periodo estudiado.

Palabras clave: efecto globo, ecuaciones estructurales, cultivos ilícitos, modelo SUR, guerra contra las drogas.

Resumo

O objetivo deste artigo é testar estatisticamente a presença de efeitos globo sobre os cultivos de coca nos principais países produtores da Região Andina (Colômbia, Peru e Bolívia) durante o período 1990-2009. A metodologia empírica consistiu na estimação de um modelo de equações simultâneas utilizando o método SUR, que pode explicar o comportamento de hectares cultivados de coca, com base em um conjunto de determinantes. Os resultados mostram evidências empíricas a respeito da presença de efeitos globo na região andina durante o período estudado.

Palavras-chave: efeitos globo, modelo SUR, equações estruturais, culturas ilícitas, guerra contra as drogas.

INTRODUCTION

After the culmination of the first phase of Plan Colombia in the year 2007 there has been much analysis and discussion regarding its efficiency and the achievements attained in the so called war on drugs in Colombia and the Andean region (Abadie, Acevedo, Kugler & Vargas, 2006; Arce & Reales, 2006; Mejía & Restrepo, 2008, 2012; Rozo, 2012; Botero, 2013; Rocha, 2011, among others). However, there are not many works that have focused on the statistical analysis of the presence, evolution and consequences of the processes of geographical relocation of the illegal crops (coca and poppies) in this region as a result of repressive policies in certain geographical areas. This phenomenon has been denominated in the specialized literature regarding illegal goods and drug trafficking as the *balloon effect* of illegal crops[1].This is paradoxical, since the analysis of balloon effects is essential to

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[1] Some works that approach this topic are those of Abadie, Acevedo, Kugler and Vargas (2006), Arce and Reales (2006), Bagley (1988, 2012), Moreno-Sánchez, Kraybill and Thompson (2003), Dion and Russler,

understand the evolution of illegal activities in a context of repression of their supply. It is due to the presence of *balloon effects* that historically, during the last decades, the decrease in the crops in some regions or countries has been contrasted by their increase in other territories.

The purpose of this article is to statistically put to the test the presence of balloon effects in coca crops in the geographical territory corresponding to the main cocaine producing countries of the Andean region (Colombia, Peru, and Bolivia) during the period 1990-2009, which corresponds to the period in which Plan Colombia was implemented in its first phase of application, also known as Plan Colombia I (Rojas, 2007). Therefore, the main research question to be answered next is: is there enough empirical evidence to affirm that the behavior of the coca crops in the region was affected by the presence of balloon effects? It is from there that other specific questions arise: what factors were determinants in the evolution of illegal crops between 1990 and 2009? Did balloon effects have any incidence on the level of effectiveness of the repressive policies regarding the supply of drugs? What are the main characteristics and mechanisms of the identified balloon effects?

Through the estimation of an econometric model which explains the evolution of coca crops in Colombia, Peru, and Bolivia, it is examined if there is enough statistical evidence to disregard the hypothesis that *throughout the 1990-2009 period there have been balloon effects in the geographical territory corresponding to the cocaine main producing countries of the Andean region.* To put this hypothesis to the test, an econometric model of apparently non-related regressions SUR *(*Seemingly Unrelated Regressions) is used, which explains the evolution of coca crops in these countries throughout the period studied.

This article has been organized as follows, apart from the introduction. In the second section what the balloon effect consists of is explained. In the third section there is a descriptive analysis regarding the presence of balloon effects in coca crops in Colombia during the studied period. In the fourth, the methodology used is explained. In the fifth, the results obtained are presented. Finally, some conclusions are put forward.

WHAT DOES THE BALLOON EFFECT CONSIST OF?

Before stating the facts that make evident the presence of balloon effects in the Andean region during the final decade of the last century and the first in of the 21st century, it is convenient to bear in mind that in the field of the economics of crime and, in particular, in that of the economic theory of illegal goods, the visible influence that balloon effects have in the development of the different stages of the productive chain of illegal drugs in repressive contexts has been acknowledged (Nadelmann, 1989; Caulkins, Crawford & Reuter, 1993; Mejía & Restrepo, 2013).

(2008), Reyes (2014), Dávalos, Bejarano and Correa, (2009), Dávalos *et al.* (2011), Caicedo (2006), and Rouse and Arce (2006).

The balloon effect is considered to be the result of the execution of government policies against the dynamic of the markets of illegal goods. The government policies do not manage to eliminate the activities in the markets, on the contrary, they lead to changes and operational responses on the side of the criminals, such as changes of the place of production, reduction and decentralization of the production, and an increase in violence or intimidation towards the institutions (Arce & Reales, 2006).

In fact, legislation that seeks to prohibit the production, commercialization and consumption of illegal drugs leads producers to relocate the productive activities of their goods and the production of others, as is the case of Colombia (Bagley, 1988). This author affirms that the first indication of the presence of a balloon effect in Colombia was observed between the end of the 70s and the beginning of the 80s, as a result of the militarization and the anti-illegal drugs' effort in la Guajira. These caused a displacement of the drug crops (marijuana) and the activities of transport of illegal drugs to other areas of the country like the oriental plains and the Amazonian jungle, instead of eradicating these activities.

Afterwards, evidence was found of the drop in coca crops in Peru and Bolivia and an increase in the number of hectares of coca crops in Colombia between 1987 and 2001 (Moreno-Sánchez, Kraybill & Thompson, 2003). For the period 1987-2001, these authors estimate econometric regressions to explain the area cultivated with coca in Colombia (in hectares –ha-), based on several factors, such as the base price of coca in areas of cultivation in that country, the eradicated area in the same country, the price of plantain in the cultivation areas (as the main substitute crop for coca), and the area cultivated with coca crops in Peru and Bolivia; all the independent variables are lagged in a period of time. In the context of a model of minimum ordinary squares (MOS), the authors show that the elasticity of the hectares cultivated with coca crops in Colombia with respect to those in Peru and Bolivia is not statistically different from one: a change of 1% in the hectares cultivated with coca crops in Peru and Bolivia decreases by a percentage close to 1% the hectares cultivated with coca crops in Colombia. This means that the efforts to reduce the area cultivated with coca crops in Colombia are blocked by the increase in the cultivated area in the other two countries mentioned, which suggests the presence of the spatial relocation of the crops with small changes in the aggregated field of production (Moreno-Sánchez et al., 2003).

The relocation of coca crops has also been corroborated as from the implementation of Plan Colombia. In the World Drug Report of 2010 (UNODC, 2010) it is put forward that the reinforcement of the repression of cocaine supply, from the year 2000, reduced the number of hectares cultivated with coca in Colombia and displaced them to Peru and Bolivia during the first decade of the 21st century (Bagley, 2012). Nevertheless, according to Mejía and Posada (2007), until 2005 there was no conclusive evidence that supported the presence of the balloon effect in the Andean countries during the first five years of the past decade.

However, for other authors (Dion & Russler, 2008), since the implementation of Plan Colombia, it has been observed that there is a process of the dispersion and reconstitution

of the crops in the interior of this country, expanding to areas that before 2005 there was no cultivation of coca leaves. *The presence of the dispersion and decentralization of the illegal activities in the interior of a country* is another characteristic of the balloon effect. In the Colombian case, it is shown that there are large crops in more disperse and distant areas from the presence of state infrastructure so as to escape its repressive policy (Dion & Russler, 2008), but at the expense of devastating the biodiversity of tropical forests and Amazonian jungles, abundant and inaccessible (Dávalos, Bejarano & Correa, 2009; Dávalos et al., 2011).

Likewise, works like that of Reyes (2014) give an account of the ability to adapt and of the effective response of coca crops in some municipalities in Colombia when the anti-drug policy was reinforced. This means –according to the author- that the increase in the eradication of crops leads to an increase less than proportional in the coca crops; therefore, there is an effective response, but not an immediate one, from those who cultivate coca leaves. In the same way, Moreno-Sánchez *et al.* (2003) find that until the year 2001, the cultivated areas in the municipalities, in view of the eradication policies, increased as much as the efforts of eradication intensified.

The balloon effect brings about negative externalities for the environment and biodiversity, as was mentioned previously. The works of Dávalos *et al.* (2009 and 2011) and Rincón-Ruiz and Kallis (2013) account for the deforestation caused by the eradication of and fumigation by aspersion on the coca crops in the agricultural frontiers in Colombia. At the same time, the devastating social consequences of these repressive policies to the supply are described. The population of the new territories colonized is overwhelmed by the increase in violence, crime and forced displacement, for instance indigenous people and Afro-Colombian communities.

In fact, for Díaz and Sánchez (2004), the expansion and scaling of the armed conflict during the 90s has a significant effect on the increase in the production of coca leaves in Colombia. Likewise, Botero (2013) shows that the hardening of the anti-drug policy in Colombia increases the homicide and forced displacement rates during the period between 1999 and 2010.

On the other hand, Peter Reuter (2014) recently highlighted the influence of the *balloon effect* in the analysis of the mobility of drug-trafficking networks. In his article, this author presents a general but precise definition of the *balloon effect hypothesis,* about the ways in which the activities of the production and trafficking of illegal drugs are rearranged when faced with the repression exerted by the authorities of control in the different stages of the productive chain, mainly through the implementation of different interception plans of illegal drug consignments or the eradication of illegal crops:

> Simply put, this hypothesis advances that if authorities get tougher on producing, trafficking, or dealing in one location, then the targeted activity will be displaced to another location with no more than temporary inconvenience to the participants. The

long term consequences, in terms of availability and price to users, will be slight, particularly if the intervention is close to the production site (Reuter, 2014, p. 33).

In this article the analysis focuses on the fulfillment of the balloon effects in the stage of the cocaine production chain corresponding to illegal crops. However, the presence of this particular type of balloon effects also has implications for the study of other types of balloon effects in other stages of the productive chain. The latter corresponds to a topic that deserves to be dealt with in further studies on the matter.

Justification of the research

In view of the fact that none of the works developed so far on the topic have carried out an econometric analysis to put to test the simultaneous presence of balloon effects in the three main cocaine producing countries throughout the period between 1999 and 2009, this work intends to fill the gap in the study of illegal crops, applying a model of structural equations –SUR-, which manages to appropriately capture the interactions of the relocation processes of illegal crops in the Andean region. In this sense, there is a double contribution of this work: firstly, it presents a conceptual and descriptive analysis of the balloon effect throughout the period corresponding to the two previous decades, which is useful to understand the evolution of coca crops in the Andean region. Secondly, the hypothesis that *throughout the studied period there have been balloon effects in the Andean region* is statistically put to the test. This allows the updating and expanding of the analysis carried out for the 1987-2001 period by Moreno-Sánchez *et al.* (2003); but, the novelty of this work is the use of a model of a structural nature, as is SUR. In addition, these contributions allow for an efficient evaluation of the eradication policies of the crops during the period of study, which is at present really important in order to evaluate the results of the anti-drug policy and, in particular, of Plan Colombia during the previous decades. This can be done nowadays as there is more clarity as regards the evolution of coca crops, the production of cocaine and their prices during the last two decades.

DESCRIPTIVE ANALYSIS

There is sufficient descriptive evidence that there are balloon effects for the coca leaf crops and the potential production of dry coca leaf in the Andean region throughout the observed period.

During the period 1990-2010 there was a significant decrease in the number of hectares cultivated with coca for the three main producing countries (Colombia, Peru, and Bolivia). Crops went from 211,700 hectares in 1990 to 158,000 hectares in the year 2010, for the three Andean countries, which is translated into a reduction of 25% in the coca crops for that period at an average annual rate of -1.45 % (UNODC, 1999, 2010 and 2011). But it is necessary to divide the temporal analysis so as to identify two different patterns of behavior from the incidence of the repression policies on the supply and the evolution of the social, economic, and political conditions.

The first period corresponds to the nineties, a period in which the total number of hectares of the three Andean countries increased by 9600 ha, until it reached 221,300 in the year 2000. This represents a 4.5% growth between these two years of reference and an annual implicit growth rate of 0.44% for that same period. However, the participation of the countries within the total of cultivated hectares changed throughout the decade, as can be seen in Figure 1. In the case of the crops in Colombia, there is a 300% growth, from 40,100 hectares at the beginning of the period, to 163,300 (ha) at the end, which represents an annual implicit growth rate of 14%. Conversely, the number of cultivated hectares in Peru and Bolivia dropped: in the former at an annual implicit rate of -12.4 %, and in the latter at an annual implicit rate of -10.3 % (calculations made by the authors based on information from UNODC, 1999, 2010 and 2011.)

The literature describes some factors that explain the upsurge and growth of illegal crops in Colombia during the 1990s. The first is the expansion of the irregular armed conflict in Colombia which is outlined in works such as those of Díaz and Sánchez (2004), Posada and Mejía (2007), among others. These works suggest that after the dismantling of the two large cartels in the first five years of the decade of the nineties, the guerrillas and *autodefensas* acquired greater preponderance in the production and commercialization of cocaine. Thus, the great illegal armed groups improved their capacity to finance their insurgent and paramilitary actions and, in that way, managed to amplify their military power and logistic abilities to control larger territories.

Secondly, during the 1990s there was a consolidation and expansion of the agricultural border dedicated to the cultivation of coca in Colombia. The farmers, who were victims of the agricultural crisis caused by the loss of competitiveness of Colombian coffee and policies of economic opening implemented in Colombia, saw illicit crops as an alternative to their reduced benefits. The farmers expanded the territory of coca crops and organized politically to defend their territories from fumigations, although with limited independence from armed agents, especially the guerrillas (Thoumi, 2009).

Third, after the disarticulation of the drug cartels, such as those of Medellin and Cali, a restructuration of the production and commercialization of cocaine took place in Colombia. During this decade an important number of new organizations dedicated to the illegal trade of drugs emerged, which had to hire the guerrillas and *autodefensas* for the maintenance of their security systems and the provision of supplies to process cocaine (Thoumi, 2009). These drug dealers expanded their political work and developed alliances with the political class in order to defend their interests, at a local as well as a national level (Duncan, 2014).

Fourth, the increase of plantations in Colombia during this period is attributed to the strong repression exerted in Peru during the government of Fujimori (Thoumi, 2009). As from 1995 the strategy called *bringing down the air bridge with Colombia,* was established, which consisted of the destruction and interception of aircraft loaded with coca from Peru. In the same way, during the first half of the 1990s the prices of coca in its main producing regions in Peru went down and producers were forced to contribute with bribes to the corrupt police forces and governmental agents (Thoumi, 2009).

Finally, in the case of Bolivia the *Plan Dignidad* (Dignity Plan) was implemented, which rapidly reduced the crops at the end of the 1990s in that country. This Plan consisted of the gradual reduction of the compensations for the elimination of coca crops during the second mandate of Banzer (1997-2001) (Laserna, 2009).

The second period corresponds to the first decade of the 21st century. The behavior patterns of illicit crops in the Andean countries were the opposite of those during the 90s. The total number of hectares cultivated with coca crops in Colombia, Peru, and Bolivia decreased between the years 2000 and 2010, going from 221,300 hectares to 158,000 hectares. This reduction of 63,300 hectares is equivalent to a 28% decrease between those two time references and represents an annual average implicit growth rate close to -3.4 % for that same period.

For the case of Colombia, the number of cultivated hectares dropped, going from 163,300 at the beginning of the period, to 62,000 in the year 2010. This corresponds to a reduction of over 101,000 hectares, which is equivalent to a 62% loss of the cultivated area in two years. This is an annual average reduction of 9.23%, which is the result of the strengthening of the anti-drug policy with the different components of Plan Colombia, according to authors like Posada and Mejía (2007). With this multiple strategy eradication and aerial fumigation were intensified in the coca regions using satellite images to focus and locate the crops more efficiently. In this way, Colombia went from 73% of cultivated area to 39% during the stated period (2000-2010).
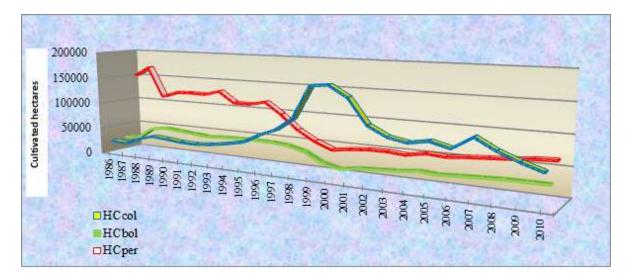
On the other hand, the number of cultivated hectares in Peru and Bolivia increased. In Peru it went from 43,400 hectares in the year 2000 to 61,200 hectares in the year 2010. At the same time, in Bolivia the numbers doubled, going from 14,600 at the beginning of the period to 30,900 at the end. This increase in Peru and Bolivia suggests that the repressive strategy on the supply, as well as the resources and attention were focused on Colombia (Bagley, 2012).

In Bolivia, there were several coca-growers' protests and revolts at the beginning of the 21st century due to the economic and social impact of the eradication of coca crops within the framework of the Plan Dignidad (Laserna, 2009). From that moment on, the crops started to grow again and with the coming into office of Evo Morales a challenge was presented: fight against drug trafficking without eradicating coca crops or repressing the coca-growers (Laserna, 2009). With this purpose, the "Strategy to fight against drug trafficking and to revalorize coca" was formulated for the period 2007 to 2010, which had two axis of action: a repressive one against drug trafficking and its related crimes, and another one of social control and the use of the coca crops that were intended to be maintained on 20,000 hectares (Laserna, 2009).

In Peru, coca crops stabilized as from 1998 due to a series of key factors (Soberón, 2009). According to Soberón, from that year the crops of the Peruvian coca-growing valleys were reestablished because the collateral activities to this illegal business, such us the transport
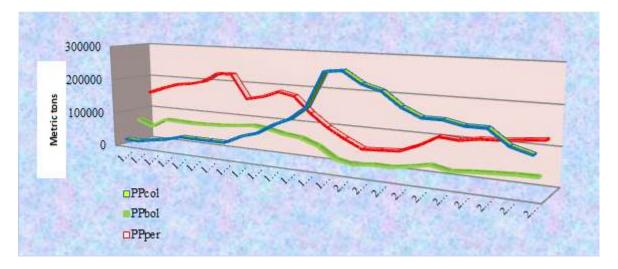
of coca, cocaine and supplies, and the lands dedicated to cultivating the coca leaf, were divided into much smaller plots that were hidden, where eradication and fumigation were difficult (Soberón, 2009). In addition, the Peruvian government institutionally abandoned the coca-growing regions, allowing for the establishment of criminal and corrupt economic and social structures that complicate the sustainable development of the land in Peru (Soberón, 2009).

The above temporal description of the evolution of coca crops reveals that during the 1990-2000 period the crops increased in Colombia while they decreased in Peru and Bolivia. Conversely, during the following decade the opposite happened: the crops decreased in Colombia at the same time that they grew and stabilized in Peru and Bolivia. Figure 1 illustrates this behavior: here it can clearly be observed that the tendencies in Colombia are juxtaposed with the tendencies observed in Peru and Bolivia.

Figure 1. Hectares of coca crops cultivated by country (HC)
Source: 1986-1987: (UNODC, 1988); 1990-1994: (UNODC, 2001); 1995-2010: (UNODC, 2010, 2011).

In the same way, it can be observed that there is a balloon effect for the production of coca leaf, as it can be seen in Figure 2.

Figure 2. Potential production of coca leaf by country (PP)
Source: 1986-1987: (UNODC, 1988); 1990-1994: (UNODC, 2001); 1995-2010: (UNODC, 2010, 2011).

METHODOLOGY

All the statistics come from a database organized with statistics wholly extracted from the UNODC information system, which, at the same time, uses information from the Monitoring Integrated System of Illicit Crops (SIMCI by its acronym in Spanish)[2]. Since the measurement of the statistics of potential production of coca leaf carried out by UNODC is based on a series of estimations made from the measurement of hectares cultivated with coca, the statistical analysis that is presented below focuses on the study of the determinants of the hectares cultivated with coca throughout the 1990-2009 period.

The list of variables used, together with their definition and signs expected in the estimation, are found in Table I. It is worth noting that the variable of the proportion of the agricultural added production with respect to Bolivia's GDP was extracted from statistics of the Word Bank.

Table 1. Description of the variables of the SUR system

Period: 1991-2009	**Data: time series**	**Market:** coca production	**Methodology:** SUR
Variables	**Definition**		**Expected sign**
lnhccol$_t$	Natural logarithm of the area cultivated with coca crops in Colombia (ha). Source: UNODC		It does not apply,

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[2] From now on reference will be made to all the information from the information system of UNOCD, as just UNOCD

	(1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	dependent variable
$lnhccol_{t-1}$	Natural logarithm of the area cultivated with coca crops lagged for a period in Colombia (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Positive
$lnp1usa09_t$	Natural logarithm of the street value in US dollars of coca/gram by purity levels adjusted for 2009 inflation for the USA 1990-2009. Source: World Drug Report 2011.	Positive
$lnhcbolper_t$	Natural logarithm of the area cultivated with coca crops in Bolivia and Peru (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Negative
$lnecol_{t-1}$	Natural logarithm of coca crop eradication for Colombia (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Negative
dummycol	Dummy variable which captures the structural change caused by Plan Colombia from the year 2001	Negative
lnedplan	Interactive dummy variable between the logarithm of a lagged eradication and the structural change caused by Plan Colombia	Positive
$lnhcbol_t$	Natural logarithm of the area cultivated with coca crops in Bolivia (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report, 2010).	It does not apply, dependent variable
$lnhcbol_{t-1}$	Natural logarithm of the area cultivated with coca crops lagged for a period in Bolivia (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Positive
$lnebol_{t-1}$	Natural logarithm of coca crop eradication for Bolivia (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Negative
dummybol	Dummy variable which captures the structural change caused by the anti-drug repression plan of President Banzer for the years 1998-2000.	Negative
lnedbol	Interactive dummy variable between the logarithm of lagged eradication and the structural change caused by the anti-drug repression plan	Positive

	of President Banzer	
$\textbf{ppibagrbol}_t$	Proportion of the added value of the agricultural sector in the total GDP for Bolivia. Source: World Bank.	Positive
$\textbf{lnhccolper}_t$	Natural logarithm of the area cultivated with coca crops in Colombia and Peru (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Negative
$\textbf{lnhcper}_t$	Natural logarithm of the area cultivated with coca crops in Peru (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	It does not apply, dependent variable
$\textbf{lnhcper}_{t-1}$	Natural logarithm of the area cultivated with coca crops lagged for a period in Peru (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Positive
$\textbf{lneper}_{t-1}$	Natural logarithm of coca crop eradication for Peru (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Negative
$\textbf{dummyper}$	Dummy variable which captures the structural change caused by Fujimori's repressive period (1991-2000)	Negative
$\textbf{lnedper}$	Interactive dummy variable between the logarithm of lagged eradication and the structural change caused by Fujimori's repressive period.	Positive
$\textbf{lnhccolbol}_t$	Natural logarithm of the area cultivated with coca crops in Colombia and Bolivia (ha). Source: UNODC (1986-1998 Global Illicit Drug Trends 1999; 1999-2009 World Drug Report 2010).	Negative

Source: data base built from information retrieved from UNODC

For this work, a set of regressions were specified and estimated, corresponding to a SUR model, which seeks to empirically examine some of the determinants of the hectares cultivated with coca in Colombia, Peru, and Bolivia and, in particular, puts to the test the hypothesis that *throughout the 1990-2009 period there have been strong balloon effects in the geographical territory corresponding to the main cocaine producing countries of the Andean region.*

This model is pertinent because it captures the possible correlations in the error terms between the regressions that explain the number of cultivated hectares for the three main producers which, in this case are key, due to the presence of balloon effects and the

interrelations derived from the integration of the productive chain to illegal businesses among the three countries. Given the geographical nature of the variables studied in this research, the hectares cultivated with coca in Colombia, Peru, and Bolivia could be correlated with each other and, at the same time, there could be factors that are not taken into consideration in the specifications that are correlated to factors from Colombia, Peru, and Bolivia. This means that the cultivated hectares of a cocaine producing country can be correlated to the hectares cultivated with coca of the producers that are geographically close. Until now, no work on the topic has used the SUR model to examine the balloon effect for the whole of the Andean region during the period 1990-2009. This is, therefore, the main contribution of this work. Further works should update the model to determine what has happened with the dynamics of coca crops in the region during the last decade.

As is usual, the SUR model was estimated through the generalized least squares (GLS) method in order to achieve a more efficient estimation than through ordinary least squares (OLS) (Greene, 2008) and the following starting assumptions on the structure of the covariance matrix were considered:

1) In each equation of the SUR system the error term does not present autocorrelation or heterocedasticity

2) The correlation between the errors of each specification of the SUR system is contemporary, this means that:

$$E\left(U_j U_i\right) = \sigma_{ij} I_T, \quad i \neq j \qquad i, j = 1, 2, 3, \ldots, m,$$

where m is the number of equations of the model –in our case, 3 equations, one for each of the main producers of the region (Bolivia, Colombia, and Peru) and T for the number of

Using a matrix notation, the model can be represented as follows:
$$\mathbf{HC} = \mathbf{X\beta} + \mathbf{U}, \qquad\qquad [1]$$

where $\mathbf{HC}$ is the vector of hectares cultivated with coca of dimension $T \cdot 3 \times 1$, $\mathbf{X}$ is

a matrix of dimension $T \cdot 3 \times \sum_{i=1}^{3} K_i$, β is the vector of coefficients of dimension $\sum_{i=1}^{3} K_i$,

and $\mathbf{U}$ is the vector of random errors of dimension $T \cdot 3 \times 1$. The model can also be represented in more detail, as follows:

$$\begin{bmatrix} \mathbf{HC}_{Col} \\ \mathbf{HC}_{Bol} \\ \mathbf{HC}_{Per} \end{bmatrix} = \begin{bmatrix} \mathbf{X}_{Col} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{X}_{Bol} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{X}_{Per} \end{bmatrix} + \begin{bmatrix} \mathbf{U}_{Col} \\ \mathbf{U}_{Bol} \\ \mathbf{U}_{Per} \end{bmatrix} \qquad [2]$$

In this system of structural equations, each equation constitutes a classic regression; for that reason, the parameters could be estimated consistently, but not efficiently using OLS for each equation separately (Greene, 2008). The matrix of variance covariance is $\mathbf{\Omega} = \mathbf{\Sigma} \otimes \mathbf{I}$ where

$$\mathbf{\Sigma} = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} \end{bmatrix} \qquad [3]$$

In this case the OLS estimator ignores the information contained in the covariance between contemporary observations of different equations. This behavior would only be efficient in the case that said covariance equaled zero. Therefore, the GLS method is used for the estimations to be efficient (Greene, 2008).

In the equations' system, a clash captured by the error term of one of the equations of one of the three countries can be affecting the supply of coca to the other countries. The system of SUR equations is as follows:

$$\text{lnhccol}_t =$$
$$\propto_0 + \propto_1 \text{lnhccol}_{t-1} + \propto_2 \text{lnp1usa09}_t + \propto_3 \text{lnhcbolper}_t + \propto_4 \text{lnecol}_{t-1} + \propto_5 \text{lnedplan} + \propto_6 \text{dummycol} + \varepsilon_t \qquad [4]$$

$$\text{lnhcbol}_t = \beta_0 + \beta_1 \text{lnhcbol}_{t-1} + \beta_2 \text{lnp1usa09}_t + \beta_3 \text{lnhccolper}_t + \beta_4 \text{ppibagrbol}_t + \beta_5 \text{lnebol}_{t-1} + \beta_6 \text{lnedbol} + \beta_7 \text{dummybol} + \varepsilon_t \qquad [5]$$

$$\text{lnhcper}_t = \gamma_0 + \gamma_1 \text{lnhcper}_{t-1} + \gamma_2 \text{lnp1usa09}_t + \gamma_3 \text{lnhccolbol}_t + \gamma_4 \text{lneper}_{t-1} + \gamma_5 \text{lnedper} + \gamma_6 \text{dummyper} + \varepsilon_t \qquad [6]$$

It is vital to add that with longer time series it could be interesting to use time series techniques as the intervention analysis for multivaried time series. However, with the information available for the period studied, the series are short, for we consider it appropriate to use a model of a structural nature, as is SUR. This model is the most appropriate to examine the simultaneous presence of balloon effects for the three South American countries. Future works for longer periods could explore time series methods.

RESULTS

In Table 2, the results of the SUR model are presented with the dependent variable *cultivated hectares* for the main cultivating countries of coca leaf in South America: Colombia, Bolivia and Peru. The variables are found in logarithms, with the exception of the participation of the agricultural GDP for Bolivia in the total product, for a better interpretation. In each equation –for each country- a variable has been included that captures the incidence of balloon effects; for Colombia, this corresponds to the lnhbolper variable, which measures the sum of the cultivated hectares in Peru and Bolivia (in logarithms); for Bolivia, this corresponds to the lnhcolper variable, which measures the sum of cultivated hectares in Peru and Colombia (in logarithms); for Peru, this corresponds to the lnhcolbol variable, which measures the sum of cultivated hectares in Bolivia and Colombia (in logarithms). As was previously mentioned, in their model, Moreno-Sánchez *et al.* (2003) incorporate an analogous variable to capture the balloon effect in the case of the hectares cultivated with coca in Colombia, based on the crops in the other two countries of the region.

The Breusch-Pagan test of independence of the equation errors indicates that the errors are correlated, so the SUR methodology is adequate for the analysis of coca crops in Colombia, Bolivia, and Peru. On the other hand, the error correlations matrix shows that coca crops in Colombia and Peru are highly correlated and that coca crops in Bolivia do not correlate significantly with the markets of Colombia and Peru.

Table 2. SUR Model with variables of the balloon effect

	$lnhccol_t$	lnp1usa09	lnhcbolper		$lnecol_{t-1}$	dummyc	lnecdpla	R^2
Equation [4]	endogenous	0.282** (0.124)	-1.06*** (0.093)		0.090*** (0.019)	2.554*** (0.836)	-0.025***	0.95
Variables	$lnhcbol_t$	lnp1usa09	lnhccolper	ppibagrb	$lnebol_{t-1}$	dummybol	lnecdpo	R^2
Equation [5]	endogenous	0.391** (0.267)	-0.842* (0.467)	16.307*** (3.740)	-0.158* (0.087)	12.469 (8.452)	-1.334 (0.891)	0.75
Variables	$lnhcper_t$	lnp1usa09	lnhccolbol		$lneper_{t-1}$	dummyper	lnecdper	R^2
Equation [6]	endogenous	0.396*** (0.168)	-1.334*** (0.120)		-0.158 (0.127)	-1.184 (1.263)	0.173 (0.139)	0.90
Breusch-Pagan Independence Test	$\chi^2 = 9.757$**							
Residuals' correlation matrix								
	$lnhccol_t$	$lnhcbol_t$	$lnhcper_t$					
$lnhccol_t$	1.0000							

lnhcbol$_t$	0.2110	1.0000	
lnhcper$_t$	0.6812	0.0704	1.0000

The standard errors appear in parenthesis.
*<0.1;**<0.05;***<0.01

Source: Calculations made by the authors based on the variables constructed.

The results indicate that a rise in the street-value of cocaine in the United States leads to a rise in the cultivation of coca crops in the three countries. This is explained by the incentives to increase production, which are caused by an increase in the expected profits of the traffickers as a result of the increase in the value in the United States, and the contrary happens when prices drop. This effect can be seen as a *direct or supply effect* of the prices of drugs in places of consumption over the production of cocaine and coca leaf in the producing countries. The reason why the street value of the alkaloid has an influence on the number of hectares cultivated with coca in the producing countries is that the whole productive chain maintains a relatively high level of vertical integration under the power of major drug traffickers, whose incentives –and, therefore, those of the agents that participate on the extremes of the chain- are regulated by the evolution of the business profits, the dynamics of which depend on the behavior of the prices in large centers of consumption[3].

According to this result, it can be said that the long term tendency of the price of cocaine to drop –in bulk as well as street value- that took place in the United Stated throughout the period studied (UNODC, 2011) *ceteris paribus* brought about incentives for cocaine producers to produce a lower quantity of cocaine and, as a consequence, coca-growing farmers cultivated less coca.

In the fourth column of Table 2, there is the variable that captures the possible presence of balloon effects in the South American sample. It is observed that the variable is significant for the three equations and presents the expected sign, corroborating the existence of coca crop relocation processes in Colombia, Peru, and Bolivia. This is a fundamental result to prove the presence of strong balloon effects among the three countries. According to our

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[3] It is important to observe that in a different statistical model –to the one that due to limitations of space was not mentioned in this work- evidence was found, for the case of Colombia, of another type of effect, this time an *indirect effect* opposed to the one mentioned in the text, which goes from the hectares cultivated to consumption prices: a higher (lower) number of cultivated hectares *ceteris paribus* leads to an increase (decrease) of the supply price in Colombia which, at the same time, causes increases (decreases) in the production of cocaine, which result in decreases (increases) in the demand prices in the United States. In fact, both effects are not contradictory to one another: the *direct effect* can be thought of as a *supply effect*- of the prices in the places of consumption, in this case the United States, to the hectares cultivated with coca crops in the producer countries- while the *indirect effect* can be thought of as a *demand effect* , which is developed for the case of Colombia, a country that, for being the greatest producer of cocaine, is the one that has a greater incidence on the prices in large centers of consumption, in this case the United States.

model (see Table 2), a one per cent increase in the number of hectares cultivated with coca in Peru and Bolivia produces *ceteris paribus* a decrease of more than 1.06% in the number of hectares cultivated with coca in Colombia. On the other hand, a 1% increase in the number of hectares cultivated with coca in Colombia and Peru *ceteris paribus* leads to a decrease of 0.842 % in the number of hectares cultivated with coca in Bolivia. Finally, a 1% increase in the number of hectares cultivated with coca in Colombia and Bolivia *ceteris paribus* leads to a 1.334 % decrease in the number of hectares cultivated with coca in Peru.

These findings imply a unitary elasticity (of −1.06 %) of the hectares cultivated with coca in Colombia against those in Peru and Bolivia, which confirms the data obtained by Moreno-Sanchez *et al.* (2003) for Colombia during the 1988-2001 period. On the other hand, the elasticity of the hectares cultivated in Peru against those in Colombia and Bolivia is higher than 1 in absolute value (of -1.334%); this result reveals that the cultivated hectares in this country are elastic against the behavior in the ones in the other two countries. Finally, for Bolivia the hectares cultivated with coca also depend on the behavior of the same variable for the other two countries, although in this case elasticity is lower than 1, but close to that value (of -0.842 %). The lower elasticity of the cultivated hectares for Bolivia is the result of the stability and importance that the consumption of the coca leaf for traditional uses has in that country.

The economic importance of this finding lies in that the net effect of repression –and, particularly, of eradication- exerted in any of the three countries tends to be null during the period of analysis, due the rapid capacity of illegal activities to relocate in the other two countries. It is vital to understand that the balloon effect is not a mere invention related to the behavior of an irrelevant market, where with a constant demand, a drop in the supply of certain producers, would lead to an increase in the supply of other producers. In fact, it is about the determining result in a field of crime economics, which should be understood in the context of illegal markets subject to repression. The key is that repression of drugs – eradication, in this case- does not manage to reduce the added supply, given the capacity and versatility that illegal agents have to reproduce their activities in other contexts – spatial, geographic, and even economic, in case there is diversification of illegal activities-, which depend, on a micro level, on the capacity to react strategically to the repression exerted by the authorities of control (Raffo & Segura, 2015)[4].

In this way, the results obtained in the presence of balloon effects are conclusive: they play an essential role in the analysis and are determinants of the hectares cultivated with coca in the producing countries.

It is important to add that in the case of Colombia, although the number of crops decreased according to UNODC during the period 2000-2009, there is also evidence of balloon effects within the country: there were geographical relocation processes of the crops from some regions of the country to others as a result of the eradication policies applied (Thoumi,

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[4] Raffo and Segura (2015) analyze the strategic behavior of drug traffickers and other agents linked to them, through which in a micro level the hydra effect of illegal activities is explained (Ortiz, 2002, 2003, 2009), which is related to the balloon effect. See below the conclusions of this article.

2009). This led to an expansion of the crops to a greater number of departments in the country, despite the reduction in the number of registered hectares with coca. In the words of Thoumi: "When under Plan Colombia, which started in 1999, an intensive eradication method started, there were coca plantations in 12 departments. In 2003, they had been extended to 23 out of the 32 departments (UNODC 2004, p. 15). Simultaneously, the average size of the illegal plantations decreased given that farmers sought to avoid aerial fumigation (Thoumi, 2009, p. 85)[5].

On the other hand, the proportion of the agricultural GDP in Bolivia has the expected incidence on the hectares cultivated with coca and is highly significant. This result is explained by the tradition of the consumption of the coca leaf that exists in that country since remote times. In Bolivia, as in other South American countries, diverse communities acknowledge that this plant has valuable healing and medicinal properties. This custom has strong cultural, political and economic roots in the aboriginal communities, of indigenous and *mestizo* origin, of this nation. Therefore, this outcome shows that coca crops in Bolivia have had a relevant role in the agriculture of that country during the last decades. This explains why coca-growers have had such a determining influence in Bolivian politics, especially during the last few decades. For that reason, Evo Morales' government policy has been seen from the very beginning as an agenda that defends the rights of coca-growers in that country. Although –as it was mentioned before- as president of Bolivia, Evo Morales took on the challenge of fighting against drug trafficking without eradicating coca crops or infringing on the rights of coca-growing farmers (Laserna, 2009).

The lagged eradication variable ($lnecol_{t-1}$) is significant for Colombia, but does not have the expected sign. Which means that in net terms –controlled by the considered factors- eradication turns out to be counterproductive throughout the observed period. This outcome coincides with the counterproductive effect of eradication found by Moreno-Sánchez *et al.* (2003) for Colombia during the period 1987-2001. Moreover, this counterproductive effect, corroborates the presence of *hydra effects* (Ortiz, 2002, 2003 and 2009), which are explained in a micro level by the strategic reactions of drug traffickers to the repression, which make that it paradoxically leads to a reproduction of illegal business and, therefore, of illegal crops. This is consistent with the sign of the coefficients of the dummy variables associated with Plan Colombia. Despite the fact that the dummy variable with interaction (lnecdplan) is significant and has a negative impact, the structural change without interaction dummy (dummycol) is also significant, but it is associated with a rather high positive coefficient. This reaffirms something evident: Plan Colombia improved the effectiveness of the repression of the activities through its interaction with eradication. However, its initial impact was counteracted by the opposing forces derived from the *balloon and hydra effects.*

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[5] Further works could empirically analyze the presence of balloon effects throughout the country, using panel-type models.

In fact, the positive sign of the coefficient of the lagged eradication variable confirms the importance of balloon effects so that the eradication policies not to have the expected effect for the case of Colombia.

For the case of Bolivia the lagged eradication variable ($lnebol_{t-1}$) does have a negative impact, as was expected, over the number of hectares cultivated with coca, although this variable was only 10% significant. According to the estimations, it is found that a 1% increase in the eradication produces *ceteris paribus,* a 0.158 % decrease in the number of hectares cultivated with coca in that country. Conversely, the dummy variables turned out not to be significant. The same type of effect remains after controlling through the other factors. Nevertheless, the lack of significance of the dummy variables reveals that, in fact, the severe repression exerted at the end of the 1990s through the so-called *Plan Dignidad,* during the second presidential period of Hugo Bánzer, was useless. This idea is supported by Laserna (2009), who suggests that the harsh repression exerted during that short period was actually counterproductive, taking into consideration what happened during the following years.

In contrast, the eradication variable was not significant for Peru. Neither was the dummy variable. This outcome implies that the net impact of eradication controlled by other factors is irrelevant. What is indicated by the estimated model is that the *net effect* of the eradication policy is null, so in *net terms* –controlled by the other factors- the eradication policy is *ineffective*. For this reason, the drop in the number of cultivated hectares during the 90s is not explained by the repression exerted by the government of Fujimori, but due to other factors. Which ones? Our work also sheds light on this: the drop in the prices of hard drugs in the United States, on the one hand, and the presence of strong balloon effects with the other countries of the region, on the other.

The estimations of the SUR model go hand in hand with the interrelation hypothesis of the illegal economies of the Andean sample. Thus, the estimations show evidence in favor of the hypothesis, given that there is a trade-off between the different productions of coca crops in Colombia, Bolivia, and Peru, and the strong interdependence between the number of cultivated hectares in Colombia and Peru. But there is something else to add regarding the SUR model: its good adjustment also indicates that there are other unidentified factors apart from the balloon effects that are captured by the correlations of the error terms among the three countries. What kind of factors could those be? Here the vertical integration of the whole chain of illegal activities in the surrounding geographical area corresponding to the three countries studied can play a crucial role. It took place during the observed period, especially in Colombia and Peru, given that part of the coca leaf transformed into alkaloid in the Colombian territory has come –from the beginning of the traffic of cocaine in the 70s and to a greater scale in the 80s- from Peru (Bagley, 1988).

The tendencies observed show that these processes of transit from Peru to Bolivia became strong again during the past decade with the decrease in the number of illegal crops in Colombia as a result of the pressure exerted through Plan Colombia. This greater vertical integration of the productive chain between Colombia and Peru is in part explained by their

geographical proximity. But, also, in the case of Bolivia, there are clues that during the past decade the higher links of the chain were strengthened (elaboration and processing of the alkaloid) (Laserna, 2009), allowing for a greater vertical integration of the illegal economy of this country with that of the other two. The fact that the partial correlation between the number of cultivated hectares in Colombia and Peru is higher than that obtained for Bolivia and Colombia, on the one hand, and for Bolivia and Peru, on the other, is proof of this (from 0.6812 against 0.211 and 0.0704 respectively). It is also important to observe that, as was expected, the partial correlation of cultivated hectares of Colombia and Bolivia is considerably larger than the one found for Peru and Bolivia. In addition, in the three cases the partial correlations are positive. This confirms that the role of Colombia in the productive chain is different than the one of the other two countries, which do not maintain strong complementarities of their illegal economies between each other and focus on the first links of the chain.

So as to complete the analysis, the new model was run again without the interactive variables of balloon effect. The interactive dummy variables were not included in order to simplify the system as much as possible. The results of this second model are presented in Table 3. This new system of equations is also robust (according to the Breusch-Pagan test) and, in general, it preserves the same results as the previous model; although now the price variable is not significant for Colombia. Additionally, the dummy variable of structural change for Bolivia becomes significant and with a negative associated coefficient. The same variable becomes significant, but not with a positive associated coefficient for Peru. But there is an outstanding novelty between this model and the first: now partial correlations in the matrix of residuals become negative and relatively high for the case of Colombia and Peru, and the same happens in the case of Colombia and Bolivia. This is due to the fact that the balloon effects are not captured explicitly in this last model, but through the apparent correlations between the error terms.

Table 3. SUR Model without variables of balloon effect

Variables	$lnhccol_t$	$lnp1usa09_t$		$lneccol1_{t-1}$	dummycol	R^2
Equation [4]	endogenous	-0.342 (0.358)		0.169*** (0.033)	-0.394*** (0.836)	0.61
Variables	$lnhcbol_t$	$lnp1usa09_t$	$ppibagrbol_t$	$lnecbol1_{t-1}$	dummybol	R^2
Equation [5]	endogenous	0.2315** (0.274)	11.19*** (3.535)	-0.141* (0.088)	-0.305** (0.143)	0.67
Variables	$lnhcper_t$	$lnp1usa09_t$		$lnecper1_{t-1}$	dummyper	R^2
Equation [6]	endogenous	0.807** (0.401)		-0.1000 (0.108)	0.263* (0.159)	0.46

Breusch-Pagan Independence Test		$\chi^2 = 11.422$***	
Residuals' correlation matrix			
	$lnhccol_t$	$lnhcbol_t$	$lnhcper_t$
$lnhccol_t$	1.0000		
$lnhcbol_t$	-0.5593	1.0000	
$lnhcper_t$	-0.4880	0.2288	1.0000

The standard errors appear in parenthesis.
*<0.1;**<0.05;***<0.01

Source: Calculations made by the authors based on the variables constructed.

This second model confirms the strength of the SUR model and corroborates that there are two different types of effects that interrelate the illegal crops of the three cocaine producing countries:

1) firstly, the presence of strong balloon effects.
2) secondly, the existence of productive complementarities between the illegal economies of the three countries, which make up a natural result of the whole chain and of the comparative advantages of each country in the different links and activities in it.

It is important to mention that the estimations made have to be read with caution, given the problems of the information on illegal activities. First, the measurement of variables used is problematic, given that they are not captured directly, but through estimations and statistical approximations. This is due to the illegal and criminal nature of these activities. Second, the series are short. For this, the estimated models do not allow for prediction exercises. They are exploratory exercises that only allow for obtaining evidence on the causality relations on a qualitative level. However, this is of great importance to give it greater analytical support –theoretical and empirical- to the balance and discussion on the effectiveness that the drug supply repression policies in the Andean region during the last decades have had.

CONCLUSIONS

With all the above, there is empirical evidence that supports the presence of balloon effects in the Andean region throughout the 1990-2009 period: the estimated SUR model allows for the corroboration that there is no sufficient statistical evidence to disregard the hypothesis that throughout the 1990-2009 period there have been relevant balloon effects in the geographical territory corresponding to the main cocaine producing countries in the Andean region: Colombia, Peru, and Bolivia. Although – as it had been advised- the results

of the econometric models should be read with caution and they only give clues as to the relevance of the hypotheses at a qualitative level. For this reason, the model shows that the behavior of the cultivated hectares in any of the three producing countries (Colombia, Peru, and Bolivia) depends inversely on the hectares cultivated in the other two producing countries.

The model also reveals other interesting results: first, that the prices of cocaine (street value) in the United States have a proportional incidence on the coca crops in the three producing countries. This effect can be understood as a direct or supply effect, that the price of drugs in the places of consumption have over the production of cocaine and coca leaves in the producing countries. This indicates that the long-term drop in the wholesale and retail prices in large consumption centers like the United States and Europe throughout the period observed could have represented *ceteris paribus* a tendency of the number of cultivated hectares in the producing countries to drop. However, this impact was counteracted –especially during the 90s- by the other factors that had a positive influence on the increase of cultivated hectares, among them the presence of strong balloon effects.

Third, as was expected, evidence was found that the proportion of the agricultural GDP in Bolivia has a positive incidence on the hectares cultivated with coca in that country and it is highly significant. This result is explained by the tradition of coca leaf consumption that has existed in that country since remote times.

Fourth, it was found that the lagged eradication variable ($lnecol_{t-1}$) is significant for Colombia and has a negative sign (contrary to what was expected). This reveals that in net terms –controlled by the rest of the factors at stake- the eradication is counterproductive throughout the period observed. This also corroborates the presence of hydra effects (Ortiz, 2002, 2003 and 2009) that imply that the repression can lead to the paradoxical result of an expansion of illegal crops. The incidence of the eradication variable for the case of Colombia is cleared when compared to the sign obtained for the coefficients of the dummy variables associated with Plan Colombia: although the dummy variable with interaction is significant and has a negative impact, the structural change dummy (without interaction) is also significant, but it is associated with a quite high positive coefficient. This reveals that Plan Colombia improved the efficiency of the repression of the activities through its interaction with eradication. However, its initial impact was counteracted by the opposing forces derived from the *balloon and hydra effects*.

Fifth, for the case of Bolivia it was found that the lagged eradication variable has a negative effect on the number of hectares cultivated with coca crops, as was expected, although this variable only turned out to be 10% significant. In contrast to this, the dummy variables were not significant for this country. The lack of significance of the dummy variables is probably indicating that, in fact, the strong repression exerted at the end of the 90s through the so-called Plan Dignidad (Dignity Plan), during the second period of the presidency of Hugo Bánzer, was useless; in fact, this point of view was defended by Laserna (2009).

Sixth, for Peru, the eradication variable was not significant nor were the dummy variables. This outcome reveals that the net impact of eradication in that country, controlled by other factors, is irrelevant. It is inferred that the decrease in the number of cultivated hectares during the 90s in that country is not explained by the repression exerted by the government of Fujimori, but by other factors: on the one hand, the drop in the price of hard drugs in the United States, on the other hand, the presence of strong balloon effects.

Finally, the analysis of alternative estimation of the SUR model without variables of balloon effect indicates that there are two types of different effects that interrelate the illegal crops of the three main cocaine producing countries: first, the presence of strong balloon effects and, second, the existence of productive complements between the illegal economies of the three countries, which constitute a natural result to the vertical integration of every chain and of the comparative advantages of each country in the different links and activities in it.

The relationships detected and the fact that there is a balloon effect imply that a plan of repression of the supply –like Plan Colombia- although useful as a strategy of a *focused war on drugs,* it is useless as a *global strategy* when it is not articulated with other rigorous plans in the other producing countries. A less innocuous repression plan on the supply should be designed as a global strategy that inhibits the relocation of crops, of production and of drug-trafficking. Only in this way, the presence of balloon effects could be neutralized, in illegal crops as well as in the trafficking of drugs.

Notwithstanding, at the same time, a global strategy should demand that the trafficking and distribution of drugs be fought against with the same or greater intensity in the places and countries of transit as well as the large centers of consumption but, especially, in the latter. It is in the large centers of consumption present in countries like the United States and some European countries, where the greatest benefits of the whole productive chain are obtained. For this reason, the interception of drugs and the pursuit of traffickers and distributors have greater dissuasive and repressive impact on the last stages of the value chain .

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