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The health consequences of aerial spraying illicit crops: The case of Colombia☆

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ABSTRACT

This paper exploits variations in aerial spraying across time and space in Colombia and employs a panel of individual health records in order to study the causal effects of the aerial spraying of herbicides (glyphosate) on short-term health-related outcomes. Our results show that exposure to the herbicide used in aerial spraying campaigns increases the number of medical consultations related to dermatological and respiratory illnesses, as well as the number of miscarriages. These findings are robust to the inclusion of individual fixed effects, which compare the prevalence of these medical conditions for the same person under different levels of exposure to the herbicide used in the aerial spraying program over a period of 5 years. Also, our results are robust to controlling for the extent of illicit coca cultivation in the municipality of residence.

1. Introduction

One of the main strategies used in Colombia to fight illegal drug production and reduce the supply of cocaine is that of the aerial spraying of herbicides on coca crops, the raw material used to produce cocaine.[3] Under Plan Colombia,[4] the average number of hectares sprayed annually with herbicides during the last decade is 128,000.[5] At its peak in 2006, 172,000 ha were aerially sprayed with glyphosate, the herbicide used in the aerial spraying program in Colombia. The effectiveness of this approach has been thoroughly defended by the US, yet attacked and questioned by NGOs and opponents of the so-called "war on drugs". Nevertheless, the debate about the effectiveness of aerial spraying campaigns and their collateral effects is often grounded in ideologies and rarely takes the available scientific evidence seriously. However, both structural evaluations (Mejía and Restrepo, 2016) and reduced-form estimation techniques (Reyes, 2014; Rozo, 2014 and Mejía et al., 2015) have exploited exogenous sources of variation to assess the impact of aerial spraying campaigns on the reduction of coca cultivation in Colombia, consistently indicating that the effects are very small. On top of its limited effectiveness, this "chemical war" (as it is often called by opponents of the war on drugs) has been linked with all sorts of collateral negative effects. Examples include distrust felt towards state and government institutions by affected populations,[6] non-negligible negative effects on the environment (especially on amphibian populations through the contamination

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[1] Part of this paper was written while the author was a Visiting Fellow at the Center for Global Development during the summer of 2014.

[3] Poppy seeds in the case of heroin production and coca bushes in the case of cocaine production.

[4] Plan Colombia is the name of a joint strategy launched in 2000 between the governments of Colombia and the US for the fight against illegal drugs and organized crime.

[5] 128.000 ha correspond to 0.3% of the total arable land in Colombia. These calculations were done with information from the 2014 National Agricultural Census.

[6] See Felbab-Brown (2009) and García (2014), Landy (1988), Navarrete-Frías and Thoumi (2005), among others.

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of water sources),[7] and negative health effects for affected populations exposed to the herbicides. However, it is important to note that most of the evidence regarding these collateral effects comes from fieldwork, with few observations having been made, thus generating problems of internal and external validity. Both fieldwork and anecdotal evidence on the effects of aerial spraying on health are plagued by confounding factors that make it difficult to link aerial spraying as a direct cause of the aforementioned maladies. One of the most prominent confounding factors is that of coca cultivation itself. More precisely, given the high spatial correlation between coca cultivation and the occurrence of aerial spraying campaigns, it can be easily argued that if coca cultivation and cocaine production themselves make indiscriminate use of pesticides and other agricultural inputs and chemical precursors, then these activities may be the ones generating the negative health and environmental consequences observed by researchers in the field. In short, most of the evidence (anecdotal, from field work and empirical) is plagued by issues of endogeneity and omitted variables that make it hard to reach causal conclusions regarding the effects of spraying campaigns on health outcomes.

In this paper, we use a large administrative panel data set collected by the Ministry of Health that contains individual health records across a five-year period. This data allows us to observe individuals more than once during the period of analysis. Therefore, our identification strategy relies on the fact that we can construct a panel of individuals and include fixed effects at this level. As thus, we are able to control for individual unobservable characteristics that do not change over time, such as baseline health. We merge these health records together with precise information on the location and exact timing of aerial spraying events (at a daily and municipal level) in order to disentangle the causal effects of the aerial spraying of herbicides on a broad range of health outcomes. Our identification strategy tackles the problems of endogeneity present in the previous literature since it relies on the fact that each aerial spraying event is neither announced nor anticipated. Running a regression model we are able to reject the hypothesis that there is a predictable pattern for aerial spraying over time.[8] Therefore, we assume that individuals cannot anticipate with certainty the time and extent of exposure to aerial spraying campaigns. This enables us to exploit a quasi-natural experiment to test the causal impact of exposure to glyphosate on human health. Moreover, in our view this quasi-experiment is the closest we can get to a randomized experiment (which, for obvious reasons, would be impossible to implement in the context of human exposure to glyphosate).

On the one hand, our health data contains the individual-level registries of medical consultations for more than 76 million (individual-time) observations. This is an unbalanced panel that covers a period of five years. On the other hand, we have official records from the Colombian National Antinarcotic Police for the number of square kilometers sprayed daily per municipality over a period of five years, that is, between January 2003 and December 2007. These are precisely the years that evidence the highest levels of aerial spraying during the last 15 years under Plan Colombia. Combining these two panel data sets we estimate individual fixed-effects regressions that test whether there exists an increase in the probability of experiencing a health problem related to herbicide exposure. The fixed effect model captures the exposure to different levels of aerial spraying for the same individual in different moments in time. We also include month and year fixed effects that control for seasonal illnesses or harvesting seasons. Our findings coincide with the medical literature and robustly indicate that the aerial spraying of glyphosate increases the probability of having dermatological and respiratory problems, as well as miscarriages (Sanborn et al., 2012; Sanborn et al., 2007; Cox 1995a; Sherret, 2005; Regidor et al., 2004; Solomon et al., 2007). These results are robust to different specifications of the empirical model and to the inclusion of a wide range of controls, including the extent of coca cultivation at the municipality level. It is important to highlight that given the nature of our data we are unable to capture health consequences in the long-term that might translate into reduced life expectancy, quality of life or productivity.

We run a placebo test in which we take as the dependent variable the proportion of two conditions that, in principle, should be completely unrelated to exposure to the spraying campaigns: accidents and bone fractures.[9] As expected, the results show that exposure to the spraying campaigns does not lead to an increase in the fraction of medical consultations related to these two diagnoses. In addition, we perform a placebo test for timing of exposure by opening the window onto a longer period of time. The results show that the effect loses significance or disappears when using an inappropriate time window.

Our paper offers four main strengths and contributions in relation to the existing literature. First, to the best of our knowledge, this is the first paper in the literature that uses a quasi-experiment to estimate the effects of the spraying of illicit crops on various health outcomes in a drug-producing country. In particular, given that the exact timing and magnitude of spraying campaigns are unannounced, it is difficult to anticipate spraying events are arguably an exogenous shock from an individual's point of view, and this strengthens our identification strategy and the internal validity of our results. Second, the large sample size of our dataset also allows us to find robust and precise results in the econometric specifications, even if the actual effects are small. We use a dataset that contains administrative records for all of the health service institutions in Colombia from 2003 to 2007, accounting for more than 76 million visits to the doctor and approximately 3 million completed and non-completed birth registrations. By using information from across the entire Colombian population, our results exhibit greater external validity than those performed in the field or in laboratories by epidemiologists or medical doctors. Third, our daily data is appropriate for the establishing of a precise link between the date and magnitude of aerial spraying, and the date on which individuals go to the hospital to see the doctor or visit the emergency room. Finally, from the administrative health records used we are able to construct a panel for individuals that go to a health service provider more than once during our period of analysis. The possibility of comparing the same individual over time, by estimating an individual fixed-effects model, isolates all instances of genetic, behavioral, and other time-invariant, unobserved individual heterogeneities. This automatically rules out a range of confounding factors from our study and omits the variable biases present in cross-sectional studies.

[7] See Cox (2004), Imming (2010), Navarrete-Frías and Veillete (2005) and Relyea et al. (2006) for studies documenting the effects of aerial spraying with glyphosate on the environment (deforestation, pollution of water sources, etc.) and animal species.

[8] We run a regression for the daily amount of aerial spraying on different time variables, which include: day of the week, day of the month, month of the year, and year. This regression tests whether spraying has a predictable pattern over time. We find no statistical difference in the average sprayed in the day of the month, and no difference in spraying between days of the week, except for Wednesdays when a lower amount of spraying takes place on average. Regarding month of the year, May, June and July, together with November and December, exhibit a lower amount of spraying on average. With these results we are confident that, at least on a daily basis, aerial spraying is an unexpected or unanticipated shock.

[9] We define accidents by using the following categories from the ICD10 diagnoses: traumatisms and fractures (codes starting with S), injuries and collisions (V codes), falls, bites or stings (W codes), burns or poisoning (X codes). Bone fractures comprise some specific codes of the S category and so represent a subset of accidents.