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RESEARCH NOTE

Uprooting or Sowing Violence?: Coca Eradication and Guerrilla Violence in Colombia

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ABSTRACT

Belligerent nonstate actors including terrorist organizations often exploit illicit economies to fund their activities. In Colombia numerous belligerent groups are involved in illegal narcotics markets. For more than 20 years, the Colombian government has responded with targeted eradication of illicit crops, intending to undermine the groups' sources of revenue while simultaneously disrupting the illicit drug economy. Despite its duration, this policy's effect on guerrilla violence remains unclear. Examining the potential for violent backlash to these tactics, this research note assesses the impact of aerial coca crop eradication in Colombia from 2004–2005 on domestic Colombian guerrilla kidnappings, assassinations, and terrorism.

ARTICLE HISTORY

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Colombia has faced long-standing threats from belligerent organizations that have led to escalating civil conflict and violence.¹ Connected with terrorism, targeted assassinations, and kidnappings, groups such as the *Fuerzas Armadas Revolucionarias de Colombia* (FARC) and the *Ejercito de Liberación Nacional* (ELN), are among the strongest and most violent leftist guerrilla groups in Latin America.² Parallel to this violent guerrilla threat, illicit economies have also thrived in Colombia, primarily driven by coca crops and the cocaine industry. The dual threat of guerrilla violence and cocaine intersected in the 1980s when guerrilla groups began profiting from the coca trade through taxation.³ This convergence complicated counter-narcotic policy in Colombia, as counteracting the drug trade potentially risked agitating, or even inadvertently strengthening, the guerrillas.⁴

Among attempts to counter narcotics and Colombian guerrilla violence, coca eradication policy has been a particularly contentious issue. The Colombian government first pursued limited efforts to eradicate coca plants in 1984, and has engaged in large-scale coca crop eradication since 1994.⁵ Aerial eradication was the primary method, involving flying planes over areas of coca cultivation and dropping glyphosate, a plant-killing poison, on the crops. The main motive behind this policy was to undermine the drug trade. Yet eradication may also undercut the guerrilla organizations in Colombia by destroying a main source of their income, thus reducing their ability to perpetrate violence.⁶ In addition, eradication may

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reduce the drug trade's destabilizing effect on the rule of law, and increase the government's power in regions threatened by the guerrilla movement.⁷

Despite the potential for reduced violence and illicit drug production, critics of eradication policies have leveled a number of challenges. From a public health perspective, Camacho and Mejia have identified a number of negative health impacts on rural Colombians from dropping glyphosate in mass quantities across the countryside.⁸ These include respiratory distress, impaired consciousness, pulmonary edema, shock, arrhythmias, and renal failure.⁹ Another prominent critique of aerial coca eradication is that it inadvertently strengthens guerrillas and increases violence. By removing the major source of income for some rural farmers, aerial eradication may turn those who are economically dependent on the crop against the government and render them more likely to support the guerillas.¹⁰

At present, the empirical literature regarding the impact of illicit crop eradication suggests that these policies may either exacerbate or mitigate guerilla violence. As such, it is vital to assess the impact of aerial coca crop eradication on a range of types of guerrilla violence in Colombia, and doing so within a single tactical period provides statistical opportunities to disentangle the eradication from other military counternarcotic policies.¹¹ Belligerent groups within Colombia have demonstrated that they are strategically sophisticated, and have been able to tailor their responses to nuanced reactions from the Colombian government.¹² As such, for groups like the FARC and the ELN, different tactics such as terrorism, targeted assassinations, and kidnappings may serve different political and financial goals. Concomitantly, studies exploring only one of these tactics or aggregate violence rates may miss important empirical links between eradication and the proportionality of violence perpetuated by these groups. Further, as the impacts of these policies may vary across political regimes potentially driving the existing divergent results, this research note examines the impact of the widespread and relatively consistent use of aerial eradication by the Uribe government in 2004 and 2005.¹³

Colombia, Cocaine, and Belligerent Groups

Colombia is one of the world's largest producers of cocaine, along with Bolivia and Peru.¹⁴ Of the cocaine consumed in the United States, it is estimated that at one point more than 90 percent was grown in Colombia.¹⁵ Cocaine became a prominent commodity in Colombia in the 1980s as drug traffickers who previously dealt in marijuana transitioned to cocaine, which was easier to transport and more financially lucrative.¹⁶ The most prominent of these groups, the FARC, was initially opposed to the drug trafficking trade. First formed in 1964 as a response to rural Colombian desire for land reform stemming from colonial disenfranchisement, the FARC considered the illicit drug economy to be counterrevolutionary and actively fought against it.¹⁷ As coca farming became more prevalent among their constituency, the FARC renounced their opposition to illicit crops and became an active participant in the illicit drug economy.¹⁸

While several other Colombian guerrilla groups have emerged and faded since the 1960s, outside the FARC, the most prominent group with regard to violence has been the ELN. Also formed in the 1960s, the ELN's founding members consisted of radical Catholic priests, students, and left-wing intellectuals.¹⁹ Geographically, the ELN has a more urban constituency than the FARC.²⁰ Although the ELN also condemned the drug trade for years after the FARC had embraced it as a source of income, the ELN likewise eventually succumbed to its financial allure.²¹

Both groups' engagement with the illicit drug economy has benefitted them substantially. Estimates from the early 2000s approximated that the FARC derived 48–60 percent of its \$350 million annual income from drug trafficking alone.²² Colombian officials however have suggested that this income figure is closer to \$1 billion annually.²³ In contrast, the drug trade only accounted for 6–20 percent of the ELN's income during the early 2000s.²⁴ Instead, the ELN traditionally focused on extortion and kidnapping, garnering 60 percent and 28 percent of its income from the two activities, respectively.²⁵

While Colombian presidential regimes have adopted a variety of strategies, eradication has remained a pivotal piece of the Colombian government's response to the drug trade and the guerrilla threat for decades. As coca cultivation rapidly spread in the second half of the 1990s, the state increasingly employed eradication as a counternarcotic and counterinsurgency strategy, spraying up to 66,000 hectares across six departments in 1998.²⁶ In 2000 (marked by a vertical line in Figure 1) U.S. funding under Plan Colombia stimulated the expansion of Colombian eradication efforts.²⁷ As a result of numerous guerrilla organizations' advances during the Pastrana administration (1998–2002), subsequent policies were far more punitive in nature, particularly under the Uribe administration (2002–2010).²⁸ This move toward increased counterinsurgency strategies can be also be seen in the aerial eradication program that would reach its peak in 2006, when a total of 172,026 hectares were sprayed across 16 departments.²⁹

Growing security concerns, mostly stemming from the FARC's military victories, helped sweep Alvaro Uribe into power in late 2002 upon a platform promising to crack down on the guerrillas. Uribe's security-focused policies, combined with military reforms already in progress, generated a wave of successes against the FARC in particular. During this time, the Colombian military focused on professionalization, revitalizing its education system, and establishing local forces across the country. A one-time war tax raised around US\$800 million, giving the Colombian military the resources it needed for successful reformation.³⁰ Uribe eased the previous

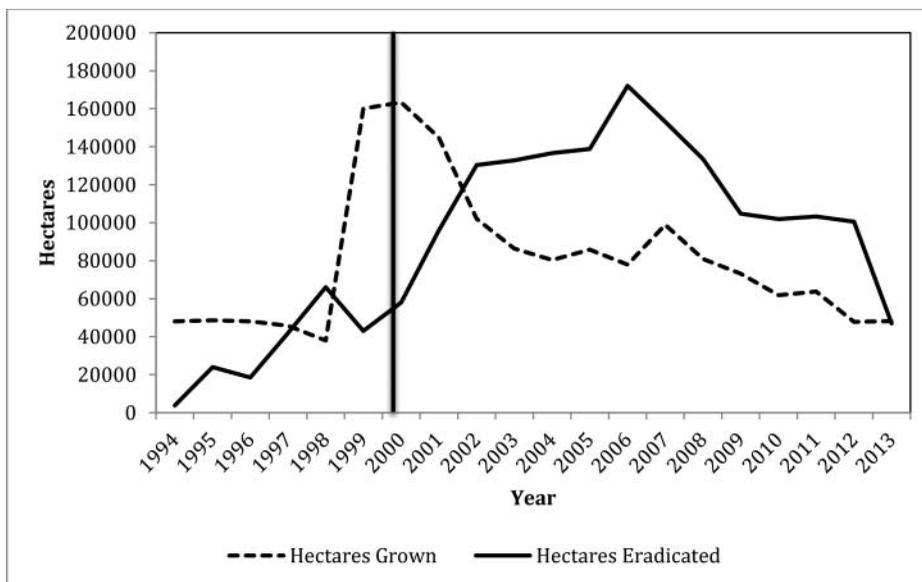


Figure 1. Annual coca grown and aerial eradication 1994–2013. Sources. DIRAN, UNODC.

administrations' restrictions on aerial spraying, leading to higher and relatively stable eradication levels for his first few years of office.³¹ The military's changed approach put the FARC on the defensive. The new and improved Colombian forces were first deployed against the guerrillas in the departments of Caquetá and Putumayo in May of 2002 as part of the first stage in Plan Colombia.³² By June 2004, Uribe had finished putting into effect the second stage, Plan Patriota, and 17,000 Colombian troops were sent into guerrilla territory in the departments of Putumayo, Meta, Cudinamarca, and Arauca.³³

In contrast to the punitive strategies directed toward the FARC, the Uribe administration engaged in peace talks with the ELN between June 2004 and April 2005.³⁴ Landel, however, asserted that these talks produced "no results."³⁵ Furthermore, aerial coca eradication continued through this period in at least 27 of the 33 Colombian departments.³⁶ Consequently, as neither ELN violence nor aerial coca eradication ceased during these peace negotiations, it remains an important empirical question whether the higher and more consistent application of aerial coca eradication during this period impacted violence committed by either the FARC or the ELN.

The Impact of Eradication on Violence Levels

The ability of coca eradication efforts to undermine guerrilla organizations in Colombia has garnered divergent conclusions among academics and within the empirical literature.³⁷ Among those suggesting that eradication decreases violence, Piazza has argued that it cuts into narcotics trade revenues by increasing the cost of production through increased risk, which in turn also cuts into the operating funds of guerilla organizations.³⁸ However, the impact of eradication on belligerents' finances is questionable because its effectiveness is unclear. Coca farmers have devised numerous techniques to prevent aerial sprayings from destroying their crops, including interspersing illicit crops with licit crops to evade detection, washing plants immediately after they have been sprayed, and applying chemicals to protect the plants from the effects of the eradication chemicals.³⁹ Potentially due to these techniques, Rozo found that for an area treated with glyphosate spraying, cultivation in the area only decreased by 25 percent.⁴⁰ Instead, Rozo suggests that coca production moved or was displaced to areas further away from treated areas, and presents aggregate coca cultivation data to support this.⁴¹ Further, even if eradication is successful, it could raise short-term coca prices, compensating for reduced long-term revenue.⁴² Reuter argues that the cost of the leaf is negligible compared to the refiner's profits, and therefore any increase in the cost of the coca leaf is largely irrelevant to guerilla groups, as it will not outstrip the profits.⁴³

Beyond strict market forces, Piazza and Kleiman have argued that eradication decreases guerrilla violence by contesting the "chaos" effect and establishing rule of law.⁴⁴ Piazza asserts that "illicit drug markets foster political instabilities within countries and undermine domestic security and the capacity of the state to maintain civil order by projecting power internally."⁴⁵ Fiorentini and Peltzman similarly have argued that for states like Colombia, the illicit economy often operates in a competitive manner to the licit economy, placing those involved in the drug economy in a rivalry with the state itself.⁴⁶ Facing subsequent threats to the state-held monopolies on force, resources, and political capital, undermining illicit crop economies thus becomes a vital method for the government to retain power.⁴⁷ Therefore, by eradicating the illicit drug market and establishing rule of law, the government denies guerrilla violence an environment in which to thrive.

Theoretical arguments contending that eradication increases violence have also been offered, drawing on both quantitative and qualitative accounts. Drawing on municipal-level data from Colombia, Rozo suggests that increases in violence may be driven by traffickers' retaliation against the government for the sprayings or through increased confrontation between drug traffickers and the military groups that patrol the flight paths of the plane prior to a spraying.⁴⁸ Also supported by Felbab-Brown's qualitative analysis, it has been found that eradication efforts did not have a meaningful impact on Colombian guerrillas' military capacity. She presents that eradication increases belligerents' political capital, reduces the targeted population's willingness to cooperate with the government, and makes the rural farmers more likely to actively support the belligerents, all factors which positively impact violence.⁴⁹ Felbab-Brown also outlines several specific ways that the guerrillas gain political capital from their involvement in illicit economies, including protecting farmers' illicit crops against government eradication efforts, exploiting nationalist sentiment by fighting against the U.S.-backed Plan Colombia, establishing order in unruly regions, and providing social services.⁵⁰ Thus it appears that two types of political capital can be gained from involvement in illicit economies: legitimacy, "the population's belief that the belligerents' actions are justified," and popular support, "the population's voluntary provision of supplies, shelter, and intelligence to the belligerents."⁵¹

The Importance of Subnational Variation

Across the prior quantitative analyses of the effect of illicit crop eradication on terrorism, findings support both of the perspectives presented above. Drawing on data from 170 countries from 1986–2006, Piazza found that for every 100,000 hectares of coca crop destroyed, there was an average reduction of 0.5 attacks for both domestic and transnational terrorism.⁵² As the Colombian government sprayed an average of 108,233 hectares every year from 2000–2013, this estimate suggests that the impacts on terrorism would likely be negligible for Colombia. However, these aggregated findings mean little for Colombia, or indeed any nation, as any direct application of these findings would be an ecological fallacy.⁵³

The existing literature further indicates that aggregated findings may obscure important geographic and temporal variation. While Piazza uses country-year as his unit of analysis, Holmes et al. conducted a department-year level analysis from 1999–2001 in Colombia and found that eradication was associated with higher levels of leftist violence.⁵⁴ In an even more granular analysis, Rozo conducted a municipality-year analysis in Colombia from 2000–2010 that found a 1 percent increase in eradication in a municipality led to a 4.23 percent increase in the homicide rate in the following year.⁵⁵ Coupled together, Holmes et al. and Rozo's findings suggest that eradication is counterproductive to the goals of reducing leftist violence, and that national-level data may underestimate or misrepresent the impact of these policies.

A growing body of literature also suggests that it is unclear whether any relationship may be consistent across political regimes. For example, examining the impact of government actions on terrorism within the Israeli–Palestinian conflict between 1987 and 2004, Dugan and Chenoweth display that repressive actions by Israel were either unrelated or related to increases in subsequent terrorism depending on the tactical period examined.⁵⁶ This suggests that political and social contextual factors may influence decisions to commit violence rather than purely the nature of punishment and policy. Choi further presents that terrorism is less likely in strong democracies because there are fewer lawless areas in which terrorists

thrive, suggesting that within-nation variation in democratic strength may also influence any relationship between aerial coca eradication and violence.⁵⁷ Consequently, by examining the relatively stable tactical period between 2004 and 2005, the findings from this study will help to further examine if the findings of Rozo and other scholars are consistent across Colombian tactical periods.

While previous studies exploring the relationship between coca crop eradication and violence have focused on terrorism, it is not the only option available to those who choose to respond with violence.⁵⁸ Other viable options include targeted assassinations and kidnapping, which provide potentially less lethal and more targeted disincentives for rival groups and the government, and may be more attractive for groups seeking to retain the support of their constituencies. Given their roles as pseudo-states in many Colombian regions during the period being examined, responding with disproportionate violence may have eroded the belligerent groups' local political support.⁵⁹ Concomitantly, if they responded proportionately to the nonlethal act of crop eradication, one would expect a subsequent increase in kidnappings but not for the more lethal acts of terrorism or assassinations. Analyzing different types of less lethal violence is also vital for understanding the broader impacts of aerial coca eradication. Kidnappings have been a prominent form of violence committed by narcotraffickers and guerrilla groups in Colombia, accounting for half of all kidnappings globally.⁶⁰ As kidnappings were also a major source of income for both the ELN and the FARC, their omission from any analysis exploring the impacts of aerial coca eradication may obscure important strategic and theoretical insights regarding guerilla violence.⁶¹

The Present Study

Exploring the potentially heterogeneous impacts of coca eradication on different types of subsequent violence within Colombia, this research note examines monthly, department-level data from 2004 and 2005. Theoretically and empirically, 2004 and 2005 are particularly important due to the specific context of Colombian counterinsurgency and relatively stable counternarcotics efforts under President Uribe during these years. Despite claims that the Colombian military was successfully combating the illegal armed groups and that guerrilla violence sharply declined, the role of coca eradication in this effort is unclear.⁶² In distinguishing the impact of aerial coca eradication from other military efforts, the comparatively consistent overall military strategy during this period provides a unique statistical opportunity. Uribe's new approach to combating the guerrillas was largely implemented by 2004 and remained consistent throughout 2005.⁶³

Although annual eradication levels increased only slightly from 2003 through 2005 (as can be seen in [Figure 1](#)), these annual figures obscure a great deal of variation in eradication across months ([Figure 2](#)) and departments ([Figure 3](#)). The years prior to and immediately after this time period were characterized by large swings in eradication levels and accompanying military strategies, rendering aggregated estimates problematic. Beyond 2005, the Colombian government, the FARC, and the ELN would continue to change their overall strategies and tactics. Taking statistically advantage of this unusual stability in government tactics and accounting for subnational variation, this research note attempts to disentangle the impact of aerial coca eradication on terrorism, targeted assassinations, and kidnappings committed by the FARC and the ELN.

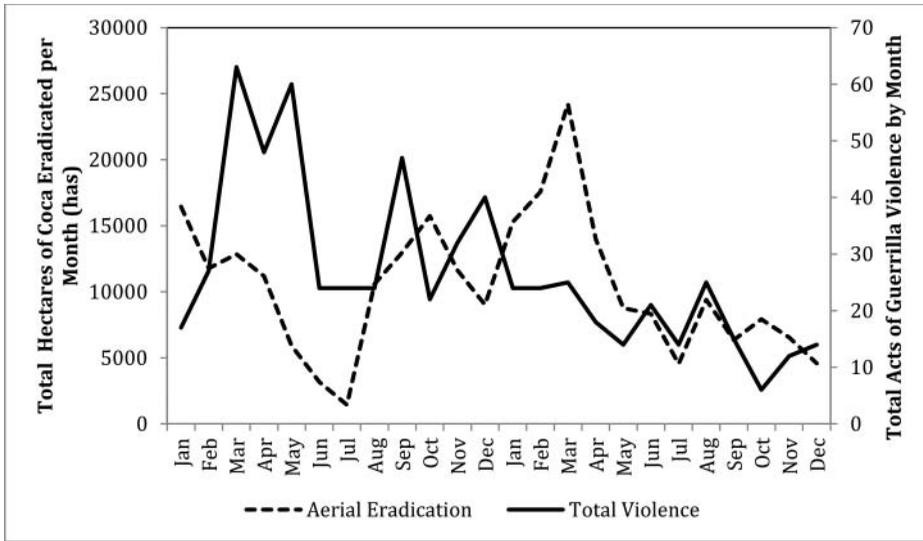


Figure 2. Monthly aerial coca eradication and violence 2004–2005. *Sources.* GTD, DIRAN, UNODC, Centro Nacional de Memoria Histórica.

Hypotheses

Given the divergence in the potential link between illicit crop eradication and violence, it is unclear at present whether the aerial eradication of coca crops in Colombia results in an increase or decrease in guerrilla violence. Eradication may lead to increased violence through the farmers' alienation from the government, leading to increased support for guerrilla groups and thus subsequent violence. However, aerial eradication may also improve the rule of law

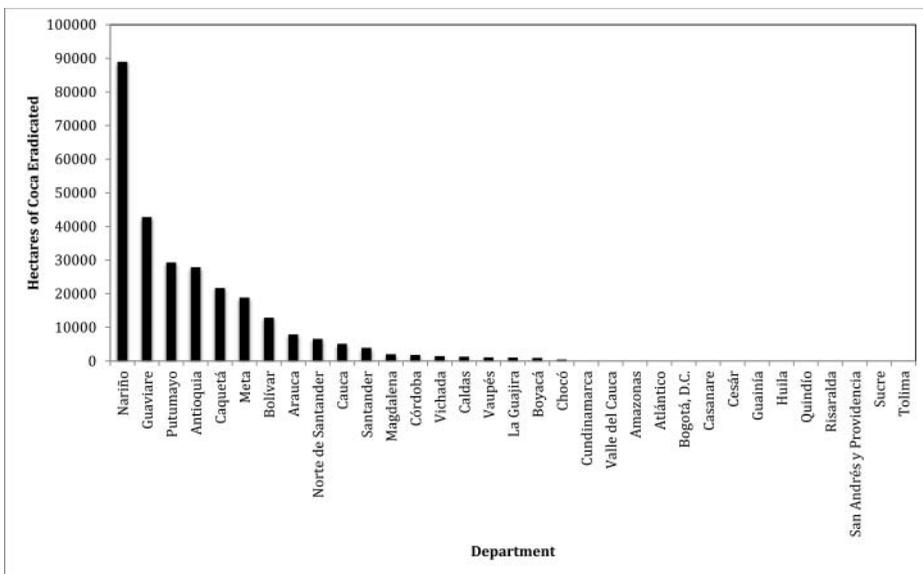


Figure 3. Aerial coca eradication 2004–2005 by department. *Sources.* DIRAN, UNODC.

and undermine operational guerilla capacity, instead reducing violence. Based on the above discussion, any impact of aerial coca eradication on subsequent violence would also be dependent on the guerilla organization's reliance on the coca market as a means of funding. For groups that are more proportionately reliant on coca production and trafficking for operational support, this study presents that any impact on subsequent violence would likely be magnified for these groups compared to organizations that have more diversified incomes. As the FARC relies more heavily on coca financially for its operational capacity when compared to the ELN during this period, this study also presents that any impact on violence will be greater for the FARC when compared to the ELN.⁶⁴

Demonstrating at times sophisticated responses to economic and market pressures, the extant literature suggests that these belligerent groups can be considered to be rational actors.⁶⁵ As assassinations and terrorism are not the only available alternatives for those who choose to respond with violence, the impacts of coca eradication would be most likely seen in nonlethal forms of violence such as kidnapping. This research note thus suggests that kidnapping may be more attractive for groups seeking to retain the support of their constituencies, and hypothesizes that any impacts of coca eradication would most likely be seen in kidnapping compared to other forms of violence. Based on this reasoning and the above discussion, this study examined the following hypotheses:

- H1:** Increases in aerial coca eradication will either increase or decrease subsequent total guerilla violence within Colombia.
- H2:** The magnitude of the impact of changes in aerial coca crop eradication on each type of violence will be larger for the FARC than for the ELN.
- H3:** Changes in aerial coca crop eradication will impact kidnapping more than assassinations or terrorism.

Data

In order to assess these three hypotheses, data concerning 2004 and 2005 were gathered from a number of different sources. These measures were compiled to document a variety of different violence types used by Colombian belligerent group and the area of attempted coca eradication, as well as to control for a number of important social and economic factors. The present dataset comprises monthly data recorded for each of the 33 departments within Colombia, yielding a total of 792 observations over the two-year span investigated by this article. To examine whether there was any important heterogeneity in the impact of violence generated by aerial coca eradication, this study identified that terrorism, assassination, and kidnappings were among the most salient forms of violence used by Colombian belligerent groups. To produce findings that were partially comparable to the study conducted by Piazza and others who have examined terrorism within Colombia, the count of terrorist incidents in each department were gathered from the Global Terrorism Database, compiled by the National Consortium for the Study of Terrorism and Responses to Terrorism (START).⁶⁶ The frequency of kidnappings and assassinations were gathered from the *Secuestros* (kidnappings) and *Asesinatos Selectivos* (targeted assassinations) databases, respectively, of the *Centro Nacional de Memoria Histórica*.⁶⁷

Measurements for the primary independent variable, thousands of hectares of aerial coca eradication, were obtained through the United Nations Office on Drug and Crime and its satellite program in Colombia (SIMCI). While these data were obtained through this source, it should be noted that the *Dirección Antinarcótica de la Policía Nacional* (DIRAN) was the

source of coca eradication data. Other studies have highlighted that terrorist and other belligerent groups may also engage in the production of other illicit substances such as opiates, however cocaine is the primary drug produced and trafficked by both the FARC and the ELN.⁶⁸ Further, as cocaine is the drug most targeted by the Colombian government during the period being examined, it is of primary research interest in this context.⁶⁹ Concordantly, while other drug interdiction policies may also impact belligerent violence, their impacts were likely to be of smaller magnitude and potentially more relevant to previous tactical periods of this conflict.⁷⁰ In order to ensure temporal ordering, all independent and control variables were also lagged by one month. Although a number of other temporal intervals were also estimated (2–4 months), the findings for a lag of one month produced the most consistent estimates that were robust across a number of specification strategies and are presented below.⁷¹ Additional tables documenting the findings for these additional models are available from the authors on request.

A number of additional control variables were also included in all of the models estimated by this study. Drawing on data provided by the *Departamento Administrativo Nacional de Estadística* (DANE) on department-level gross domestic product (GDP), population, homicide rate, Gini Coefficient, displaced people received, and annual exports were also included in the following analyses. In line with previous studies examining coca eradication practices in Colombia, these variables were included in order to account for the potential impact of other economic and social factors, as well as other forms of violence and collateral consequences from the ongoing conflict. Potential multicollinearity was also investigated, and both population ($r = 0.9586$) and GINI ($r = 0.4205$) were excluded from the following analyses in favor of GDP. In order to account for the peace talks between the Colombian government and the ELN, a dummy variable was included in all analyses that captures the period between June 2004 and April 2005.

Method

To assess the impact of aerial coca eradication on violence in Colombia, negative binomial fixed effects models were used to examine these department-level monthly data. Given that each of the dependent variables examined by this article was a count variable, negative binomial regression was selected in order to avoid potential issues of over dispersion, and each variable was modeled using fixed effects regression in order to account for any unobserved time-stable heterogeneity that one would expect to exist among departments.⁷² Due to the temporal and spatial correlation among observations resulting from these factors, ignoring these spatial and temporal factors could otherwise result in type I errors, thus limiting the ability to discern the impact of aerial coca eradication of subsequent violence. As such, the following models make use of within-department variation in order to observe relationships in the data. Although this method does not account for any unspecified dynamic heterogeneity in the model within departments, this fixed effects method presents a means of rendering unobserved time-stable differences among departments moot.⁷³

Findings

Across 2004 and 2005, there were 203 targeted assassinations, 77 incidents of terrorism, and 404 kidnappings that were observed that had an identified department in Colombia. The majority of terrorism during this period occurred in 2005 ($f = 41, 53.2$ percent), whereas

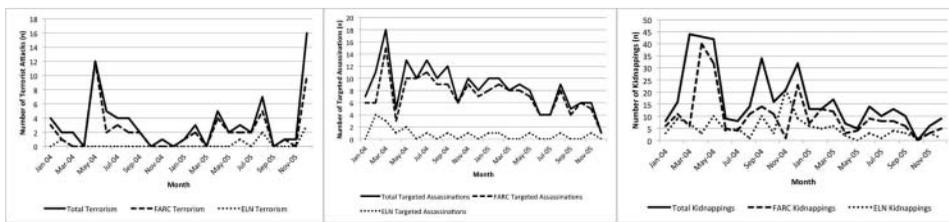


Figure 4. Monthly terrorism, assassinations, and kidnappings 2004–2005. *Sources.* GTD, DIRAN, UNODC, Centro Nacional de Memoria Histórica.

2004 had more assassinations ($f = 123$, 60.6 percent) and kidnappings ($f = 287$, 71.0 percent). Far from the homogeneity across the year assumed in the incidence of these violent events within yearly analyses, **Figure 4** displays a number of marked peaks and troughs within these data. Indeed, the highest number of assassinations in a month ($f = 18$ in March 2004) was followed by a reduction in the following month of 72.2 percent ($f = 5$ in April 2004). A similar relatively immediate decrease for kidnappings was also observed in June 2004 ($f = 44$), which was followed in July by a reduction of 79.5 percent ($f = 9$). Likewise, the two peaks for terrorism seen in **Figure 4** followed months with no recorded terrorism and one recorded terrorism event respectively. **Figure 4** also demonstrates key differences in these violent acts committed by the FARC and the ELN. At no point did the ELN commit more terrorism or assassinations than the FARC. Conversely, it is evident that the ELN was relatively more active with regard to kidnappings during this period, committing 120 out of the 404 observed kidnappings (29.7 percent).

Providing further credence for examining the relationship between coca eradication and violence using monthly data, this study also found important monthly trends in all three dependent variables. As it can be seen in **Figure 4**, both assassinations and kidnappings appeared to have an overall negative slope throughout this entire period, net of the more extreme months noted above. When each of these variables were examined using ordinary least squares (OLS) regression as to the relationship between the month and number of violent events, both assassinations ($\hat{\beta} = -0.03$, $p = .003$) and kidnappings ($\hat{\beta} = -0.01$, $p = .002$) were found to have statistically significant negative overall slope during this period. Consequently when taken as a nation, these data suggest that yearly analyses may overestimate the impact of policies instituted in 2004, which would be particularly problematic if they were instituted later in the year.

Investigating the first hypothesis, Model 1 in **Table 1** tests relationship between aerial coca eradication and violence within Colombia. These findings indicated a negative statistically significant relationship between the change in the thousands of hectares aerially eradicated and total violence in Colombia in the following month ($\hat{\beta} = -0.162$, $p = .025$). This suggests that departments that experienced months with an increase in aerial coca eradication were statistically associated with a decrease in total violence in the following month, providing support for hypothesis 1.

When this relationship was examined for terrorism, assassinations, and kidnappings separately (Models 2–4), it was evident that the different types of violence were impacted to varying extents by aerial coca eradication. Although all three types of violence had numerically negative coefficients, only the impact of the change in aerial coca eradication on

Table 1. Fixed-effects negative binomial findings for the impact of hectares of coca aerially eradicated.

Lagged DVs	Model 1	Model 2	Model 3	Model 4
	β (SE) Combined violence	β (SE) All terrorism	β (SE) All assassinations	β (SE) All kidnappings
Aerial hectares eradicated	-0.162* (0.072)	-0.05 (0.122)	-0.146 (0.106)	-0.198 [^] (0.114)
Peace negotiations	0.125 (0.126)	0.054 (0.311)	0.134 (0.171)	0.148 (0.178)
GDP	0.013 (0.012)	0.039* (0.017)	-0.027 (0.03)	0.009 (0.012)
Poverty rate	0.047*** (0.013)	0.098*** (0.027)	0.037 (0.027)	0.03 [^] (0.016)
Homicide rate	0.012** (0.004)	0.031*** (0.008)	0.011 (0.01)	0.008 (0.005)
Unemployment	-0.034 (0.034)	0.03 (0.06)	-0.019 (0.055)	-0.046 (0.04)
Exports	-0.001 (0.226)	0.448 (0.365)	0.992 (0.587)	-0.132 (0.259)
Displaced people	0.041 (0.023)	0.009 (0.393)	-0.006 (0.052)	0.044 (0.027)
Constant	-3.818 (1.051)	-9.878 (2.147)	-1.368 (2.048)	-3.636 (1.282)

Two-tailed, [^] $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$.

kidnappings was found to be marginally statistically significant ($p = .08$). It should be noted that this finding would have been statistically significant ($\alpha = 0.05$), had a one-tailed negative hypothesis been used. Within the sensitivity analyses run by this study however, the relationship between changes in aerial coca eradication and kidnappings in the following month was found to be statistically significant using two-tailed hypotheses when this relationship was examined using over-dispersion corrected Poisson fixed effects models ($\hat{\beta} = -0.360$, $p = .03$) and for the standard fixed effects models ($\hat{\beta} = -0.095$, $p = .04$). Importantly for studies examining terrorism however, this study failed to find any support for a relationship between aerial coca eradication and terrorism regardless of model specification. Taken together, these findings add conditional support to the claim that the impact of coca eradication policies may vary across types of violence.

Examining the second hypothesis, Models 5 and 6 were used to investigate whether violence committed by the FARC was impacted more by coca eradication than the ELN (Table 2). Supporting this hypothesis, Model 5 found that increases in aerial coca eradication were associated with lower amounts of violence committed by the FARC in the following month ($\hat{\beta} = -0.231$, $p = .02$), while no impact was detectable for the ELN in Model 6 ($\hat{\beta} = -0.03$, $p = .755$). These findings were evident whether or not the peace negotiations between the ELN and the Colombian government were controlled for in both models. Concordantly, this study finds evidence that the impact of aerial coca eradication was only evident during this period for violence committed by the FARC.

Exploring this relationship for each type of violence committed by the FARC and the ELN, Models 7–12 were concerned with determining whether this relationship was driven by more proportionate and nonlethal violence. In line with hypothesis 3, this study predicted that the relationship between aerial coca eradication and violence would be most evident for the less-lethal crime of kidnapping. Across these six models, a numerically negative coefficient was observed for aerial coca-eradication on all types of violence for both the FARC and the ELN. This relationship only reached marginal statistical significance for FARC kidnappings however ($p = .08$). This finding would have been found to be statistically significant had a one-tailed negative hypothesis been used. Within the sensitivity analyses run by this study, however, this relationship was found to be statistically significant for the over-dispersion corrected Poisson fixed effects model ($\hat{\beta} = -0.471$, $p < 0.001$) and for the standard fixed effects model ($\hat{\beta} = -0.068$, $p = .04$). Taken together, these findings suggest that there was a



Table 2. Fixed-effects negative binomial findings for the impact of hectares of coca aerially eradicated.

Lagged DVs	Model 5		Model 6		Model 7		Model 8		Model 9		Model 10		Model 11		Model 12	
	FARC Violence	β (SE)	ELN Violence	β (SE)	FARC Terrorism	β (SE)	ELN Terrorism	β (SE)	FARC Assassinations	β (SE)	ELN Assassinations	β (SE)	FARC Kidnappings	β (SE)	ELN Kidnappings	β (SE)
Aerial hectares eradicated	-0.23*	(0.098)	-0.03	(0.096)	-0.138	(0.199)	-0.128	(0.709)	-0.126	(0.107)	-0.192	(0.376)	-0.299 [^]	(0.175)	-0.011	(0.098)
Peace negotiations	0.258 [^]	(0.148)	0.035	(0.243)	0.133	(0.38)	0.045	(1.013)	0.189	(0.183)	0.189	(0.524)	0.265	(0.229)	0.053	(0.275)
GDP	0.001	(0.016)	0.018	(0.019)	0.012	(0.025)	0.044	(0.242)	-0.031	(0.037)	-0.098	(0.1)	-0.004	(0.014)	0.024	(0.022)
Poverty rate	0.022	(0.019)	0.047	(0.024)	0.075*	(0.032)	0.129	(0.107)	0.026	(0.032)	0.062	(0.052)	0.018	(0.02)	0.029	(0.028)
Homicide rate	0.007	(0.006)	0.002	(0.009)	0.033**	(0.009)	-0.007	(0.041)	0.005	(0.011)	-0.002	(0.021)	0.009	(0.006)	0.002	(0.01)
Unemployment	-0.042	(0.041)	-0.053	(0.066)	0	(0.073)	-0.123	(0.237)	-0.03	(0.063)	0.087	(0.133)	0.003	(0.048)	-0.1	(0.074)
Exports	0.411	(0.316)	-0.514	(0.459)	0.735	(0.497)	-0.176	(0.549)	0.129 [^]	(0.07)	0.106	(0.146)	0.072	(0.282)	-0.676	(0.526)
Displaced people	0.009	(0.035)	0.067	(0.045)	0.025	(0.046)	-0.093	(0.191)	-0.038	(0.059)	0.115	(0.086)	0.074*	(0.033)	0.052	(0.053)
Constant	-1.941	(1.513)	-4.388	(1.929)	-8.897	(2.57)	-9.525	(8.51)	0.211	(2.454)	-5.724	(4.152)	-4.405	(1.614)	-3.001	(2.265)

Two-tailed, [^] $p < .1$, * $p < .05$, ** $p < .01$.

relationship between aerial coca eradication and FARC kidnappings in the following month during this period. Similar tests were also run for the other models examined, but all failed to yield any statistically significant results for the change in coca eradication on each type of violence in the following month. This study thus finds partial support for hypothesis 3 as overall kidnappings and kidnappings by the FARC were the only types of violence that were observed to be impacted by changes in aerial coca eradication while no connections were found with terrorism or assassinations. Regardless of model specification, this study did not find any support, however, that total ELN violence or any specific form of ELN violence was impacted by aerial coca eradication.

Discussion and Conclusions

After accounting for time-stable and a number of time-variable department-level influences, this study found evidence that there was a negative relationship between changes in aerial coca eradication and violence in the following month between 2004 and 2005 in Colombia. The above findings further displayed that when disaggregated, this impact was only seen for violence committed by the FARC during this period and that this impact did not extend to the ELN. Potentially due in part to the low number of terrorist attacks and assassinations committed by the ELN during this period and the peace talks between the Colombian government and the ELN, these findings suggest that the impact of changes in aerial coca eradication likely vary across belligerent groups. Although this study was not concerned with directly examining the mechanism for the link between coca eradications and violence, this finding was in line with predictions made by this study on the basis of economic reliance and resultant organizational disruptions.

Rather than being seen as counterevidence to the studies conducted by Holmes et al. and Rozo, who both found positive impacts of coca eradication on violence in Colombia, this study instead suggests that these divergent findings may instead be a product of the varying tactical and political contexts of these actions.⁷⁴ As the period examined here was characterized by more security-focused and consistently applied policies as well as large-scale military reforms, it is perhaps unsurprising that these policies generated a different impact than those in the period preceding the Uribe administration that was examined by Holmes et al.⁷⁵ While it would have been beneficial to compare the findings from this period to those from other political and tactical periods as mentioned above, due to the limited availability of department-level monthly coca eradication data, this study was limited to only assessing the years 2004 and 2005. Although this period was advantageous to examine due to the relative stability of other counternarcotic policies, thus being a prime candidate for using fixed effects models, the findings from this period may not reflect the impact on violence for similar policies during other administrations. As such, this study strongly encourages future research in this area to examine whether any findings are consistent across tactical and political regimes within Colombia.

The observed negative impact of coca eradication on kidnappings committed by the FARC also requires further research to better theoretically situate. As the ELN was less financially dependent on coca, due to its relatively greater reliance on kidnappings compared to the FARC, it was postulated that the ELN was better financially situated to withstand the disruptions provided by coca eradication, which was not contradicted by the observed null findings. However, if this negligible impact on violence was due to economic disruption as this

was taken to suggest, one might expect that a rationally acting group would engage in alternative profit-generating activities. This would then lead to groups like the FARC engaging in more kidnappings in order to supplement the income lost due to coca eradication, in lieu of terrorism or assassinations that would likely only drain resources. As this study found the opposite to be the case, with an observable decrease in FARC kidnappings, this evidence does not appear to support a link between coca eradication and terrorism that is driven solely by financial reasoning by the FARC. While this finding on its own is consistent with Piazza's claim that coca eradication addresses political instabilities that undermine domestic security, it is important to note that this finding was limited to kidnappings and did not extend to terrorism or assassinations, suggesting little impact during this period on lethal forms of violence.⁷⁶ Further, this reduction in kidnappings suggests that this form of violence was not used to supplement income lost from destroyed coca crops. Consequently, this study highlights the need for future research that places a high priority on examining the nonfinancial consequences of coca eradication to better understand these findings.

A number of notable limitations were evident in this study. This study focused on the impact of aerial coca eradication on Colombian belligerent violence in the following month. Although the findings generated by the sensitivity analyses suggest that this period was an appropriate length of time to observe an impact, due to the relatively short temporal period observed, the null findings for other lags examined by this study may also be due to the decreased sample sizes resulting from longer lags. Consequently, these findings highlight the need to establish whether any impacts of aerial coca eradication on Colombian assassinations or terrorism may take longer than one month to manifest.

Overall, the results of this study suggest that coca eradication has a negative impact on overall violence committed by belligerent groups within Colombia. However, when disaggregated it was evident that this observed impact was only evident for violence committed by the FARC, and specifically only for kidnappings. Consistent with the negative findings observed by previous studies on the impact of coca eradication, this study suggests that this impact may only be limited to groups that derive an important proportion of their operational financing from coca production of trafficking. Despite this, this study also generated findings that were inconsistent with a purely financially driven explanation, suggesting there are important political and social factors that may also be necessary to explain the link between coca eradication and violence.

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Notes

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