EUI DEPARTMENT OF ECONOMICS

The Opium of the People: Essays on Counter-narcotics Efforts in Afghanistan

Christophe-Aschkan Askar Mery-Khosrowshahi

Thesis submitted for assessment with a view to
obtaining the degree of Doctor of Economics
of the European University Institute

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European University Institute
Department of Economics

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A. Méry

Abstract

The idea of this PhD thesis is to document the link between the counter-narcotics operations that took place in Afghanistan in the years 2008-2015 and the Afghan civil conflict, which has led to the terrible outcome of the year 2021.

In the first chapter, I propose a microeconomic model to describe the effect of counter-narcotics law enforcement on the supply of drugs when territorial control is contested. I assume, as is seen on the field, that if insurgents take power, then drug producers are protected against counter-narcotics operations, but that they have to pay taxes on their production. I show that under some circumstances the influence of drug producers on the outcome of conflict induces a complementarity between investment in narcotics production and insurgent support. This complementarity has two effects: 1) It mitigates the efficacy of counter-narcotics operations 2) It generates a trade-off between the war on drugs and counterinsurgency. In the second chapter, I address point 1) by estimating the elasticity of opium supply to counter-narcotics operations in Afghanistan. I find that law enforcement had little impact, with a 1% increase in opium eradication causing a reduction of roughly a third of a percent in opium supply the following year. Moreover, this effect is driven by northern regions, far from the Taliban's strongholds which concentrate most of the country's production. In the third chapter, I turn to point 2) and estimate the effect of counter-narcotics operations on the population's self-declared support for military actors. I find that those provinces where law enforcement induced the eradication of 10% or more of the total opium-cultivated area exhibit greater sympathy for opposition armed groups, such as the Taliban, and less trust in the national army. This effect is driven by the Pashtun sub-population, which agricultural sector relies heavily on opium cultivation.

These results empirically confirm the existence of a trade-off between counter-narcotics and counterinsurgency. Since law enforcement was originally meant to weaken the Taliban insurgency, these results should be of interest to policymakers.

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What they say is true. Finishing a PhD is an arduous task, during which one often feels lonely. But when it is finally over, and when one takes the time to look around, it becomes clear that one was never alone. And that this the very reason why one succeeded.

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Chapter 1

Counternarcotics and Counterinsurgency: Competing Objectives of State Development?

Abstract

I propose a microeconomic model to study the effect of counter-narcotics law enforcement on the supply of drugs when territorial control is contested. I assume that if insurgents take power, then drug producers are protected against narcotics control, but that they have to pay taxes on their production. I show that under some circumstances the influence of drug producers on the outcome of conflict induces a complementarity between investment in narcotics production and insurgent support. This complementarity generates a trade-off between the war on drugs and counterinsurgency. The model is applied to case of opium production in Afghanistan.

Keywords: Counter-Narcotics, Counter-Insurgency, Law-Enforcement, Illegal Goods, Opium, Afghanistan

Introduction

> *'Where the government and its foreign backers were seen as responsible for the deteriorating economic position of the local farmers, the Taliban were portrayed as responding to the plight of the farmers, offering protection against those who were bringing both the military campaign and the opium ban across the canal.'*

The quotation above, taken from [Mansfield, 2014, p61], does not only raise awareness on the difficulties of combining counter-narcotics policies with counterinsurgency. It also begs the question: What are the economic mechanisms linking insurgent support and drug production and how do they impact the war on drugs?

Despite numerous real-life examples of interplay between insurgents and drug producers, most of the theoretical research on farmers' incentives to supply drugs avoids this issue entirely[1,2]. For example, the seminal work of Clemens [2008] models the opium industry using a classic demand and supply framework, where eradication is a shift in the net income from opium production. Similarly, Ibanez and Carlsson [2010], Palacios [2012], Andersson [2013], Greenfield et al. [2017] all model drug control as an exogenous risk, with no possible feedback from producers.

Yet, the situation of countries like Afghanistan motivates the need for a theory capturing the entanglement between the narcotics industry and civil conflict. There are two reasons for this. First, as I show in this work, this entanglement directly affects the dynamics of drug control, which should be of primary interest to policy-makers. Secondly, the unintended consequences, such as insurgent support, of counter-narcotics policies can

[1] Political scientists, however, have been studying this issue from a qualitative perspective for some time. See, for example, Nixon and Ponzio [2007], Werb et al. [2008], Felbab-Brown [2010] and Coyne [2016], as well as numerous policy reports like Blanchard [2009], Peters [2009], Mansfield [2014] and Greenfield et al. [2017], to quote only a few. Details about the implementation of counter-nacotics policies in Afghanistan can be found in Chapter 2 of this work.

[2] An interesting exception is Lind et al. [2014], where farmers are passive observers of local conflict, which acts as a signal on the future probability of counter-narcotics law enforcement. But this paper tries to show how conflict causes opium production, and does not address crop eradication. Another relevant exception is Mejia and Restrepo [2016], which develops a vertical model of drug production in Colombia. However, it is essentially a market equilibrium model which does not allow for a detailed study of the farmers' incentives.

jeopardize the very ability of the government to govern and thus, to remain in power. This article is a first attempt at embedding the narcotics production process in a simple framework where territorial control is disputed between a government and insurgents, and where drug producers can influence the outcome of conflict by supporting the side of their choice.

In the same spirit of Andersson [2013], I focus on the Afghan case and propose a microeconomic model studying how farmers allocate their land between opium and other agricultural goods, such as wheat. Opium, unlike wheat, can be used to obtain loans, in the form of opium-denominated debt. The existence of such a debt mechanism matters because resource-poor farmers depend on credit to fund their consumption before harvest. And also because the cost of borrowing is tied to the uncertainty surrounding opium production.

Indeed, in the model presented here, upon deciding on land allocation and debt, an opium producer does not know under what regime production will take place. If the government takes power over the territory, then opium is made illegal. This means that, when it is able to do so, the government might try to enforce the law by destroying opium fields, thus inducing a production risk. If the insurgents take power, then opium producers are entirely protected against eradication, but they have to pay taxes on their production.

A key feature of this work is that, depending on their political preferences and economic incentives, farmers can shift the balance of power between the government and the insurgents. Thus, popular support has a direct impact on the opium production risk, which ties the issue of territorial control to the economic incentives of opium producers.

My first finding is that, when it comes to the efficacy of counter-narcotics policies, one must take into account not one, but two sources of rivalry between the government and the insurgents. The first is the conflict over territorial control, which is partially determined by farmers' support. The second is the tension between law enforcement and insurgent taxation policies which, together, and together only, specify the economic incentives faced by opium producers. Since these incentives, and political preferences, dictate which side receives support, policy choices will be crucial to the 'winning of hearts and minds'. For example, without counter-narcotics law enforcement, and unless they are strongly pro-insurgents, opium producers will decide to support the government to avoid the burden of insurgent taxation. By contrast, when there is a possibility of eradication, even pro-government farmers might turn to the insurgents to avoid the production risk associated with government control.

My second finding is that the entanglement between the opium industry and the insurgency induces a complementarity between investment in opium production and insurgent support. Understanding this complementarity is vital to predict the effect of law enforcement on opium supply. For instance, the basic logic behind crop eradication is that it reduces the returns from opium and thus disincentivizes farmers from cultivating it. I show that this logic is only partially true, even for wealthy farmers[3]. This is because, holding political preferences fixed, law enforcement always causes insurgent support to rise. But if insurgent support and opium production are complementary, this will increase opium production.

A third finding is that for risk-averse producers who depend on opium-denominated debt, counter-narcotics law enforcement will not only directly raise insurgent support, but also indirectly, through equilibrium effects. By pushing farmers to raise opium production to compensate for the expected consumption loss, an increase in eradication risk will increase the marginal benefit of supporting the insurgents. This indirect effect makes counter-narcotics law enforcement particularly harmful to the government in impoverished areas.

An important conclusion from this work is thus that counter-narcotics and counterinsurgency are competing objectives of state development, which might very well work against one another.

The rest of this paper is organized as follows. Section 1.1 presents the model's ingredients and the producer's optimization problem. Section 1.2 characterizes the solution to this problem and provides intuitions about the mechanisms at play. Section 1.3 presents the model's comparative statics, focusing on the impacts of an exogenous increase in law

[3] That eradication policies can be ineffective at reducing opium supply for resource-poor producers has already been documented by [Andersson, 2013, Proposition 1].

enforcement. Section 1.4 concludes. The proofs of the results presented below are given in Appendix 1.5.7.

1.1 Model

1.1.1 The Environment

Players.– This is a two-period game with two players; An opium producer and a lender. The producer owns agricultural land, which can be shared across opium and wheat crops. Land allocation is decided in period 1, while production is realized between period 1 and 2. Once production sold, its revenue is used to buy the economy's only consumption good, which is wheat. The producer can also decide how much support they provide to the insurgents, and what quantity of opium they want to put on the advance sale market in order in fund their period 1 (before-harvest) consumption. The lender, by contrast, decides how much opium they demand on the advance sale market. Details of this transaction are given below. All players seek to maximize their expected lifetime utility.

Territorial Control.– In period 1, territorial control has no industrial effect since there is no production (see Footnote 5). In period 2, the territory can be controlled by either the government G or by the insurgents I. The binary random variable $\iota \in \{0, 1\}$ is equal to 1 if and only if the territory is under insurgent control. When this is the case, period 2 opium sales are taxed at rate $\tau \in [0, \overline{\tau}]$, where $\overline{\tau} < 1$ represents the insurgents' fiscal capacity[4]. Besides, the producer's utility is reduced by $N \in \mathbf{R}$. The number N can be interpreted as a 'political preference' parameter. A positive value of N means that, all else being equal, the producer favors government over insurgent control, whereas a negative

[4] It is well known that, in Afghanistan, Taliban insurgents have benefited from imposing the *ushr*, an opium tax roughy equal to $\tau \simeq 0.1$ depending on sources, on opium producers living on territories under their control. See, for example, [Blanchard, 2009, n.44, p23]. Importantly, taxation and advance sales of opium are two separate phenomena: *"The nature and function of advance payments appeared to be different and independent from the system of taxing opium poppy sales. While non-government authorities such as the Taliban appeared to be heavily involved in collecting taxes on opium sales, advance payments were collected by private persons such as traffickers or businessmen."* [UNODC, 2018b, p50]. See also Footnote 11 below.

value of N means that the producer suffers from government control, as described in Equation (1.1).

$$\begin{aligned} \text{Producer favors government control:} \quad & N > 0 \\ \text{Producer is neutral:} \quad & N = 0 \\ \text{Producer favors insurgent control:} \quad & N < 0. \end{aligned} \tag{1.1}$$

The probability that the insurgents take control over the territory is

$$\sigma(s) \equiv \text{Prob}(\iota = 1), \tag{1.2}$$

where $s \in [0, 1]$ is the producer's support for the insurgents, which is exerted as cost $c(s) \equiv \frac{c}{2}s^2$, with $c > 0$. This control can be compared to the variable[5] $(1 - i) \in [0, 1]$ from Berman et al. [2011]. Here, the cost $c(s)$ arises from risks taken by the producer, such as communicating with outlaws, or from the provision of material resources to the insurgents, such as food or shelter. Importantly, insurgent support s shifts the power balance between the insurgents and the government[6]. This is why when s is low, I occasionally say that 'the farmers support the government'. However, given the existence of a convex cost $c(s)$, this is not strictly rigorous (see also Footnote 5). I make the following assumption

$$\sigma(s) \equiv \underline{\sigma} + \delta s \quad \text{for all } s \in [0, 1] \tag{1.3}$$

where $\underline{\sigma} > 0$ represents the insurgents' intrinsic power, and $\delta \in (0, 1 - \underline{\sigma})$ gives the maximum effect of popular support on that power. It can be understood as the degree to which popular support is decisive to the outcome of conflict. I let $\overline{\sigma} \equiv \sigma(1)$ denote the

[5] Although these authors assume support is costless. One could argue that if support is immaterial, such as information sharing (like in Berman et al. [2011]), then making it costly would suggest that the territory is under government control in period 1.

[6] From equations (1.2) and (1.3), it is clear that this support also alters the uncertainty faced by the producer. For example, if $\sigma(s)$ is close to 1, then the producer is quite certain that the territory will be seized by the insurgents. No eradication will take place, but opium production will be taxed at a known rate. However, if $\sigma(s)$ is close to $1/2$, then the producer does not know who will seize the territory and, if the government takes power, they will not know whether their opium production will be eradicated or not.

maximal value of $\sigma(s)$. In a location where the state is strong, like in the surrounding of Kabul in Afghanistan, one expects $\overline{\sigma}$ to be low. This would imply that both $\underline{\sigma}$ and δ are low. However, in any location with weak government presence, like in the South of Afghanistan where the local population is decisive to the outcome of territorial conflict, the value δ can become relatively large. When the territory is under government control, which happens with probability $(1 - \sigma(s))$, there are no taxes or utility shift, but opium production is at risk of being eradicated, as described in the next paragraph.

Opium Eradication.– As in Andersson [2013] and Lind et al. [2014], I let $\theta \in \{0, 1\}$ be a binary random variable equal to 0 if and only if opium is eradicated between period 1 and 2. The variable θ is realized after territorial control ι. Then, in any territory controlled by the government ($\iota = 0$), the probability of eradication is denoted by

$$\gamma \equiv \text{Prob}(\theta = 0|\iota = 0), \tag{1.4}$$

and is interpreted as the government's effort to enforce the anti-narcotics law through eradication. It is perfectly observed by all the players[7]. Eradication has probability 0 in a territory controlled by the insurgents. This means first that when they are in control of a territory, insurgents can prevent law enforcement. Secondly, that they are not willing to ban opium[8]. It is also assumed that eradication policy γ is chosen by the government before territorial control is realized and that it is observed by all the players. I let $\overline{\gamma}$ denote the supremum value of γ, which is assumed to lie in $(0, 1)$. Qualitatively, $\overline{\gamma}$ represents the state's gross legal capacity. This capacity is limited, that is, even if the government invests large resources in opium eradication, the probability of law-enforcement is never

[7]Equivalently, as in the empirical study of Chapter 2, one can assume that γ is the observed probability of eradication of the preceding year, which perfectly sets the belief for this year.

[8]Formally, this assumption says that $\text{Prob}(\theta = 0|\iota = 1) = 0$. The first point above is justified by empirical observations. In Khogiani, for example: *"With more significant AGE [Anti-Government Elements] presence in both upper and lower Achin in 2013 and a growing sense of a government that could no longer draw on the coercive power of the US military, most respondents in these areas were confident that their opium crop would remain unscathed."* [Mansfield, 2014, p26-27]. The second point is justified by assuming that the insurgents' revenue relies on opium production (through taxation) and that there is no conflict of objectives, so that it would always be optimal for the insurgents to select $\theta = 1$ and some $\tau \in (0, \overline{\tau}]$.

1. This is easily justified in practice, as eradication is a complicated process involving many actors (see Section 2.1 from Chapter 2). Moreover, as soon as the authorities invest in law-enforcement, there is a risk that eradication will take place. Said differently, if the authorities invest in law-enforcement, no level of resistance can totally remove the risk of eradication. Given definitions (1.2) and (1.4), the unconditional probability of eradication is

$$\Gamma(s, \gamma) \equiv (1 - \sigma(s))\gamma, \tag{1.5}$$

which properties, inherited from $\sigma(s)$ and γ, are given in Equation (1.10) from Appendix 1.5.1. The quantity $(1 - \overline{\sigma})\overline{\gamma}$ can be interpreted as the government net legal capacity, that is, its capacity to enforce the law on a contested territory, before it has effectively seized control of it. Importantly, insurgent support s has an effect on $\Gamma(s, \gamma)$, that is $\Gamma_s(s, \gamma) \neq 0$, if and only if the government invests in law enforcement $\gamma > 0$.

Agricultural Production.– The opium producer owns a size $L = 1$ of land. I denote by f_o, f_w the strictly concave technologies for opium and wheat production respectively. Their properties are described in Equation (1.11) from Appendix 1.5.1. The only production factor is land input. Let $l \in [0, 1]$ be the share of land allocated to opium crops in period 1. Agricultural supply is realized between period 1 and period 2 as follows.
If the insurgents take control of the territory ($\iota = 1$), then the period 2 opium supply is[9] $f_o(l)$, which market value is taxed at rate $\tau \in [0, \overline{\tau}]$ by the insurgents. If the government takes control of the territory ($\iota = 0$), then there are no taxes, but the opium output $f_o(l)$ is eradicated with probability γ, so that the expected opium supply becomes $(1-\gamma)f_o(l)$. The share of land $(1-l)$ not allocated to opium is allocated to wheat production. Wheat is never taxed and, since it is a legal crop, it is not subject to eradication either. Therefore, the supply of wheat is $f_w(1 - l)$ in all cases. It is assumed that the producer is a price taker (see below).

[9] As we will see below, a part q_o of this opium output can be sold in advance. That bit is not submitted to taxation.

Advance sales of future opium harvest[10]*.–* After land allocation l was decided, but before territorial control ι, eradication θ or production are realized, the producer can allocate part of their future opium output $f_o(l)$ to the advance opium sale market, which is interpreted as an informal credit market and which functions as follows.

The risk-neutral lender, who is typically a shop owner[11], decides on the quantity $q_o^d \geq 0$ of opium they demand on the advance opium sale market. Each unit is valued at the period-1 relative price[12] of opium, denoted by P_1, so that pre-buying the quantity q_o^d costs $P_1 q_o^d$ to the lender. If and only if opium eradication has not taken place ($\theta = 1$), a quantity q_o^d of opium is delivered to the lender in period 2, which they then sell (to finance their consumption) at the period-2 relative price of opium, denoted by P_2. It is assumed that the price P_2 is not influenced by either the opium supply or law enforcement. If opium eradication has taken place ($\theta = 0$), then the lender receives nothing. The demand side of the market is perfectly competitive, so that the lender makes no profit in the long-run. On the supply side, the opium producer decides on the quantity $q_o^s \geq 0$ they want to put on the advance sale market. If the quantity q_o^s is supplied, then pre-sale yields the capital $P_1 q_0^s$ to the producer in period 1. The quantity $P_1 q_0^s$ is interpreted as an loan taken by the producer/borrower to the lender in order to finance their period 1 consumption, with a cost of borrowing defined by $\frac{P_2}{P_1} - 1$ (see Equation (1.7) below). To honor their opium-denominated debt, the producer/borrower commits to delivering a quantity q_0^s of opium in period 2 to the lender if and only if opium eradication has not taken place ($\theta = 1$). If $q_o^s > 0$ and if eradication has taken place ($\theta = 0$), then the producer defaults on their debt and suffers a lump-sum disutility $D \geq 0$, which represents a form of punishment, independent of q_o^s[13], imposed by the lender on the borrower. As discussed

[10] The importance of informal credit in the Afghan opium industry has been widely documented by political scientists (see Pain [2008] for a review). But its role in the incentives faced by opium producers much less so. The purpose of this paper is to illustrate how wealth and dependence on credit can alter the comparative statics associated with an increase in law enforcement.

[11] On credit sources: *"Typically shopkeepers and traders have been the main source of credit, usually in the form of advance payments on opium."* [World Bank, 2004, p79].

[12] All prices are relative to the price of wheat, which is then chosen as the numeraire with a price normalized to 1.

[13] When defaulting, farmers are held accountable through different means. See [World Bank, 2004, p79, p83]: *"Creditors have adopted authoritarian tactics to ensure borrowers repay their debts. Stories of creditors taking the daughters of those that owe them money are not uncommon, The confiscation of domestic possessions, the compulsory purchase of land (at preferential rates), and creditors pursuing*

above, in this case, the lender receives no payment. Assuming that the lender observes l and that the farmer cannot over-commit[14], the decision q_o^s is subject to the 'borrowing constraint' $q_o^s \leq f_o(l)$.

The advance sale market is not subject to any form of taxation, by neither the government nor the insurgents. This is important, as when both γ and τ are large, this might give producers an incentive to pre-sell a larger share of their future opium output to avoid eradication or taxes.

Variation by Locations.– The framework above can only be interpreted as a micro-level model, which setup should be adapted to the location studied. As hinted above, it is clear that parameters such as the intrinsic power of insurgents $\underline{\sigma}$, the importance of popular support δ, or the initial wealth of farmers y_1 (see below), etc., will vary by region, particularly in a divided country like Afghanistan.

Timing

Opium production, territorial conflict and law enforcement take time. Thus, while land allocation is decided in period 1, territorial control ι, eradication status θ and output are only realized in period 2. Pre-sale of opium and insurgent support, by contrast, are executed immediately. The timing is as follows.

Law enforcement γ and insurgent taxation τ policies are exogenously given.

Period 1

1. The producer first chooses the share $l \in [0, 1]$ of land allocated to opium production. The remaining share $(1 - l)$ is allocated to wheat crops. Then, they decide on the

absconders across the border into Pakistan have all been used to recoup outstanding loans". Of course, if $q_o^s = 0$, then $D = 0$.

[14]This assumption is justified by the fact aht lenders are often in close proximity to the opium fields: *"In the late 1990s UNODC reported that traders typically limited their salaam payments to farmers that were considered 'credit-worthy'. This generally translated into farmers that were known to the trader, owned land in the area or who had record of providing quality opium in return for a salaam payment. Typically traders restricted their provision of advances to farmers within their district or neighboring districts"* [World Bank, 2004, p79].

quantity $q_o^s \in [0, f_o(l)]$ of opium they supply to the advance-sale market, and the amount of support $s \in [0,1]$ they provide to the insurgents, at cost $c(s)$.

2. The lender observes l and s, and decides on the quantity $q_o^d \geq 0$ they demand on the advance-sale market. As will be seen below, with risk-neutrality of the lender, the final volume exchanged on the advance sale market is $q_o = q_o^s$.

3. The transaction takes place on the advance-sale market. Period 1 consumption takes place.

Period 2

4. The territorial control variable ι is realized. The insurgents take power ($\iota = 1$) with probability $\sigma(s) \in (0,1)$. With the remaining probability $(1 - \sigma(s))$, the government takes control of the territory. The distribution $\sigma(s)$ is described by Assumption (1.3).

5. The opium eradication variable θ is realized. If the insurgents are in power ($\iota = 1$), then opium eradication does not happen, so that $\theta = 1$ with probability 1. Net opium supply $(f_o(l) - q_o)$ is taxed at rate $\tau \in [0, \overline{\tau}]$ by the insurgents. Otherwise, if the government is in control of the territory ($\iota = 0$), then there are no taxes, but eradication takes place ($\theta = 0$) with probability $\gamma \in (0,1)$.

6. Period 2 consumption takes place. Lifetime payoffs are realized according to equation (L) and (P) below.

1.1.2 Payoffs

The Lender.– In period 1, the lender pre-buys a quantity $q_o^d \geq 0$ of opium at relative price P_1. In period 2, they are delivered the quantity q_o^d of opium if and only if no eradication has taken place, which has probability $(1 - \Gamma(s,\gamma))$, as described in Equation (1.5). This quantity can then be sold at relative (exogenous) price[15] P_2. When eradication has taken

[15] As a first approximation, it is assumed that P_2 is not influenced by either supply or eradication risk (which shifts the supply curve). This needs not be the case in reality, as discussed in Footnote 9 from Chapter 3.

place, the lender has no possibility to retrieve their investment. Assuming they maximize their expected profit and discount the future at rate $1/(1+r)$, the lender's problem is given by

$$\max_{q_o^d \geq 0} \quad -P_1 q_o^d + (1-\Gamma(s,\gamma))\frac{P_2 q_o^d}{1+r}. \tag{L}$$

Since the market is perfectly competitive, lenders make zero expected profits on the long-run. This condition gives the following result, which is analogous to Equation (9) from [Andersson, 2013, p922]

$$P_1 = P_1(s,\gamma) = (1-\Gamma(s,\gamma))\frac{P_2}{1+r}, \tag{1.6}$$

This shows that if the unconditional probability of eradication $\Gamma(s,\gamma)$ increases, then the relative price $P_1(s,\gamma)$ of advance sale opium must decrease[16]. Thus, $P_1(s,\gamma)$ is interpreted as the terms of the loan awarded to the producer by the lender, which depend on the risk of default. In fact, it is easy to see that the cost of borrowing, which I define as

$$\rho(s,\gamma) \equiv \frac{P_2}{P_1(s,\gamma)} - 1 = \frac{r+\Gamma(s,\gamma)}{1-\Gamma(s,\gamma)} \tag{1.7}$$

is an increasing function of the unconditional probability eradication. The equilibrium period-1 price of opium can thus be written $P_1(s,\gamma) = \frac{P_2}{1+\rho(s,\gamma)}$.
By Equation (1.10) from Appendix 1.5.1, under law enforcement ($\gamma > 0$), if the producer increases its support s to the insurgency, then the cost of borrowing decreases. Thus, while they cannot influence the period 2 market price P_2, the producer can influence the price they face $P_1(s,\gamma)$ upon borrowing. Without law enforcement ($\gamma = 0$), insurgent support has no effect on the borrowing cost, which is at its lowest level $\rho(s,0) = r$.
Symmetrically, for any fixed level of insurgent support, by investing in law-enforcement γ, the government makes credit more costly to opium producers. The properties of $\rho(s,\gamma)$

[16] Field observations suggest that $\frac{1-\Gamma(s,\gamma)}{1+r} \simeq 0.5$. Moreover, in practice, P_1 also depends on the borrower's assets which determine the revenue of the lender in case of default. Here, it is assumed that those collateral assets are zero. See [World Bank, 2004, p80]: *"Consequently, those with land would receive the traditional advance payment of 50% of the market price of opium that day, however, those individuals without land but with other assets (such as farm equipment, livestock etc) received only 30%-40% of the current price."*.

are summarized in Equation (1.12) from Appendix 1.5.2.

With risk neutrality, the lender's optimum is undetermined and the size of the advance sale market is fixed by the supply side. In what follows, I denote by $q_o = q_o^s$ the final quantity exchanged on this market.

The Producer.– In both periods, the instantaneous utility from consumption of the producer is described by the function $c \mapsto u(c)$ which is assumed to be strictly increasing and strictly concave in $c \in \mathbf{R}_+$. Period-1 consumption is constrained by the value of initial endowments of consumption good $y_1 \in \mathbf{R}$ and the amount of opium-denominated debt, thus yielding constraint (C1) below. When $y_1 \geq 0$, it is understood that the producer has some initial wealth. When $y_1 < 0$, the producer holds some debt that can only be repaid through borrowing[17] q_0. Period-2 consumption is constrained by the value of wheat production and the realized revenue from opium after debt has been repaid[18], yielding constraint (C2) below. Given that the producer is assumed to discount the future at rate $\frac{1}{1+r} \in (0,1)$, the producer's problem is given by

$$\max_{l,s,q_o,c_1,c_2 \geq 0} \quad u(c_1) - c(s) + \frac{1}{1+r}\mathrm{E}\Big[u(c_2) - (1-\iota)(1-\theta)D1_{\{q_o>0\}} - \iota N\Big] \tag{P}$$

$$\text{s.t.} \quad c_1 \leq \frac{P_2}{1+\rho(s,\gamma)} q_o + y_1 \tag{C1}$$

$$c_2 \leq (1-\iota)[f_w(1-l) + \theta P_2(f_o(l) - q_o)] + \iota[f_w(1-l) + (1-\tau)P_2(f_o(l) - q_o)] \tag{C2}$$

$$l \leq 1 \tag{R1}$$

$$q_o \leq f_o(l) \tag{R2}$$

$$s \leq 1 \tag{S}$$

where $D \geq 0$ is the punishment suffered by the producer in case of default on their

[17] If debt is too high, then (R2) will necessarily bind but the consumer will not be able to consume in period 1. Such overindebted producers would not receive further credit and, therefore, I assume that $y_1 \geq y_{\min} \equiv -\frac{(1-(1-\sigma))\overline{\gamma}}{1+r}P_2 f_o(1)$, which means that even when borrowing cost is the highest, the producer can always consume in period 1 if they allocate enough land to opium production and sell their future product in advance. It is also assumed that if $y_1 > 0$, it cannot be carried over to period 2.

[18] If $\iota = 1$, that is, if the insurgents take over power, (and thus $\theta = 1$), then the opium output is $f_o(l)$, of which a quantity q_o is delivered to the lender. The remaining value $P_2(f_o(l) - q_o)$ is taxed at rate τ by the insurgents so that the opium revenue is $(1-\tau)P_2(f_o(l) - q_o)$. If $\iota = 0$, then opium crops are illegal and their revenue is $\theta P_2(f_o(l) - q_o)$, where $\theta = 1$ with probability $1-\gamma$, described in Paragraph 1.1.1.

opium-denominated debt, N represents preferences for government control, and the expectation E is taken over the joint distribution of (ι,θ).

I denote by c_2^I the period 2 consumption when the territory is held by insurgents, by $\overline{c}_2^G$ the period 2 consumption when the territory is held by the government and eradication has not taken place ($\theta = 1$), and by $\underline{c}_2^G$ the corresponding consumption when eradication has taken place ($\theta = 0$). Details are given Appendix 1.5.2.

1.2 Solution

1.2.1 Initial Wealth and Debt

Result 1 *Regardless of law-enforcement or insurgent tax rate, a sufficiently wealthy opium producer will not sell any of their future opium output in advance. Symmetrically, a resource-poor producer will always sell all of their future output in advance. That is, there always exist $\overline{y}_1 \geq \underline{y}_1$ such that for any solution (l^*, s^*, q_o^*), one has*

$$y_1 > \overline{y}_1 \Longrightarrow q_o^* = 0 \qquad \textit{(Wealthy producer)}$$

$$y_1 < \underline{y}_1 \Longrightarrow q_o^* = f_o(l^*) \qquad \textit{(Resource-poor producer)}$$

This result is quite intuitive. Indeed, either the chosen level of debt q_o^* is 0, or it is strictly positive, in which case the marginal gain from holding even more debt must be non-negative (otherwise, one could increase the objective by reducing the level of debt). Now, an increase in q_o^* increases period 1 consumption by relaxing Constraint (C1) and reduces period 2 consumption by tightening Constraint (C2). If $q_o^* > 0$, and thus the marginal effect on U is to be nonnegative, then the period 1 marginal utility must not be too small compared to this of period 2, which, by concavity, imposes that c_1^* is not too large compared to c_2^*. If the producer's initial wealth is large enough, this condition will never be satisfied and they will prefer not to hold any debt. Symmetrically, if the debt constraint is not binding ($q_o^* < f_o(l^*)$), then holding more debt should not be profitable and the marginal effect on U of increasing q_o^* should be non-positive. This imposes that the marginal utility from period 1 is not too large compared to this of period 2, which, by concavity, imposes that c_1^* is large enough. Thus, if y_1 is low enough, this condition will never be satisfied and one must have[19] $q_o^* = f_o(l^*)$.

1 provides sufficient conditions on initial wealth y_1, independent of the policies γ and τ, to predict the producer's debt choice. However, depending on law enforcement and insurgent taxation, there might be producers, not matching any of the above two conditions, who will either decide not to hold any debt or to pre-sell all of their future opium output. For example, as insurgent taxation τ decreases, then lowering one's debt level becomes relatively more profitable, and some producers with wealth below $\overline{y}_1$ will decide not to hold any debt. Symmetrically, if law enforcement, and thus the cost of borrowing, is high enough, then some producers with wealth larger than $\underline{y}_1$ will decide to pre-sell all of their future opium output[20].

Result 2 *As insurgent taxation decreases, a greater share of producers will decide not to hold any debt. Symmetrically, as law enforcement increases, a greater share of producers will decide to sell all of their opium in advance. That is, there always exist functions* $\overline{y}_1(\tau) < \overline{y}_1$*, with* $\overline{y}_1'(\tau) > 0$*, and* $\underline{y}_1(\gamma) > \underline{y}_1$*, with* $\underline{y}_1'(\gamma) > 0$*, such that for any solution* (l^*, s^*, q_o^*) *corresponding to the policies* (γ, τ)*, one has*

$$y_1 > \overline{y}_1(\tau) \Longrightarrow q_o^* = 0$$

$$y_1 < \underline{y}_1(\gamma) \Longrightarrow q_o^* = f_o(l^*)$$

In what follows, I focus on the two categories presented in Result 1, keeping in mind Result 2, that is, that the policies (γ, τ) can either increase or decrease the share of the initial wealth distribution falling into either of these two cases.

[19]Note that this result is in accordance with empirical observations. [World Bank, 2004, p78]: *"The resource poor typically sell their entire crop prior to the harvest".*

[20]Consider the proof of Result 1 from Appendix 1.5.7. A sufficient condition for $q^* = 0$ is $y_1 > (u')^{-1}\big(u'\big(f_w(1) + P_2 f_o(1)\big)(1-\tau)\big)$. By concavity of u, this condition becomes easier to satisfy as τ becomes smaller. Similarly, as soon as $y_1 < f_w(1-\bar{l}) - \frac{P_2}{1+\rho(s,\gamma)} q_o^*$, one must have $q_o^* = f_o(l^*)$. Holding other factors fixed, this condition becomes easier to satisfy as law enforcement γ, and this the cost of borrowing $\rho(s,\gamma)$, increases.

1.2.2 Support for Insurgents

In the perspective of Problem (P), insurgent support s is interpreted as a determinant of the probability $\sigma(s)$ that the insurgents take control over the territory. This probability, in turn, acts on the producer's utility through three channels (in addition to the cost $c(s)$).

1. **Credit Channel.** First, if and only if there is a risk of anti-narcotics law-enforcement, increasing insurgent support reduces this risk. On the advance sale market, this means that as insurgent support grows it becomes less risky to lend capital to the opium producer, and thus the borrowing cost decreases accordingly. This decrease, in turn, relaxes constraint (C1) and allows resource-poor producers to consume more in period 1.

2. **Institutional Channel.** Secondly, by increasing the probability that the insurgents take control over the territory, insurgent support shifts distribution of the 'institution' (law enforcement versus taxation) in period 2. The producer becomes less likely to be subject to eradication and more likely to have to pay taxes. This is essentially a trade off between consumption utility under insurgent control and consumption utility under government control. It depends on the government and the insurgents' policy choices.

3. **Preference Channel.** Thirdly, as insurgent takeover becomes more likely, the producer becomes exposed to the 'political preference cost' if they are favorable to the government. Moreover, if they hold debt and if there is law enforcement, insurgent support reduces the risk of incurring the cost of default.

These three channels can be tracked through the producer's optimality condition for the choice of insurgent support s, as in Equation (FOC s) below.

$$\frac{\sigma'(s)}{1+r}\left(\underbrace{\gamma P_2 q_o u'(c_1)}_{\text{Channel 1}} + \underbrace{\left[\mathrm{E}[u(c_2)|\iota=1] - \mathrm{E}[u(c_2)|\iota=0]\right]}_{\text{Channel 2}} - \underbrace{(N - \gamma D 1_{\{q_o>0\}})}_{\text{Channel 3}}\right) = c'(s) \quad \text{(FOC } s\text{)}$$

From the above reasoning and Equation (FOC s), it is clear that the gain from insurgent support is closely tied to 1) the law enforcement and insurgent taxation policies and 2) the producer's initial wealth.

For example, if $\gamma = 0$, then there is no risk of eradication or default, and borrowing cost is at its lowest level[21]. In this case, insurgent control brings no period 1 consumption gain to the opium producer (channel 1 is blocked), and it can only hurt their business in period 2 (channel 2 hurts the producer[22]). Moreover, if there is no law enforcement, then the producer never defaults on their debt. Then, the only reason to support the insurgents is the political preference N. But even if the producer favors insurgent control, without law enforcement, a sufficiently wealthy producer may still prefer to support the government to avoid paying taxes on the opium production they sell in period 2. This is the topic of Result 3 below.

Result 3 *Without anti-narcotics law enforcement, there can be no support for the insurgents, unless the producer favors insurgent control strongly enough. That is, if $\gamma = 0$, then $s^* > 0$ implies*

$$0 \geq u(c_2^I) - u(\bar{c}_2^G) \geq N. \tag{1.8}$$

Using equations (1.14) and (1.15) from Appendix 1.5.2, one notices that, once land allocation l is fixed, the difference $u(c_2^I) - u(\bar{c}_2^G)$ is either 0, if all the future opium output is sold on the advance sale market, or it is strictly negative and depends on the opium tax rate τ imposed by the insurgents. Result 3 thus says that, in the absence of anti-narcotics law enforcement, there can be no support for the insurgents unless the producer favors insurgent control strongly enough to outweigh the burden of insurgent taxation.

Indeed, if the producer is wealthy enough not to pre-sell all of their future opium output, $q_o < f_o(l)$, then as soon as $\tau > 0$ insurgent support requires that[23] that $N < 0$, that is, if the opium producer is neutral or in favor of the government, then they will never support the insurgents in the absence of law enforcement .

Even in an environment where the producer favors insurgent control, a producer who has

[21] See the discussion of Equation (1.7), and Equation (1.12) from Appendix 1.5.2.

[22] For details, see Proposition 2 from Appendix 1.5.2.

[23] By equations (1.14) and (1.15), as soon as $\tau > 0$ and $q_o < f_o(l)$, one has $c_2^I < \bar{c}_2^G$, which implies $u(c_2^I) - u(\bar{c}_2^G) < 0$ by monotonicity of u.

not sold all of their future opium output in advance might still choose not to support the insurgents because the tax rate they impose is simply too large[24].

These remarks are important because they show that, by limiting law enforcement (especially when the insurgents extract resources from the opium producers through taxation), the government can always insure itself at least some popular support. By those who are not intrinsically against it, first, but also by pro-insurgents who suffer economically from taxation. As will be seen below, increasing law enforcement in this model can only curb that popular support as we are considering a population, the opium producers, who heavily depend on opium production[25].

By contrast, when there is law enforcement, even if the producer is in favor of the government, supporting the insurgents can become optimal as soon as the eradication risk is larger than the tax rate imposed by the insurgents, or when the cost of default is large enough, as stated in the next result.

Result 4 *A sufficient condition for insurgent support ($s^* > 0$) is*

$$(\gamma - \tau)\big(u(\overline{c}_2^G) - u(\underline{c}_2^G)\big) > N - \gamma D 1_{\{q_o > 0\}}, \tag{1.9}$$

Moreover, if the government invests resources in law enforcement and the producer holds some debt ($\gamma q_o > 0$), or if insurgents impose some taxation ($\tau > 0$), then the inequality above can be weakened.

To see this, consider the three channels discussed above. When the probability of an insurgent takeover increases, the net gain to the producer arising from channel 2 is simply the difference in consumption utilities $\mathrm{E}[u(c_2)|\iota = 1] - \mathrm{E}[u(c_2)|\iota = 0]$. As shown in the proof of Proposition 2, by risk aversion, this difference is always at least as large as the left-hand term of Equation (1.9). Naturally, the net cost arising from channel 3 is the corresponding right-hand term. Since channel 1 above can never hurt the producer and

[24] That is, one would have $0 > N > u(c_2^I) - u(\overline{c}_2^G)$.

[25] See, for example, Section 3.1 from Chapter 3 of this work for a discussion. In the years 2008-2010, at least 1.5 million people were growing opium each year, and producers consistently reported poverty as a leading reason to grow opium. The share of the Afghan population depending directly or indirectly on opium for sustenance is thus significant.

will strictly benefit them when they hold debt and there is some law enforcement[26], the condition of Equation (1.9) is sufficient to ensure at least some insurgent support.

Result 4 illustrates the fact that enforcing the law opens up new channels through which insurgent support can improve the producer's utility. Indeed, as soon as there is law enforcement, the producer faces the risk of having their opium production destroyed. If they hold debt, and since debt is opium-denominated, this would necessarily lead to default which imposes a disutility D. If the the eradication risk is larger than the taxation rate ($\gamma > \tau$), then a sufficient condition to have some insurgent support is $\gamma D \geq N$, which simply states that the expected cost of default must be larger than the preference for government control. This condition is always satisfied if[27] $N \leq 0$. Thus, in any region where the government is not particularly popular, a relatively high rate of law enforcement will lead to insurgent support.

Moreover, even if the eradication risk is low ($\gamma < \tau$), a resource-poor producer would still find it optimal to support the insurgents under the *same* condition as above. This is because by Result 1 resource-poor producers sell all of their future opium output in advance, which means that taxation does not impact their period-2 consumption[28], and therefore does not alter their incentives (channel 2 is blocked). But law-enforcement still puts them at risk of suffering the default cost D. Thus, the adverse effect of anti-narcotics law enforcement on insurgent support might be more acute in resource-poor areas, independently of the tax rate imposed by the insurgents. I summarize the above two remarks in the following result.

Result 5 *In any region where the government is not particularly popular ($N \leq \gamma D$), a relatively high rate of law enforcement ($\gamma > \tau$) will lead to insurgent support. Moreover, even if law enforcement is weak, resource-poor producers will still support the insurgents for fear of defaulting on their debt.*

[26] Without law enforcement, insurgent support has no effect on the borrowing cost, so that channel 1 is blocked.

[27] However, if $D = 0$, $q_o = f_o(l)$, $\gamma = 0$ and $\tau = 0$, then the above condition must be strengthened to $N < 0$.

[28] To see that, use equations (1.14) and (1.15) and note that when borrowing is maximal ($q_o = f_o(l)$) one has $\bar{c}_2^G = \underline{c}_2^G$. Thus Equation (1.9) simply becomes $\gamma D \geq N$.

A third point of interest regarding Result 4 is that the inequality in Equation (1.9) can be weakened as soon as $\gamma q_o > 0$. For example, even if $\gamma = \tau > 0$ and $D = 0$, so that there is no default cost, any neutral or insurgent-liking ($N \leq 0$) opium producer who holds some debt will still find it optimal to support the insurgents. The reason is that supporting insurgents if (and only if) there is law enforcement always reduces the borrowing cost $\rho(s, \gamma)$, which increases period 1 utility (channel 1). Without law-enforcement ($\gamma = 0$), this channel would be blocked.

1.2.3 Land Allocation

As discussed above, the land allocation decision l takes place in period 1 while production is realized in period 2, after the state (ι, θ) is realized. But when law enforcement policy γ and insurgent support s are fixed, the uncertainty relating both to institutions (law enforcement or taxation) and to production (eradication risk) is known. Thus, upon deciding on land allocation, the producer can equalize the expected marginal gain of increasing l with the corresponding expected marginal cost[29]. Now, while the cost of increasing l is always to reduce the production of wheat, and thus period 2 consumption, the gain is more subtle and will depend on initial wealth.

Consider a wealthy producer, for example. By Result 1, they will not take on any opium-denominated debt. Instead, they will sell all of their opium production to fund their period 2 consumption. Consequently, a variation in the land allocated to opium will not affect period 1 consumption at all, but will only induce a period 2 trade off. Increasing l will increase opium production (if only if eradication does not take place) and the marginal gain of this increase will vary depending on the insurgents' tax policy[30], which determines the share of the additional opium supply that can be consumed in period 2 if the insurgents are in power.

On the other hand, if the producer is resource-poor, they will sell all of their future opium output in advance. Then, increasing l does not bring any consumption gain in period

[29] That the solution is always interior for land allocation, $l \in (0, 1)$, is shown in Proposition 5 from Appendix 1.5.7.

[30] Since wheat is not taxed, this policy does not enter the marginal cost of increasing l.

2. However, it does relax the borrowing constraint (R2). If there is consumption gain to be made from extra debt, this will increase the producer's utility by allowing them to consume more in period 1. Thus, when the producer is resource-poor, the choice of l induces an inter-temporal trade-off.

The above reasoning shows that the dynamics at play are different for wealthy and resource-poor producers. This will not only play a role in land allocation, but also in the comparative statics when we look at the effects of exogenous changes in the policies (γ, τ). In what follows, I study each of these cases separately.

Wealthy Producer: Constraint (R2) is slack

Consider a wealthy producer $y_1 > \overline{y}_1$. By Result 1, at any solution (l^*, s^*, q_o^*) of Problem (P'), this producer will not take on any debt: $q_o^* = 0$. Then, the first-order optimality condition associated with l is $\frac{\partial U}{\partial l}(l^*, s^*, 0) = 0$. Using Equation (1.31) from Appendix 1.5.5, this is equivalent to

$$(1-\sigma(s^*))(1-\gamma)\underbrace{P_2 f_o'(l^*)}_{\substack{\text{Increase}\\ \text{in period 2}\\ \text{consumption}\\ \iota=0,\theta=1}} u'(\overline{c}_2^{G*}) + \sigma(s^*)\underbrace{(1-\tau)P_2 f_o'(l^*)}_{\substack{\text{Increase}\\ \text{in period 2}\\ \text{consumption}\\ \iota=1,\theta=1}} u'(c_2^{I*}) = \underbrace{f_w'(1-l^*)}_{\substack{\text{Decrease}\\ \text{in period 2}\\ \text{consumption}}} \mathrm{E}[u'(c_2^*)] \tag{FOC-W l}$$

which shows that the producer equalizes the expected marginal gain from an increase in l with the corresponding expected marginal cost. As discussed above, the expected marginal cost of increasing l arises from the decrease of period 2 consumption due to the reduction in wheat supply (see Equation (C2′)). Symmetrically, the marginal gain of increasing l arises from the increase period 2 consumption when eradication does not take place ($\theta = 1$). When the insurgents are in control, this gain depends on their tax policy τ. This is the intra-temporal trade off mentioned above.

Without law enforcement (or insurgent taxation[31]), Condition (FOC-W l) simplifies to an

[31] With insurgent taxation, the effect discussed here is more subtle and depends on risk aversion. To see this, note that when insurgent taxation τ increases, the only term of the net marginal gain of increasing l that changes is $\sigma(s^*)(1-\tau)P_2 f_o(l^*)u'(c_2^{I*}) - f_w'(1-l^*)\sigma(s^*)u'(c_2^{I*})$. If the producer is sufficiently risk-averse, the first term will increase with an increase in τ. Since the second term always increases with τ, at first sight, the effect is ambiguous. This is addressed in the comparative statics section of the appendix (see Paragraph 1.5.4).

equalization of the value of the marginal product of opium with this of wheat[32]. Roughly speaking, the producer maximizes utility by maximizing the profits from the production process. It behaves like a firm.

With law enforcement, period-2 consumption necessarily decreases, which increases the corresponding expected marginal utility. This raises the marginal cost of increasing l, that is, the right-hand term of Condition (FOC-W l). On the other hand, law enforcement reduces the returns to opium by making it more likely that the production is destroyed. This reduces the marginal gain of increasing l, that is, the left-hand term of Equation (FOC-W l).

Therefore, to maintain the first-order condition above with law-enforcement, one must increase the returns to opium by reducing the amount of land allocated to this crop. This yields the following result.

Result 6 *A wealthy producer will always allocate their land such that the gross value of the marginal product of opium is strictly larger than this of wheat. That is, for any solution* (l^*, s^*, q_o^*) *to Problem (P') with* $y_1 > \overline{y}_1$*, one has*

$$P_2 f_o'(l^*) > f_w'(1 - l^*).$$

Moreover, as soon as $\gamma > \tau$*, the previous inequality can be strengthened to*

$$(1 - \Gamma(s, \gamma) - \tau\sigma(s^*))P_2 f_o'(l^*) > f_w'(1 - l^*),$$

which means that the net value of the marginal product of opium is strictly larger than this of wheat.

Result 6 will play an important role when studying the comparative statics of wealthy producers.

[32]That is, if $\gamma = \tau = 0$, then the condition above reduces to $P_2 f_o'(l^*) = f_w'(1 - l^*)$. The solution to that equation is denoted by $\bar{l}$ in the proof of Proposition 8. See Appendix 1.5.7.

Resource-Poor Producer: Constraint (R2) is binding

I now turn to the resource-poor producer : $y_1 < \underline{y}_1$. By Result 1, at any solution (l^*, s^*, q_o^*) of Problem (P'), this producer will sell all of their future opium output in advance: $q_o^* = f_o(l^*) > 0$. This implies that there is no uncertainty regarding period-2 consumption[33]: $c_2^* = f_w(1 - l^*)$. Then, the first-order optimality condition associated with l is $\frac{\partial U}{\partial l}(l^*, s^*, f_o(l^*)) + \lambda f_o'(l^*) = 0$, where $\lambda > 0$ is the Lagrange multiplier associated with Constraint (R2). As discussed above, the additional term $\lambda f_o'(l^*)$ arises because the producer hits the debt constraint while it would be strictly profitable to hold more debt[34]. Since increasing l relaxes this constraint, it will necessarily benefit the producer. Combining equations (1.34) and (FOC q_o) from the appendix, the optimality condition can be rewritten

$$\underbrace{\frac{1}{1+\rho(s,\gamma)} P_2 f_o'(l^*)\, u'(c_1^*)}_{\substack{\text{Increase in period 1} \\ \text{consumption due to} \\ \text{a "relaxation" of (R2)}}} = \frac{1}{1+r} \underbrace{f_w'(1-l^*)\, u'(c_2^*)}_{\substack{\text{Decrease in} \\ \text{period 2} \\ \text{consumption}}} \qquad \text{(FOC-RP } l\text{)}$$

which again shows that the producer equalizes the marginal gain from an increase in l with the corresponding marginal cost. Here, the marginal cost is the same as before, it is a decrease in period 2 consumption due to the reduction in wheat production[35]. However, since the producer's wealth is low enough to ensure that Constraint (R2) will still bind even following a small increase in l, increasing l never increases period 2 consumption. Instead, it will increase utility by relaxing the debt constraint and allowing the producer to consume more in period 1. This is what yields the inter-temporal trade-off discussed above[36]. Here, the producer behaves like a consumer seeking to smooth consumption over

[33] see Proposition 1 from Appendix 1.5.2.

[34] For details, notably of the fact that $\lambda > 0$, see the proof of Result 1 in Appendix 1.5.7.

[35] Note that the right-hand side of Equation (FOC-RP l) is similar to the right-hand side of Equation (FOC-W l).

[36] From Equation (FOC-RP l) one can already anticipate that the effect of an exogenous change in law enforcement will yield different results for the resource-poor producer than for the wealthy one. Indeed, here, law enforcement only affects the left-hand term of Equation (FOC-RP l), which concerns period 1. In Equation (FOC-W l), law enforcement only affected period 2 dynamics.

time, as can be seen by rearranging Condition (FOC-RP l) (and using Equation (1.7))

$$\frac{(1-\Gamma(s,\gamma))P_2 f_o'(l^*)}{f_w'(1-l^*)} = \frac{u'(c_2^*)}{u'(c_1^*)}$$

which says that the ratio of marginal returns between opium and wheat must equal the ratio of marginal utilities between period 2 and 1. This is the same equation obtained by [Andersson, 2013, Eq (17)].

Note that, when the producer is resource-poor, the law enforcement and insurgent tax policies do not influence period 2 consumption at all. The insurgent tax rate τ does not appear in optimality condition (FOC-RP l). Moreover, the law enforcement policy γ only appears as a determinant of the borrowing cost $\rho(s,\gamma)$. This is due to the fact that, for a resource-poor producer, the risk of eradication does not change the industrial returns to land allocation. This remark will be key to understand the comparative statics at play in Section 1.3.

1.3 Comparative Statics

How does a change in anti-narcotics law enforcement impact opium supply and insurgent support? This question is central to the understanding of state-building dynamics in countries like Afghanistan, where insurgent support directly influences production risk. Theoretically, the model presented in this paper documents this question by allowing us to track the effect of an exogenous increase in law enforcement γ on the opium producers' decision to supply opium on the one hand, and to support insurgents on the other. Because results are easier to interpret when insurgent taxation is relatively low, I focus on the following case.

Assumption: $\gamma > \tau$

In the same spirit as the results presented in the previous section, the dynamics at play here will depend on initial wealth, which determines a producer's dependence on credit.

Wealthy Producers

By Result 1, a wealthy producer will decide not to hold any opium-denominated debt. Consequently, their optimal land allocation will give rise to an intra-temporal period-2 trade-off. It is determined by Equation (FOC-W l). In that case, the main effect of law enforcement is to make the illegal good less appealing as a source of income for period 2 consumption, which induces substitution towards the legal crop. Law enforcement has no effect on period 1 land allocation dynamics because without debt the only source of period 1 consumption is the producer's initial wealth, which is unaffected by law enforcement. However, and that is one of the upshots of the model presented here, one must remain mindful of equilibrium effects, particularly when the risk of law enforcement is larger than the insurgent tax rate, as assumed in this section. Indeed, an exogenous increase in law enforcement raises insurgent support which, when $\gamma > \tau$, makes opium production relatively more profitable. That is, an is a complementarity between opium investment and insurgent support. Symbolically, this is given by Equation (1.37) from Appendix 1.5.6

$$\gamma > \tau \quad \Longrightarrow \quad \frac{\partial^2 U}{\partial l \partial s} > 0 \tag{1.37}$$

This channel partially cancels the previous substitution effect. This is the topic of Result 7 below.

Result 7 *For wealthy producers, an exogenous increase in law enforcement will have two opposing effects on opium supply. On the one hand, by making opium less profitable, it will reduce opium supply (direct effect). On the other hand, by increasing insurgent support it will make it more profitable to invest in opium production, which partially cancels the previous effect (indirect effect).*

The direct effect is immediate. To see this, consider Equation (FOC-W l). An exogenous increase in γ raises the marginal cost of investing land in opium production through the term $f_w'(1 - l^*)\mathrm{E}[u'(c_2^*)]$, which is increasing[37] in γ. Simultaneously, it decreases the

[37] This is because γ determines the probability of the event $\{\theta = 1\}$ under government control. Since,

corresponding marginal gain through the term $(1-\sigma(s))(1-\gamma)P_2 f_o'(l)u(\overline{c}_2^G)$. Keeping other factors fixed, this reduces the net marginal gain from investing in opium production, which causes a direct substitution effect in favor of the legal crop.

However, at any interior solution for s, an increase in law enforcement has a direct positive effect on insurgent support, which itself changes the marginal gain of investing land in opium production by $\sigma'(s^*)(1-\tau)P_2 f_o'(l^*)u'(c_2^{I*}) - (1-\gamma)P_2 f_o'(l^*)u'(\overline{c}_2^{G*})$, which can be shown to be strictly positive when $\gamma > \tau$. Moreover, by Proposition 3, the corresponding marginal cost decreases[38]. Therefore, around equilibrium, the net marginal gain of increasing l increases with s (this is Equation (1.37) above). This complementarity implies that the amount of land allocated to opium production will marginally increase as a result of the equilibrium effect following an increase in law enforcement. Interestingly, this mechanism works both ways, as shown in the following result.

Result 8 *For wealthy producers, an exogenous increase in law enforcement will have two opposing effects on insurgent support. On the one hand, by reducing utility under government control, it will increase insurgent support (direct effect). On the other hand, by reducing opium supply, it will make it less profitable to support the insurgents, which partially cancels the previous effect (indirect effect).*

The direct effect is immediate[39] . For a wealthy producer, the net marginal gain of insurgent support essentially trades off consumption utility under insurgent control with utility under insurgent control. This is Channel 2 of insurgent support (see Equation (FOC s) from Subsection 1.2.2). When law enforcement increases, the consumption utility under government control decreases, which makes insurgent support more profitable. Result 8 further shows that the equilibrium effect discussed in Result 7 also acts when considering the comparative statics of insurgent support. If law enforcement increases, then the direct substitution effect which reduces the amount of land allocated to opium

in that case, consumption is the lowest (see Proposition 1 from Appendix 1.5.2), marginal utility is the highest. Thus, an increase in γ must increase expected marginal utility.

[38] The change in marginal cost is $f_w'(1-l^*)\frac{\sigma'(s^*)}{1+r}\left(\mathrm{E}[u'(c_2^*)|\iota=1] - \mathrm{E}[u'(c_2^*)|\iota=0]\right)$. By Proposition 3 this is strictly negative when $\gamma > \tau$.

[39] Observe that the mechanism presented here is different than the one presented in Result 10 below. This is because when the producer is wealthy, they do not take on debt, so that Channel 1 of insurgent support is blocked. Here, the mechanism operates through Channel 2. See also Footnote 40.

production would reduce the net marginal gain of supporting the insurgents. Therefore, the indirect effect discussed above, which makes anti-narcotics law enforcement less effective in terms of opium supply, also mitigates the increase in insurgent support following an increase in γ.

Resource-Poor Producers

By Result 1, resource-poor producers will always borrow as much as they can to finance their period 1 consumption. As a consequence, their optimal land allocation will give rise to an inter-temporal trade off, which is determined by Equation (FOC-RP l). In that case, the main effect of law enforcement is to change the unconditional probability of eradication, which changes the borrowing cost, and thus period 1 consumption. Law enforcement has no direct effect on period 2 land allocation dynamics since resource-poor producers sell all of their future opium output in advance.

Consequently, if the producer is sufficiently risk-averse, an exogenous increase in law enforcement will have an adverse effect on opium supply. This is because, by raising the unconditional probability of eradication, it will reduce period 1 consumption, which increases period 1 marginal utility and therefore draws resources towards opium production. This effect in documented in [Andersson, 2013, Prop. 1].

However, here again, one must remain mindful of equilibrium effects. Indeed, an exogenous increase in law enforcement raises insurgent support which decreases the unconditional probability of eradication. Therefore the mechanism described above works in the opposite direction. By decreasing the unconditional probability of eradication, the exogenous increase in law enforcement will increase period 1 consumption, which decreases period 1 marginal utility and therefore draws resources away from opium production. This is why we have the following result.

Result 9 *For resource-poor producers who are sufficiently risk-averse, an exogenous increase in law enforcement will have two opposing effects on opium supply. On the one hand, because of risk aversion, it will increase the amount of land l allocated to opium* *production. On the other hand, by increasing insurgent support, it will make it less profitable to invest in opium, which partially cancels the previous effect (indirect effect).*

To see this, consider Equation (FOC-RP l). As mentioned above, the right-hand term is unaffected by law enforcement. The left-hand term, by contrast, is only affected through the cost of borrowing $\rho(s,\gamma)$, that is, through the unconditional probability of eradication $\Gamma(s,\gamma)$ (see Equation (1.7)). The direct effect of an exogenous increase in γ is to increase $\Gamma(s,\gamma)$. Because of risk-aversion, this will cause an increase in opium supply to compensate for the loss of period-1 consumption.

The indirect effect is due to the increase in s, which decreases $\Gamma(s,\gamma)$. This, in turn, pushes land allocation in the opposite direction as the direct effect. The net effect of the two is ambiguous. It will depend on factors such as the importance of popular support δ for the outcome of conflict or the marginal cost c of insurgent support.

Note that Result 9 works both ways. If the producer is *not* too risk-averse, then the effects are reversed and the comparative statics of resource-poor producers for land allocation are similar to those of wealthy producers (see Result 11 from Appendix 1.5.4).

The impact of law enforcement on the unconditional probability of eradication plays a crucial role in analyzing insurgent support as well. Because of risk-aversion, as the unconditional risk of eradication rises, the marginal gain of investing land in opium production increases too, which raises the equilibrium level of land allocated to opium. But, by Equation (1.37), this change increases the benefits of insurgent support. Therefore, in the case of resource-poor producers who are sufficiently risk-averse, an exogenous increase in law enforcement increases insurgent support through two converging channels.

Result 10 *For resource-poor producers who are sufficiently risk-averse, an exogenous increase in law enforcement will have two reinforcing effects on insurgent support. On the one hand, by reducing utility under government control, it will increase insurgent support (direct effect). On the other hand, by making it more profitable to invest in opium, it will increase the marginal benefit of supporting the insurgents, which will reinforce the previous effect (indirect effect).*

The direct effect is immediate[40]. For a resource-poor producer, the net marginal gain of insurgent support originates in the decreased borrowing cost, which arises from the reduced unconditional probability of eradication. This is Channel 1 of insurgent support presented in Subsection 1.2.2 (see Equation (FOC s) from Subsection 1.2.2). Then, an exogenous increase in law enforcement increases the period 1 marginal benefit of an increase in s in two ways. First, it augments the marginal increase in consumption due to the increase in s. Secondly, it increases period 1 marginal utility by reducing period 1 consumption.

The indirect effect is due to the fact that an exogenous increase in law enforcement increases the marginal benefit of investing in opium (because of risk-aversion) which in turn increases the benefit of insurgent support and therefore s (left term of (1.29) in Appendix 1.5.4).

1.4 Conclusion

This article investigates the role of insurgency in the fight against drugs, particularly in Afghanistan. More precisely, it studies how the interconnection between insurgency and the narcotics trade can change opium producers' economic incentives and thus the outcome of anti-narcotics policies. Its main conclusions can be easily summarized.

First, to understand the Afghan opium industry, one must take into account the tension existing between the central government, who seeks to eradicate opium production, and the insurgents, who directly benefit from it through taxation. This tension is tied to two elements: 1) Military power, which is partially determined by popular support and 2) Opium eradication and taxation policies, which set the economic incentives of the opium producers, and therefore their willingness to provide support either side of the conflict.

Only through this lens can one understand Result 5, which states that, in any region where the government is not particularly popular, a relatively high rate of law enforce-

[40] Observe, however, that the mechanism presented here is different than the one presented in Result 8. This is because when the producer is resource-poor, period 2 consumption is constant (see Proposition 1), so that Channel 2 of insurgent support is blocked. Here, the mechanism operates through Channel 1. See also Footnote 39.

ment will lead to insurgent support. This is because counter-narcotics opium policies cannot be thought of as independent, they are in direct rivalry with what 'the other side' has to offer, which is a de facto legalization of opium crops. If opium producers are under economic pressure by the government, and if the territory is contested, they will support a takeover by the insurgents, even if they are not politically favorable to them.

Secondly, understanding the entanglement between the opium industry and the insurgency is decisive to analyzing the effect of a change in counter-narcotics law enforcement on opium supply. In that regard, Result 7 is important. It states that even if the basic logic of counter-narcotics law enforcement could work -at least with wealthy producers- in a context where there would be no conflict, it simply cannot function as well when production risk is tied to territorial control. Indeed, the fact that insurgent support impacts the balance of power and that insurgents can prevent counter-narcotics law enforcement induces a complementarity between opium investment and insurgent support. As a consequence, by raising insurgent support, counter-narcotics law enforcement could indirectly increase the return to opium production and, therefore, opium supply.

Thirdly, upon conducting counter-narcotics operations, authorities must remain mindful of unintended consequences, such as increased insurgent support. Take Result 10, for example. It states that for resource-poor producers who are sufficiently risk-averse, an exogenous increase in law enforcement will have two reinforcing effects on insurgent support. First, by reducing utility under government control, it will directly increase the support insurgents receive. Secondly, by making it more profitable to invest in opium (because of risk aversion), it will increase the marginal benefit of supporting the insurgents (due to the complementarity discussed above), which will further increase insurgent support.

Said differently, the model presented in this paper suggests that counter-narcotics and counter-insurgency are two competing objectives of state development in Afghanistan.

1.5 Appendix

1.5.1 Model

The Environment

Opium Eradication.– The unconditional probability of eradication $\Gamma(s,\gamma)$, defined by Equation (1.5), inherits the following properties from Assumption (1.3)

$$\begin{aligned} \Gamma(s,0)=0 \quad \text{and} \quad \Gamma(s,\gamma)\in(0,1) \quad \text{for all } s\geq 0 \text{ and } \gamma>0 \\ \Gamma_s(s,0)=0 \quad \text{and} \quad \Gamma_s(s,\gamma)<0 \quad \text{for all } s\geq 0 \text{ and } \gamma>0 \\ \Gamma_\gamma(s,\gamma)>0 \quad \text{for all } s,\gamma\geq 0 \\ \Gamma_{s,\gamma}(s,\gamma)<0 \quad \text{for all } s,\gamma\geq 0. \end{aligned} \tag{1.10}$$

Agricultural Production.– The functions f_o and f_w denote the production technology for opium and wheat respectively. The following is assumed

$$\begin{aligned} f_o(0)=f_w(0)=0 \quad \text{and} \quad f_o(l)>0, f_w(1-l)>0 \quad \text{for all } l\in(0,1) \\ f_o'(l), f_w'(1-l)>0 \quad \text{for all} \quad l\in(0,1) \\ f_o''(l), f_w''(1-l)<0 \quad \text{for all} \quad l\in(0,1) \\ \lim_{l\to 0} f_o'(l)=\lim_{l\to 1} f_w'(1-l)=+\infty \\ f_o'(1), f_w'(1)<+\infty \end{aligned} \tag{1.11}$$

1.5.2 Payoffs

The Lender

From Equation (1.10), one sees that the cost of borrowing $\rho(s,\gamma)$ inherits from the following properties

$$\begin{aligned}\rho_s(s,0) = 0 \quad \text{and} \quad \rho_s(s,\gamma) &= \frac{\Gamma_s(s,\gamma)}{(1-\Gamma(s,\gamma))^2}(1+r) < 0 \quad \text{for all } s \geq 0 \text{ and } \gamma > 0 \\ \rho_\gamma(s,\gamma) &= \frac{\Gamma_\gamma(s,\gamma)}{(1-\Gamma(s,\gamma))^2}(1+r) > 0 \quad \text{for all } s,\gamma \geq 0 \qquad (1.12) \\ \rho_{s,\gamma}(s,\gamma) &= -\frac{\sigma'(s)}{(1-\Gamma(s,\gamma))^4}(1+r) < 0 \quad \text{for all } s,\gamma \geq 0.\end{aligned}$$

The Producer

Preferences.— I assume that the instantaneous utility function u verifies the following conditions

$$\begin{aligned}u(0) &= 0 \\ u'(c) &> 0 \quad \text{for all} \quad c \geq 0 \\ u''(c) &< 0 \quad \text{for all} \quad c \geq 0 \qquad (1.13) \\ \lim_{c\to 0} u'(c) &= +\infty \quad \text{and} \quad \lim_{c\to+\infty} u'(c) = 0 \\ u'''(c) &\geq 0 \quad \text{for all} \quad c \geq 0\end{aligned}$$

Initial wealth.— To ensure that $c_1 \geq 0$, the initial level of wealth y_1 cannot be smaller than $y_{\min} \equiv -\frac{(1-(1-\sigma))\overline{\gamma}}{1+r} P_2 f_o(1)$, which means that even in the worse of cases (when law enforcement is maximal) the producer will always be able to consume in period 1 by allocating enough land to opium production and selling all of their future production in advance.

I denote by c_2^I the period 2 consumption when the territory is held by insurgents, by $\overline{c}_2^G$ the period 2 consumption when the territory is held by the government and eradication has not taken place ($\theta = 1$), and by $\underline{c}_2^G$ the corresponding consumption when eradication has taken place ($\theta = 0$). More explicitly

$$c_2^I \equiv f_w(1-l) + (1-\tau)P_2(f_o(l) - q_o) \tag{1.14}$$

$$\overline{c}_2^G \equiv f_w(1-l) + P_2(f_o(l) - q_o) \tag{1.15}$$

$$\underline{c}_2^G \equiv f_w(1-l) \tag{1.16}$$

From these definitions, the following result is immediate.

Proposition 1 *If all the future opium output is supplied on the advance sale market (that is, if constraint (*R2*) is binding), then the producer faces no uncertainty in their period* 2 *consumption*

$$\underline{c}_2^G = c_2^I = \overline{c}_2^G. \tag{1.17}$$

*Otherwise, as soon as $q_o < f_o(l)$ (that is, if constraint (*R2*) is slack), one has*

$$\begin{aligned} \underline{c}_2^G < c_2^I = \overline{c}_2^G \quad & \text{if } \tau = 0 \\ \underline{c}_2^G < c_2^I < \overline{c}_2^G \quad & \text{if } \tau \in (0,1) \end{aligned} \tag{1.18}$$

Naturally, period 2 consumption c_2 can be interpreted as a random variable with the distribution given in Table 1.1.

c	$\text{Prob}(c_2 = c)$	$\text{Prob}(c_2 = c \mid \iota = 1)$	$\text{Prob}(c_2 = c \mid \iota = 0)$
c_2^I	$\sigma(s)$	1	0
$\overline{c}_2^G$	$(1-\sigma(s))(1-\gamma)$	0	$1-\gamma$
$\underline{c}_2^G$	$(1-\sigma(s))\gamma$	0	γ

Table 1.1: Probability Distribution of Period 2 Consumption.

One has the following immediate result.

Proposition 2 *As soon as $\gamma > \tau$, one has*

$$\text{E}[u(c_2) \mid \iota = 0] \leq \text{E}[u(c_2) \mid \iota = 1], \tag{1.19}$$

where the inequality is strict as soon as $q_o < f_o(l)$.

Result 2 is intuitive. As soon as the risk of law enforcement is larger than taxation, a

Moreover, since $u''' > 0$ by Assumption (1.13), on has the following result.

Proposition 3 *As soon as* $\gamma > \tau$, *one has*

$$\mathrm{E}[u'(c_2)|\iota = 0] > \mathrm{E}[u'(c_2)|\iota = 1],$$

which directly implies

$$\mathrm{E}[u'(c_2)] > \mathrm{E}[u'(c_2)|\iota = 1].$$

1.5.3 Solution to the Producer Problem

Proposition 4 *The feasibility set has a non-empty interior, it is closed and bounded. Consequently, by the extreme value theorem*[41]*, Problem (P) has at least one solution.*

Proposition 5 *Problem (P) is equivalent to*

$$\begin{aligned}
\max_{s, q_o \geq 0,\, l \in \mathbf{R}} \quad & u\Big(\frac{P_2}{1+\rho(s,\gamma)} q_o + y_1\Big) - c(s) && \text{(P')} \\
& + \frac{1}{1+r}\Big[(1-\sigma(s))\Big(\gamma[u\big(f_w(1-l)\big) - D1_{\{q_o>0\}}] \\
& \qquad + (1-\gamma)u\big(f_w(1-l) + P_2(f_o(l) - q_o)\big)\Big) \\
& \quad + \sigma(s)\Big(u\big(f_w(1-l) + (1-\tau)P_2(f_o(l) - q_o)\big) - N\Big)\Big] \\
s.t. \quad & q_o \leq f_o(l) && \text{(R2)} \\
& s \leq 1. && \text{(S)}
\end{aligned}$$

Proposition 6 *If the producer is sufficiently risk-averse, the objective from Problem (P') is concave.*

From now on, I suppose that the producer is sufficiently risk-averse to ensure that the conclusion from Proposition 6 holds.

[41] See, for example, Theorem 3.1.3 from [Sydsaeter et al., 2008, p106].

Proposition 7 *Let (l^*, s^*, q_o^*) be admissible for Problem (P'). Then the Kuhn-Tucker conditions are both necessary and sufficient for (l^*, s^*, q_o^*) to be a solution to Problem (P').*

Let $U(l, s, q_o)$ designate the objective function of Problem (P'). By the Kuhn-Tucker conditions, for any solution (l^*, s^*, q_o^*), there exist numbers λ and μ with

$$\frac{\partial U}{\partial l}(l^*, s^*, q_o^*) + \lambda f_o'(l^*) = 0 \tag{FOC l}$$

$$\frac{\partial U}{\partial s}(l^*, s^*, q_o^*) - \mu \leq 0 \quad (= 0 \text{ if } s^* > 0) \tag{FOC s}$$

$$\frac{\partial U}{\partial q_o}(l^*, s^*, q_o^*) - \lambda \leq 0 \quad (= 0 \text{ if } q_o^* > 0) \tag{FOC q_o}$$

$$\lambda \geq 0 \qquad \text{with } \lambda = 0 \text{ if } q_o^* < f_o(l^*) \tag{CS λ}$$

$$\mu \geq 0 \qquad \text{with } \mu = 0 \text{ if } s^* < 1 \tag{CS μ}$$

where the corresponding expressions for the partial derivatives of U are given in equations (1.31)-(1.33) from Appendix 1.5.2.

Proposition 8 *There exists an $\bar{l} \in (0, 1)$ such that for all solution (l^*, s^*, q_o^*) to Problem (P') such that* (R2) *is slack, one has $l^* \leq \bar{l}$.*

Below, I give a general characterization of the solutions to Problem (P').

1.5.4 Comparative Statics

In this subsection, I establish the comparative statics corresponding to a variation in the exogenous policies (γ, τ). For simplicity, I assume that one starts with $\gamma > 0$ and that the solution (l^*, s^*, q_o^*) to Problem (P') is such that $s^* \in (0, 1)$. Then, optimality condition (FOC s) becomes

$$\frac{\partial U}{\partial s}(l^*, s^*, q_o^*) = 0. \tag{FOC s}$$

As in Section 1.2, I focus on the following two cases:

1. Wealthy producer: $y_1 > \overline{y}_1$. In this case, by Result 1, $q_o^* = 0$ and optimal land allocation is given by
$$\frac{\partial U}{\partial l}(l^*, s^*, 0) = 0. \qquad \text{(FOC } l\text{)}$$

2. Resource-poor producer: $y_1 < \underline{y}_1$. In this case, by Result 1, $q_o^* = f_o(l^*)$ and optimal land allocation is given by
$$\frac{\partial U}{\partial l}(l^*, s^*, f_o(l^*)) + \frac{\partial U}{\partial q_o}(l^*, s^*, f_o(l^*))f_o'(l^*) = 0. \qquad \text{(FOC } l\text{)}$$

Let $\mathbf{x} \equiv (l, s)$. I define the following two mappings.

$$\bar{\mathbf{f}} \colon \mathbf{R}_+^{1+2} \to \mathbf{R}^2$$
$$(\gamma, \mathbf{x}) \mapsto \bar{\mathbf{f}}(\gamma, \mathbf{x}) \equiv \begin{bmatrix} \frac{\partial U}{\partial l}(l, s, 0) \\ \frac{\partial U}{\partial s}(l, s, 0) \end{bmatrix}$$
$$\underline{\mathbf{f}} \colon \mathbf{R}_+^{1+2} \to \mathbf{R}^2$$
$$(\gamma, \mathbf{x}) \mapsto \underline{\mathbf{f}}(\gamma, \mathbf{x}) \equiv \begin{bmatrix} \frac{\partial U}{\partial l}(l, s, f_o(l)) + \frac{\partial U}{\partial q_o}(l, s, f_o(l))f_o'(l) \\ \frac{\partial U}{\partial s}(l, s, 0) \end{bmatrix}$$

By propositions 4 and 7, for all $\gamma \geq 0$, there always exists at least one solution to Problem (P') and this solution verifies the Kuhn-Tucker conditions (FOC l)-(CS μ). Consequently, for all $\gamma \geq 0$, for Case 1 above, there exists some $\overline{\mathbf{x}}^* = (\overline{l}^*, \overline{s}^*)$ such that $\bar{\mathbf{f}}(\gamma, \overline{\mathbf{x}}^*) = 0$. Similarly, for Case 2, there exists some $\underline{\mathbf{x}}^* = (\underline{l}^*, \underline{s}^*)$ such that $\underline{\mathbf{f}}(\gamma, \underline{\mathbf{x}}^*) = 0$.

Secondly, by the proof of Proposition 7, for all y_1, the corresponding Lagrangian $\mathcal{L}$ of Problem (P') is strictly concave. Therefore, $\det\left(\frac{\partial \bar{\mathbf{f}}}{\partial \mathbf{x}}(\mathbf{x}, \gamma)\right) = \det\left(\mathbf{H}_{\mathcal{L}|y=y_1}(\mathbf{x}, \gamma)\right) > 0$ and $\det\left(\frac{\partial \underline{\mathbf{f}}}{\partial \mathbf{x}}(\mathbf{x}, \gamma)\right) = \det\left(\mathbf{H}_{\mathcal{L}|y=y_1}(\mathbf{x}, \gamma)\right) > 0$ for all feasible $\mathbf{x}$, where $\mathbf{H}_{\mathcal{L}}$ denotes the Hessian matrix of function $\mathcal{L}$.

Therefore, one can apply the implicit function theorem (see, for example, Theorem 2.7.2 from [Sydsaeter et al., 2008, p84]) to both $\bar{\mathbf{f}}$ and $\underline{\mathbf{f}}$ around $(\gamma, \overline{\mathbf{x}}^*)$ and $(\gamma, \underline{\mathbf{x}}^*)$ respectively.

Case 1: Wealthy Producers

By the implicit function theorem, there exist open balls B_1 in $\mathbf{R}$ and B_2 in $\mathbf{R}^2$ around γ and $\overline{\mathbf{x}}^*$, respectively, such that for each $\gamma \in B_1$, there is a unique $\overline{\mathbf{x}}(\gamma)$ in B_2 with $\bar{\mathbf{f}}(\gamma, \overline{\mathbf{x}}(\gamma)) = 0$. Moreover, the implicit function $\overline{\mathbf{x}}(\gamma)$ verifies

$$\begin{aligned}
\overline{\mathbf{x}}'(\gamma) \equiv \begin{pmatrix} l'(\gamma) \\ s'(\gamma) \end{pmatrix} &= -\left[\frac{\partial \bar{\mathbf{f}}}{\partial \mathbf{x}}(\gamma, \overline{\mathbf{x}}(\gamma))\right]^{-1} \times \left[\frac{\partial \bar{\mathbf{f}}}{\partial \gamma}(\gamma, \overline{\mathbf{x}}(\gamma))\right] \\
&= -\frac{1}{\det(\mathbf{H}_U)} \begin{pmatrix} \frac{\partial^2 U}{\partial s^2} & -\frac{\partial^2 U}{\partial l \partial s} \\ -\frac{\partial^2 U}{\partial l \partial s} & \frac{\partial^2 U}{\partial l^2} \end{pmatrix} \begin{pmatrix} \frac{\partial^2 U}{\partial l \partial \gamma} \\ \frac{\partial^2 U}{\partial s \partial \gamma} \end{pmatrix} \\
&= \frac{1}{\det(\mathbf{H}_U)} \begin{pmatrix} \frac{\partial^2 U}{\partial s \partial \gamma} \frac{\partial^2 U}{\partial l \partial s} - \frac{\partial^2 U}{\partial l \partial \gamma} \frac{\partial^2 U}{\partial s^2} \\ \frac{\partial^2 U}{\partial l \partial \gamma} \frac{\partial^2 U}{\partial l \partial s} - \frac{\partial^2 U}{\partial s \partial \gamma} \frac{\partial^2 U}{\partial l^2} \end{pmatrix}
\end{aligned}$$

where all the utility terms are evaluated at $(\overline{\mathbf{x}}(\gamma), 0) = (l(\gamma), s(\gamma), 0)$ with the parameter γ. Given that $\det(\mathbf{H}_U) > 0$ by the proof of Proposition 6, I focus on the entries of the right-hand matrix to study the sign of $\overline{\mathbf{x}}'(\gamma)$.

Case 1.1: Sign of $l'(\gamma)$ for wealthy producers

Using Equation (1.37) from Appendix 1.5.6, one has

$$\gamma > \tau \quad \Longrightarrow \quad \frac{\partial^2 U}{\partial l \partial s} > 0 \tag{1.37}$$

This is because, when $\gamma > \tau$, an increase in insurgent support s has two effects on $\partial U / \partial l$. First, it decreases the marginal cost $f_w'(1-l)\mathrm{E}[u'(c_2)]$ since, by see Proposition 3, $\mathrm{E}[u'(c_2)]$ is decreasing with s when $\gamma > \tau$. Secondly, it increases the marginal benefit of increasing l because $u'(c_2^I) > u'(\bar{c}_2^G)$ and $(1 - \tau) \geq (1 - \gamma)$. Therefore, the net marginal benefit of increasing l increases with s.

Using Equation (1.39) from Appendix 1.5.6, one has

$$\frac{\partial^2 U}{\partial l \partial \gamma} < 0 \tag{1.39}$$

This is because an exogenous increase in law enforcement increases the marginal cost of investing in l by raising $f'_w(1-l)\mathrm{E}[u'(c_2)]$, but reduces the corresponding gain $P_2 f'_o(l)(1-\sigma(s))(1-\gamma)u'(\overline{c}_2^G)$ since it increases the probability that the opium production is lost.

Using Equation (1.40) from Appendix 1.5.6, one has

$$\frac{\partial^2 U}{\partial s \partial \gamma} > 0 \tag{1.40}$$

This is because, when $q_o^* = 0$, the only impact of an increase of insurgent support s on utility U is to trade off consumption utility under insurgent control with consumption utility under government control[42]. Since an exogenous increase in law enforcement reduces the latter, it increases $\partial U / \partial s$.

Combining equations (1.37), (1.39) and (1.40) with the concavity of U yields

$$l'(\gamma) = \underbrace{\frac{\partial^2 U}{\partial s \partial \gamma}\frac{\partial^2 U}{\partial l \partial s}}_{>0 \text{ when } \gamma > \tau} - \underbrace{\frac{\partial^2 U}{\partial l \partial \gamma}\frac{\partial^2 U}{\partial s^2}}_{>0} \tag{1.20}$$

Therefore, we can conclude that for wealthy producers $l'(\gamma)$ is a compound of the following two effects

1. An increase in γ decreases opium land allocation l directly (right term of (1.20))
2. An increase in γ increases insurgent support s which, when $\gamma > \tau$, increases opium land allocation l (left term of (1.20))

If insurgent support has no effect on the distribution of ι, that is, if $\delta = 0$, then the first term is zero and the first effect always dominates so that: $l'(\gamma) < 0$. When $\delta > 0$, the

[42] One can compare that with the mechanics of $\frac{\partial^2 U}{\partial s \partial \gamma}$ when the producer is resource-poor.

second effect kicks in and, when $\gamma > \tau$, this effect mitigates the first one.

Said differently, an exogenous increase in anti-narcotics law enforcement will decrease opium supply for wealthy producers, but because of equilibrium effects this decrease will be smaller when popular support is decisive to the outcome of conflict. In that case, an increase in law enforcement will increase insurgent support which increases the benefits of investing land in opium production and therefore raises opium supply.

Case 1.2: Sign of $s'(\gamma)$ for wealthy producers

Combining equations (1.37), (1.39) and (1.40) with the concavity of U yields

$$s'(\gamma) = \underbrace{\frac{\partial^2 U}{\partial l \partial \gamma} \frac{\partial^2 U}{\partial l \partial s}}_{<0 \text{ when } \gamma>\tau} - \underbrace{\frac{\partial^2 U}{\partial s \partial \gamma} \frac{\partial^2 U}{\partial l^2}}_{<0} \tag{1.21}$$

Therefore, we can conclude that for wealthy producers $s'(\gamma)$ is a compound of the following two effects

1. An increase in γ increases insurgent support s directly (right term of (1.21))

2. An increase in γ decreases opium allocation l which, when $\gamma > \tau$, decreases insurgent support s (left term of (1.21))

When the producer is sufficiently risk-averse (see Equation (1.40) from Appendix 1.5.6), the first effect will dominate so that $s'(\gamma) > 0$. If insurgent support has no effect on the distribution of ι, that is, if $\delta = 0$, then both terms cancel out so that: $s'(\gamma) = 0$, which is natural since insurgent support is ineffective in that case.

Said differently, when the producer is risk-averse, an exogenous increase in law enforcement will always increase the support for insurgents, unless this support is ineffective military-wise.

Case 1.3: Sign of $l'(\tau)$ for wealthy producers

Following the same logic as above, one can establish the existence of a (different) function $\bar{\mathbf{x}}(\tau)$ verifying

$$\bar{\mathbf{x}}'(\tau) \equiv \begin{pmatrix} l'(\tau) \\ s'(\tau) \end{pmatrix} = \frac{1}{\det(\mathbf{H}_U)} \begin{pmatrix} \frac{\partial^2 U}{\partial s \partial \tau}\frac{\partial^2 U}{\partial l \partial s} - \frac{\partial^2 U}{\partial l \partial \tau}\frac{\partial^2 U}{\partial s^2} \\ \frac{\partial^2 U}{\partial l \partial \tau}\frac{\partial^2 U}{\partial l \partial s} - \frac{\partial^2 U}{\partial s \partial \tau}\frac{\partial^2 U}{\partial l^2} \end{pmatrix}$$

where all the utility terms are evaluated at $(\bar{\mathbf{x}}(\tau), 0) = (l(\tau), s(\tau), 0)$ with the parameter τ.

Using Equation (1.42) from Appendix 1.5.6, one has

$$\gamma > \tau + \text{sufficient risk-aversion} \implies \frac{\partial^2 U}{\partial l \partial \tau} > 0 \tag{1.42}$$

This is because an exogenous increase in the insurgent tax rate τ has two effects on the marginal effect on U of increasing l. First, if the producer is sufficiently risk-averse, it will increase the marginal benefit of increasing l through the term $\sigma(s)P_2 f_o'(l)(1-\tau)u'(c_2^I)$. Simultaneously, it will increase the marginal cost of increasing l through the term $f_w'(1-l)\mathrm{E}[u'(c_2)]$, which is always increasing with τ by concavity of u. When $P_2 f_o'(l)(1-\tau) > f_w'(1-l)$ and when the producer is sufficiently risk-averse, the first term will always dominate the second. By Result 6, the first property is verified if[43] $\gamma > \tau$.

Using Equation (1.43) from Appendix 1.5.6, one has (when $\delta > 0$)

$$\frac{\partial^2 U}{\partial s \partial \tau} < 0 \tag{1.43}$$

This is because the impact of an increase in insurgent support s on utility is to trade off consumption utility under insurgent control with consumption utility under government

[43] To see that, note that by multiplying $\gamma > \tau$ by $(1-\sigma(s)$ on both sides and rearranging, one obtains $(1-\tau) > 1-(1-\sigma(s))\gamma - \tau\sigma(s)$. Therefore, if $P_2 f_o'(l)(1-(1-\sigma(s))\gamma - \tau\sigma(s)) > f_w'(1-l)$, then $P_2 f_o'(l)(1-\tau) > f_w'(1-l)$. But the first inequality is guaranteed by Proposition 6 when $\gamma > \tau$.

control. Since an exogenous increase in insurgent tax rate reduces the former, it decreases $\partial U/\partial s$.

Combining equations (1.37), (1.42) and (1.43) with the concavity of U yields

$$l'(\tau) = \underbrace{\frac{\partial^2 U}{\partial s \partial \tau}\frac{\partial^2 U}{\partial l \partial s}}_{<0 \text{ when } \gamma>\tau} - \underbrace{\frac{\partial^2 U}{\partial l \partial \tau}\frac{\partial^2 U}{\partial s^2}}_{<0 \text{ when } \gamma>\tau} \tag{1.22}$$

Therefore, we can conclude that for wealthy producers, when $\gamma > \tau$ and the producer is sufficiently risk-averse, $l'(\tau)$ is a compound of the following two effects

1. An exogenous increase in τ increases the amount of land l allocated to opium (because of risk aversion) (right term of (1.22))

2. An exogenous increase in τ decreases insurgent support s which reduces the benefits of investing land in opium production and therefore reduces l (left term of (1.22))

If insurgent support has no effect on the distribution of ι, that is, if $\delta = 0$, then $\partial^2 U/\partial s \partial \tau = 0$ and the first effect always dominates so that: $l'(\tau) > 0$. In that case, the effect is entirely due to risk-aversion. When $\delta > 0$, the second effect kicks in and this effect mitigates the first one, once again, due to risk-aversion.

Case 1.4: Sign of $s'(\tau)$ for wealthy producers

Combining equations (1.37), (1.42) and (1.43) with the concavity of U yields

$$s'(\tau) = \underbrace{\frac{\partial^2 U}{\partial l \partial \tau}\frac{\partial^2 U}{\partial l \partial s}}_{>0 \text{ when } \gamma>\tau} - \underbrace{\frac{\partial^2 U}{\partial s \partial \tau}\frac{\partial^2 U}{\partial l^2}}_{>0} \tag{1.23}$$

Therefore, we can conclude that for wealthy producers, when $\gamma > \tau$, $s'(\tau)$ is a compound of the following two effects

1. An exogenous increase in τ decreases insurgent support s directly (right term of (1.23))

2. An exogenous increase in τ increases the amount of land allocated to opium l (because of risk-aversion) which raises the benefits of supporting the insurgents and therefore raises l (left term of (1.23))

If insurgent support has no effect on the distribution of ι, that is, if $\delta = 0$, then $\partial^2 U/\partial s \partial \tau = 0$ and the second effect always dominates so that: $s'(\tau) > 0$. When $\delta > 0$, the first effect kicks in and this effect mitigates the first one.

Case 2: Resource-poor Producers

Once again, following exactly the same logic as above, but with $\underline{\mathbf{f}}$ instead of $\bar{\mathbf{f}}$, one can establish the existence of a function $\underline{\mathbf{x}}(\gamma)$ verifying

$$\begin{aligned}
\underline{\mathbf{x}}'(\gamma) \equiv \begin{pmatrix} l'(\gamma) \\ s'(\gamma) \end{pmatrix} &= -\left[\frac{\partial \underline{\mathbf{f}}}{\partial \mathbf{x}}(\gamma, \underline{\mathbf{x}}(\gamma))\right]^{-1} \times \left[\frac{\partial \underline{\mathbf{f}}}{\partial \gamma}(\gamma, \underline{\mathbf{x}}(\gamma))\right] \\
&= -\frac{1}{\det(\mathbf{H}_U)} \begin{pmatrix} \frac{\partial^2 U}{\partial s^2} & -[\frac{\partial^2 U}{\partial l \partial s} + \frac{\partial^2 U}{\partial s \partial q_o} f_o'(l)] \\ -\frac{\partial^2 U}{\partial l \partial s} & \frac{\partial^2 U}{\partial l^2} + \frac{\partial^2 U}{\partial l \partial q_o} f_o'(l) + \frac{\partial U}{\partial q_o} f_o''(l) \end{pmatrix} \begin{pmatrix} \frac{\partial^2 U}{\partial l \partial \gamma} + \frac{\partial^2 U}{\partial q_o \partial \gamma} f_o'(l) \\ \frac{\partial^2 U}{\partial s \partial \gamma} \end{pmatrix} \\
&= \frac{1}{\det(\mathbf{H}_U)} \begin{pmatrix} \frac{\partial^2 U}{\partial s \partial \gamma}\left(\frac{\partial^2 U}{\partial l \partial s} + \frac{\partial^2 U}{\partial s \partial q_o} f_o'(l)\right) - \left(\frac{\partial^2 U}{\partial l \partial \gamma} + \frac{\partial^2 U}{\partial q_o \partial \gamma} f_o'(l)\right)\frac{\partial^2 U}{\partial s^2} \\ \left(\frac{\partial^2 U}{\partial l \partial \gamma} + \frac{\partial^2 U}{\partial q_o \partial \gamma} f_o'(l)\right)\frac{\partial^2 U}{\partial l \partial s} - \frac{\partial^2 U}{\partial s \partial \gamma}\left(\frac{\partial^2 U}{\partial l^2} + \frac{\partial^2 U}{\partial l \partial q_o} f_o'(l) + \frac{\partial U}{\partial q_o} f_o''(l)\right) \end{pmatrix}
\end{aligned}$$

Now, observe that

$$\begin{aligned}
\frac{\partial U}{\partial l}(l, s, f_o(l)) + &\frac{\partial U}{\partial q_o}(l, s, f_o(l)) f_o'(l) \\
&= \frac{1}{1+r}\Big[(1 - \Gamma(s,\gamma))P_2 f_o'(l) u'(c_1) - f_w'(1-l) u'(c_2)\Big].
\end{aligned} \tag{1.24}$$

Case 2.1: Sign of $l'(\gamma)$ for resource-poor producers

By Equation (1.24) above, one has

$$\frac{\partial}{\partial\gamma}\left(\frac{\partial U}{\partial l}(l,s,f_o(l))+\frac{\partial U}{\partial q_o}(l,s,f_o(l))f_o'(l)\right) = \frac{(1-\sigma(s))}{1+r}P_2 f_o'(l)u'(c_1)\Big[(c_1-y_1)R_a(c_1)-1\Big] \tag{1.25}$$

which is strictly positive if and only if the relative risk aversion $c_1R_a(c_1)$ of the producer becomes large enough. This is because an exogenous increase in law enforcement acts on period 1 marginal utility from increase in l in two ways. First, it decreases the marginal increase in consumption following the increase in l. Secondly, it reduces period 1 consumption which increases the corresponding marginal utility. If the producer is sufficiently risk-averse, then the overall change will be positive. Since, when the producer is resource-poor (so that (R2) is binding), law enforcement has no impact on period 2 utility, it follows that the overall effect is positive.

By Equation (1.24) above, one has

$$\frac{\partial}{\partial s}\left(\frac{\partial U}{\partial l}(l,s,f_o(l))+\frac{\partial U}{\partial q_o}(l,s,f_o(l))f_o'(l)\right) = -\frac{\sigma'(s)\gamma}{1+r}P_2 f_o'(l)u'(c_1)\Big[(c_1-y_1)R_a(c_1)-1\Big] \tag{1.26}$$

which is strictly negative if and only if the relative risk aversion $c_1R_a(c_1)$ of the producer becomes large enough. The effect here is exactly symmetric to the one discussed under Equation (1.25). In fact both act through a change in the unconditional probability of eradication.

By Equation (1.40) from Appendix 1.5.6, one has (when $\delta > 0$)

$$\frac{\partial^2 U}{\partial s \partial\gamma} > 0 \tag{1.40}$$

This is because, when $q_o^* = f_o(l^*)$, an exogenous increase in law enforcement increases the period 1 marginal benefit of an increase in s in two ways[44]. The first way is that it

[44]Note that the mechanics of $\frac{\partial^2 U}{\partial s\partial\gamma}$ when the producer is resource poor are different from when the

augments the marginal increase in consumption due to the increase in s. The second way is that it increases period 1 marginal utility by reducing period 1 consumption.

Combining equations (1.25), (1.26) and (1.40) with the strict concavity of the objective function, one has

$$l'(\gamma) = \underbrace{\frac{\partial^2 U}{\partial s \partial \gamma}}_{>0} \underbrace{\left(\frac{\partial^2 U}{\partial l \partial s} + \frac{\partial^2 U}{\partial s \partial q_o} f_o'(l)\right)}_{\substack{<0 \Leftrightarrow \text{relative} \\ \text{risk aversion} \\ \text{is large}}} - \underbrace{\left(\frac{\partial^2 U}{\partial l \partial \gamma} + \frac{\partial^2 U}{\partial q_o \partial \gamma} f_o'(l)\right)}_{\substack{>0 \Leftrightarrow \text{relative} \\ \text{risk aversion} \\ \text{is large}}} \frac{\partial^2 U}{\partial s^2} \tag{1.27}$$

Therefore, we can conclude that for resource-poor producers $l'(\gamma)$ is a compound of the following two effects

1. An exogenous increase in law enforcement increases the amount of land l allocated to opium production directly (because of risk aversion) (right term of (1.27)
2. An exogenous increase in law enforcement increases insurgent support s, which reduces the marginal benefit of investing in opium production (because of risk aversion) and thus l (left term of (1.27))

If insurgent support has no effect on the distribution of ι, that is, if $\delta = 0$, then $\partial^2 U / \partial s \partial \gamma = 0$ and the first effect always dominates so that: $l'(\gamma) > 0$. This is Proposition 1 from [Andersson, 2013, p924]. When $\delta > 0$, the first effect kicks in and this effect mitigates the first one.

Said differently, when the resource-poor producer is (relatively) risk-averse, an exogenous increase in law enforcement increases the probability of eradication, which increases the share of land l allocated to opium. However, since the law enforcement increase also increases insurgent support and that insurgent support decreases the probability of eradication, the second effect reduces l.

From Equation (1.27), it is clear that the effects are reversed if and the producer is not too (relatively) risk-averse, hence the following result.

producer is wealthy, although that term is always strictly positive. See above.

Result 11 *For resource-poor producers who are not too risk-averse, an exogenous increase in law enforcement will have two opposing effects on opium supply. On the one hand, it will decrease the amount of land l allocated to opium production, as for wealthy producers. On the other hand, by increasing insurgent support, it will make it more profitable to invest in opium, which partially cancels the previous effect (indirect effect).*

Case 2.2: Sign of $s'(\gamma)$ for resource-poor Producers

By Equation (1.24), one has

$$\frac{\partial}{\partial l}\left(\frac{\partial U}{\partial l}(l,s,f_o(l))+\frac{\partial U}{\partial q_o}(l,s,f_o(l))f_o'(l)\right) = \frac{1}{1+r}\Big[u'(c_1)(1-\Gamma(s,\gamma))P_2\big[f_o''(l)-\frac{(1-\Gamma(s,\gamma))P_2[f_o'(l)]^2}{1+r}R_a(c_1)\big]\big] + u'(c_2)\big[f_w''(1-l)-(f_w'(1-l))^2R_a(c_2)\big]\Big] \tag{1.28}$$

which is always strictly negative.

Combining equations (1.25), (1.37), (1.40) and (1.28), one has

$$s'(\gamma) = \underbrace{\left(\frac{\partial^2 U}{\partial l\partial\gamma}+\frac{\partial^2 U}{\partial q_o\partial\gamma}f_o'(l)\right)}_{\substack{>0 \text{ when relative}\\ \text{risk aversion}\\ \text{is large}}}\underbrace{\frac{\partial^2 U}{\partial l\partial s}}_{\substack{>0\text{ when}\\ \gamma>\tau}} - \underbrace{\frac{\partial^2 U}{\partial s\partial\gamma}}_{>0}\underbrace{\left(\frac{\partial^2 U}{\partial l^2}+\frac{\partial^2 U}{\partial l\partial q_o}f_o'(l)+\frac{\partial U}{\partial q_o}f_o''(l)\right)}_{<0} \tag{1.29}$$

Therefore, we can conclude that for resource-poor producers $s'(\gamma)$ is a compound of the following two effects

1. An exogenous increase in law enforcement increases insurgent support directly (right term of (1.29))

2. An exogenous increase in law enforcement increases the marginal benefit of investing in opium (because of risk-aversion) which in turn increases the benefit of insurgent support and therefore s (left term of (1.29))

This means that when the resource-poor producer is sufficiently risk-averse, an exogenous increase in law enforcement has two 'perverse' effects. First, it makes insurgent support more beneficial. This is always the case, independently of risk-aversion. But, by risk-aversion, it also makes it more profitable to invest in opium, which in turn makes insurgent support more beneficial, it further increases insurgent support.

Cases 2.3 and 2.4: Signs of $l'(\tau)$ and $s'(\tau)$ for resource-poor producers

Following the same logic as above, one can establish the existence of a (different) function $\underline{\mathbf{x}}(\tau)$ verifying

$$\underline{\mathbf{x}}'(\tau) \equiv \begin{pmatrix} l'(\tau) \\ s'(\tau) \end{pmatrix} = \frac{1}{\det(\mathbf{H}_U)} \begin{pmatrix} \frac{\partial^2 U}{\partial s \partial \tau}\left(\frac{\partial^2 U}{\partial l \partial s} + \frac{\partial^2 U}{\partial s \partial q_o} f_o'(l)\right) - \left(\frac{\partial^2 U}{\partial l \partial \tau} + \frac{\partial^2 U}{\partial q_o \partial \tau} f_o'(l)\right)\frac{\partial^2 U}{\partial s^2} \\ \left(\frac{\partial^2 U}{\partial l \partial \tau} + \frac{\partial^2 U}{\partial q_o \partial \tau} f_o'(l)\right)\frac{\partial^2 U}{\partial l \partial s} - \frac{\partial^2 U}{\partial s \partial \tau}\left(\frac{\partial^2 U}{\partial l^2} + \frac{\partial^2 U}{\partial l \partial q_o} f_o'(l) + \frac{\partial U}{\partial q_o} f_o''(l)\right) \end{pmatrix}$$

When the producer is resource-poor, Constraint (R2) is binding. Consequently, the producer's revenue in period 2 originates from wheat production only, not opium crops. Therefore, the producer is not taxable in period 2. Consequently, an exogenous change in insurgent taxation τ will not impact their incentives, which implies that $\underline{\mathbf{x}}'(\tau) = 0$.

To verify this, simply note that, by Equation (1.24) above, one has

$$\frac{\partial}{\partial \tau}\left(\frac{\partial U}{\partial l}(l, s, f_o(l)) + \frac{\partial U}{\partial q_o}(l, s, f_o(l)) f_o'(l)\right) = 0. \tag{1.30}$$

Moreover, by Equation (1.43) from Appendix 1.5.6, when Constraint (R2) is binding, one has

$$\frac{\partial^2 U}{\partial s \partial \tau} = 0. \tag{1.43}$$

Combining the previous two equations with the above expression for $\underline{\mathbf{x}}'(\tau)$ immediately yields the result.

1.5.5 First-Order Partial Derivatives of the Producer's Objective

Let $U(l, s, q_o)$ denote the objective function from Problem (P'). Its gradient is given by

$$\begin{aligned}\frac{\partial U}{\partial l} &= \frac{1}{1+r}\Bigg[(1-\sigma(s))\Big((1-\gamma)P_2 f_o'(l)u'(\overline{c}_2^G) \\ &\qquad - f_w'(1-l)[\gamma u'(\underline{c}_2^G) + (1-\gamma)u'(\overline{c}_2^G)]\Big) \\ &\qquad + \sigma(s)\Big(((1-\tau)P_2 f_o'(l) - f_w'(1-l))u'(c_2^I)\Big)\Bigg] \\ &= \frac{1}{1+r}\Bigg[P_2 f_o'(l)\Big((1-\sigma(s))(1-\gamma)u'(\overline{c}_2^G) + \sigma(s)(1-\tau)u'(c_2^I)\Big) - f_w'(1-l)\mathrm{E}[u'(c_2)]\Bigg] \end{aligned} \tag{1.31}$$

$$\begin{aligned}\frac{\partial U}{\partial s} &= -c'(s) + \sigma'(s)\Bigg(\gamma\frac{P_2}{1+r}q_o u'(c_1) + \frac{1}{1+r}\Bigg[(u(c_2^I) - N) - \big(\gamma[u(\underline{c}_2^G) - D1_{\{q_o>0\}}] + (1-\gamma)u(\overline{c}_2^G)\big)\Bigg]\Bigg) \\ &= -c'(s) + \frac{\sigma'(s)}{1+r}\Bigg(\gamma P_2 q_o u'(c_1) + \Bigg[u(c_2^I) - \mathrm{E}[u(c_2)|\iota = 0] - (N - \gamma D1_{\{q_o>0\}})\Bigg]\Bigg) \end{aligned} \tag{1.32}$$

$$\begin{aligned}\frac{\partial U}{\partial q_o} &= \frac{P_2}{1+\rho(s,\gamma)}u'(c_1) - \frac{1}{1+r}\Bigg[(1-\sigma(s))(1-\gamma)P_2 u'(\overline{c}_2^G) + \sigma(s)(1-\tau)P_2 u'(c_2^I)\Bigg] \\ &= \frac{P_2}{1+r}\Bigg((1-\Gamma(s,\gamma))u'(c_1) - [(1-\sigma(s))(1-\gamma)u'(\overline{c}_2^G) + \sigma(s)(1-\tau)u'(c_2^I)]\Bigg) \end{aligned} \tag{1.33}$$

where the expectation operator E is taken over the joint distribution of (ι, θ).

When Constraint (R2) is binding, one has $c_2 = f_w(1-l)$ in all states (see Proposition 1) and the gradient simplifies to

$$\frac{\partial U}{\partial l} = \frac{u'(c_2)}{1+r}\Bigg[P_2 f_o'(l)\Big(1 - \Gamma(s,\gamma) - \sigma(s)\tau\Big) - f_w'(1-l)\Bigg] \tag{1.34}$$

$$\frac{\partial U}{\partial s} = -c'(s) + \frac{\sigma'(s)}{1+r}\Big(\gamma P_2 f_o(l)u'(c_1) - [N - \gamma D]\Big) \tag{1.35}$$

$$\frac{\partial U}{\partial q_o} = \frac{P_2}{1+r}\Big((1-\Gamma(s,\gamma))u'(c_1) - (1-\Gamma(s,\gamma) - \sigma(s)\tau)u'(c_2)\Big) \tag{1.36}$$

1.5.6 Second-Order Partial Derivatives of the Producer's Objective

$$\frac{\partial^2 U}{\partial l \partial s} = \frac{\sigma'(s)}{1+r}\Big[P_2 f_o'(l)[(1-\tau)u'(c_2^I) - (1-\gamma)u'(\overline{c}_2^G)] + f_w'(1-l)\big[\mathrm{E}[u'(c_2)|\iota=0] - \mathrm{E}[u'(c_2)|\iota=1]\big]\Big] \tag{1.37}$$

> 0 as soon as $\gamma > \tau$ by Proposition 3

$$\frac{\partial^2 U}{\partial s \partial q_o} = \frac{\sigma'(s)}{1+r} P_2 \Big[\gamma u'(c_1)\left(1 - \frac{P_2 q_o}{1+\rho(s,\gamma)} R_a(c_1)\right) - \big[(1-\tau)u'(c_2^I) - (1-\gamma)u'(\overline{c}_2^G)\big]\Big] \tag{1.38}$$

$$\frac{\partial^2 U}{\partial l \partial \gamma} = -\frac{(1-\sigma(s))}{1+r}[P_2 f_o'(l) u'(\overline{c}_2^G) + f_w'(1-l)(u'(\underline{c}_2^G) - u'(\overline{c}_2^G)] < 0 \tag{1.39}$$

$$\frac{\partial^2 U}{\partial s \partial \gamma} = \frac{\sigma'(s)}{1+r}\Big[P_2 q_o u'(c_1)\big[1 + \frac{\Gamma(s,\gamma)}{1+r} P_2 q_o R_a(c_1)\big] + u(\overline{c}_2^G) - u(\underline{c}_2^G) + D 1_{\{q_o>0\}}\Big] > 0 \tag{1.40}$$

$$\frac{\partial^2 U}{\partial q_o \partial \gamma} = -\frac{P_2}{1+r}(1-\sigma(s))\big[u'(c_1) - u'(\overline{c}_2^G)\big] < 0 \tag{1.41}$$

$$\frac{\partial^2 U}{\partial l \partial \tau} = \frac{\sigma(s)}{1+r} u'(c_2^I)\Big[\big(P_2(1-\tau)f_o'(l) - f_w'(1-l)\big) P_2(f_o(l) - q_o) R_a(c_2^I) - P_2 f_o'(l)\Big] \tag{1.42}$$

$$\frac{\partial^2 U}{\partial s \partial \tau} = \frac{\sigma'(s)}{1+r}\left(\frac{\partial c_2^I}{\partial \tau}\right) u'(c_2^I) \leq 0 \quad (= 0 \text{ if and only if (R2) is binding}) \tag{1.43}$$

$$\frac{\partial^2 U}{\partial l^2} = \frac{1}{1+r}\mathrm{E}\Big[u'(c_2)\big[\frac{\partial^2 c_2}{\partial l^2} - \left(\frac{\partial c_2}{\partial l}\right)^2 R_a(c_2)\big]\Big]$$

$$\begin{aligned}\frac{\partial^2 U}{\partial s^2} &= -c''(s) + u'(c_1)\big[\frac{\partial^2 c_1}{\partial s^2} - \left(\frac{\partial c_1}{\partial s}\right)^2 R_a(c_1)\big] \\ &\quad + \frac{\sigma''(s)}{1+r}\Big[\mathrm{E}\big[u(c_2)|\iota=1\big] - \mathrm{E}\big[u(c_2)|\iota=0\big] - \big(N - \gamma D 1_{\{q_o>0\}}\big)\Big] \\ &= -c''(s) - u'(c_1)\left(\frac{\partial c_1}{\partial s}\right)^2 R_a(c_1)\end{aligned}$$

$$\begin{aligned}\frac{\partial^2 U}{\partial q_o^2} &= u'(c_1)\big[\frac{\partial^2 c_1}{\partial q_o^2} - \left(\frac{\partial c_1}{\partial q_o}\right)^2 R_a(c_1)\big] + \frac{1}{1+r}\mathrm{E}\big[u'(c_2)\left(\frac{\partial^2 c_2}{\partial q_o^2} - \left(\frac{\partial c_2}{\partial q_o}\right)^2 R_a(c_2)\right)\big] \\ &= -u'(c_1)\left(\frac{\partial c_1}{\partial q_o}\right)^2 R_a(c_1) - \frac{1}{1+r}\mathrm{E}\big[u'(c_2)\left(\frac{\partial c_2}{\partial q_o}\right)^2 R_a(c_2)\big]\end{aligned}$$

$$\begin{aligned}\frac{\partial^2 U}{\partial l \partial q_o} &= u'(c_1)\big[\frac{\partial^2 c_1}{\partial q_o \partial l} - \left(\frac{\partial c_1}{\partial q_o}\right)\left(\frac{\partial c_1}{\partial l}\right) R_a(c_1)\big] \\ &\quad + \frac{1}{1+r}\mathrm{E}\big[u'(c_2)\left(\frac{\partial^2 c_2}{\partial q_o \partial l} - \left(\frac{\partial c_2}{\partial q_o}\right)\left(\frac{\partial c_2}{\partial l}\right) R_a(c_2)\right)\big] \\ &= -\frac{1}{1+r}\mathrm{E}\big[u'(c_2)\left(\frac{\partial c_2}{\partial q_o}\right)\left(\frac{\partial c_2}{\partial l}\right) R_a(c_2)\big]\end{aligned}$$

where I used the following facts

$$\sigma''(s) = 0$$
$$\frac{\partial c_1}{\partial l} = \frac{\partial^2 c_1}{\partial s^2} = \frac{\partial^2 c_1}{\partial q_o^2} = \frac{\partial^2 c_2}{\partial q_o^2} = \frac{\partial^2 c_1}{\partial l \partial q_o} = \frac{\partial^2 c_2}{\partial l \partial q_o} = 0$$

and denoted by $R_a(c) \equiv -\frac{u''(c)}{u'(c)}$ the producer's absolute risk aversion at point c.

1.5.7 Proofs

Proof of Proposition 1. Immediate from definitions (1.14)-(1.16). ■

Proof of Proposition 2. I prove the result in a slightly more general form so that I can re-use it later. By risk-aversion of the producer, for $\tau \in [0, \overline{\tau}]$, one has

$$\begin{aligned}
\mathrm{E}[u(c_2)|\iota = 1] &= u(c_2^I) \\
&= u(f_w(1-l) + (1-\tau)P_2(f_o(l) - q_o)) \\
&= u(\tau f_w(1-l) + (1-\tau)[f_w(1-l) + P_2(f_o(l) - q_o)]) \\
&\geq \tau u(f_w(1-l)) + (1-\tau)u(f_w(1-l) + P_2(f_o(l) - q_o)) \\
&= \tau u(\underline{c}_2^G) + (1-\tau)u(\overline{c}_2^G).
\end{aligned}$$

where the inequality is strict as soon as $\tau > 0$ and $q_o < f_o(l)$. This means that, when it is translated into consumption, the producer always prefers earning what is left of their production when opium is taxed at rate τ rather than earning the returns of their whole production with probability $(1-\tau)$ and their wheat only with probability τ. Consequently, using the definition of $\mathrm{E}[u(c_2)|\iota = 0]$, one can write

$$\mathrm{E}[u(c_2)|\iota = 1] - \mathrm{E}[u(c_2)|\iota = 0] \geq (\gamma - \tau)\big(u(\overline{c}_2^G) - u(\underline{c}_2^G)\big), \tag{1.44}$$

where the inequality is strict as soon as $\tau > 0$ and $q_o < f_o(l)$. From Equation (1.44), it is clear that if $q_o < f_o(l)$, which implies $u(\overline{c}_2^G) - u(\underline{c}_2^G) > 0$, the condition $\gamma > \tau$ suffices to give the result with strict inequality. If $q_o = f_o(l)$, then c_2 is constant and the result is immediately verified with weak inequality. ■

Proof of Proposition 3. By Assumption (1.13), u' is convex. Therefore, one has

$$\begin{aligned} &(1-\gamma)u'(\overline{c}_2^G) + \gamma u'(\underline{c}_2^G) \\ &\geq u'(f_w(1-l) + (1-\gamma)P_2(f_o(l) - q_o)) \end{aligned} \tag{1.45}$$

Now, suppose that $\gamma > \tau$, since u' is strictly decreasing (by concavity of u), one further has

$$\begin{aligned} &(1-\gamma)u'(\overline{c}_2^G) + \gamma u'(\underline{c}_2^G) \\ &\geq u'(f_w(1-l) + (1-\gamma)P_2(f_o(l) - q_o)) \\ &> u'(f_w(1-l) + (1-\tau)P_2(f_o(l) - q_o)) \\ &= u'(c_2^I) \end{aligned} \tag{1.46}$$

Observe that this already gives us that, as soon as $\gamma > \tau$, one has

$$\mathrm{E}[u'(c_2)|\iota = 0] > \mathrm{E}[u'(c_2)|\iota = 1] \tag{1.47}$$

Multiplying Equation (1.46) by $(1 - \sigma(s)) > 0$ on both sides and rearranging yields

$$\begin{aligned} \mathrm{E}[u'(c_2)] \equiv (1-\sigma(s))((1-\gamma)u'(\overline{c}_2^G) + \gamma u'(\underline{c}_2^G)) + \sigma(s)u'(c_2^I) \\ > u'(c_2^I) = \mathrm{E}[u'(c_2)|\iota = 1] \end{aligned}$$

which concludes the proof. ■

Proof of Proposition 4. Pick any $l \in (0,1)$ large enough to ensure that. By the definition of $y_{\min}$ in Footnote 17, this is always possible. $\frac{1}{1+\rho(s,\gamma)}P_2 f_o(l) + y_1 > 0$. Then there always exists $q_o \in (0, f_o(l))$ such that $\frac{1}{1+\rho(s,\gamma)}P_2 q_o + y_1 > 0$. One can then choose any c_1 and c_2 such that neither (C1) or (C2) bind. Let $s \in (0,1)$. Then, all the constraints are simultaneously slack at (l, s, q_o, c_1, c_2), which shows that the feasibility set has a non-empty interior.

Moreover, it is closed because it is the intersection of the closed sets $[0,1] \times \mathbf{R}^4$, $\mathbf{R} \times [0,1] \times \mathbf{R}^3$, $\mathbf{R}^2 \times [0,+\infty) \times \mathbf{R}^2$, $\mathbf{R}^3 \times [0,+\infty) \times \mathbf{R}$, $\mathbf{R}^4 \times [0,+\infty)$ and $\{(l, s, q_o, c_1, c_2) \in$

$\mathbf{R}^5 : q_o - f_o(l) \leq 0\}$.

The feasibility set is also bounded because it is contained in the bounded set $[0,1] \times [0,1] \times [0, f_o(1)] \times [0, P_2 f_o(1)] \times [0, f_w(1) + P_2 f_o(1)]$. ■

Proof of Proposition 5. Since u is strictly increasing, constraints (C1) and (C2) will be binding at any optimum. I therefore replace the two variables c_1 and c_2 with

$$c_1 = \frac{P_2}{1+\rho(s,\gamma)} q_o + y_1 \tag{C1'}$$

$$\begin{aligned} c_2 = {} & (1-\iota)[f_w(1-l) + \theta P_2(f_o(l) - q_o)] \\ & + \iota[f_w(1-l) + (1-\tau)P_2(f_o(l) - q_o)]. \end{aligned} \tag{C2'}$$

The non-negativity constraints $c_1 \geq 0$ and $c_1 \geq 0$ are always satisfied[45]. The problem thus obtained only depends on the controls (l, s, q_o). The gradient of the new objective function is given in equations (1.31)-(1.33) below. In particular, since the event $\{\theta = 1\}$ always has a strictly positive probability, by Equation (1.31) and Assumption (1.11), one has

$$\lim_{l \to 0} \frac{\partial U}{\partial l}(l, s, q_o) = +\infty$$

which implies that $l^* = 0$ is never optimal. Similarly[46],

$$\lim_{l \to 1} \frac{\partial U}{\partial l}(l, s, q_o) = -\infty$$

which implies that $l^* = 1$ is never optimal. Therefore, one can ignore both constraints on l^*. ■

Proof of Proposition 6. Let $\mathbf{H}_U(l, s, q_o)$ designate the Hessian matrix of the objective

[45]For the first one, this is due to the fact that $y_1 \geq y_{\min}$, where $y_{\min}$ is defined in Appendix 1.5.2

[46]This result follows from Assumption (1.11). If Constraint (R2) is slack, then $\frac{\partial U}{\partial l}$ is given by Equation (1.31) and the result is immediate. If it is binding, then $c_2 = f_w(1-l)$ is constant across states and $\frac{\partial U}{\partial l}$ is given by Equation (1.34), which yields the same limit.

function U of Problem (P') at point (l, s, q_o). That is,

$$\mathbf{H}_U(l,s,q_o) \equiv \begin{pmatrix} \frac{\partial^2 U}{\partial l^2}(l,s,q_o) & \frac{\partial^2 U}{\partial l \partial s}(l,s,q_o) & \frac{\partial^2 U}{\partial l \partial q_o}(l,s,q_o) \\ \frac{\partial^2 U}{\partial l \partial s}(l,s,q_o) & \frac{\partial^2 U}{\partial s^2}(l,s,q_o) & \frac{\partial^2 U}{\partial s \partial q_o}(l,s,q_o) \\ \frac{\partial^2 U}{\partial l \partial q_o}(l,s,q_o) & \frac{\partial^2 U}{\partial s \partial q_o}(l,s,q_o) & \frac{\partial^2 U}{\partial q_o^2}(l,s,q_o) \end{pmatrix} \tag{1.48}$$

Suppose that $R_a(c) = R$ for all $c > 0$, where $R > 0$ is a fixed number, that is, u is a constant absolute risk-aversion (CARA) utility function. Consider the leading principal minors $D_r(l, s, q_o)$, $r = 1, 2, 3$, of the Hessian matrix $\mathbf{H}_U$ at an arbitrary point (l, s, q) of the (compact) constraint set. The first one is simply $D_1(l, s, q_o) \equiv \frac{\partial^2 U}{\partial l^2}(l, s, q_o)$ which is always strictly negative since u, f_o and f_w are all strictly concave[47]. The second leading principal minor is

$$\begin{aligned} D_2(l,s,q_o) &\equiv \frac{\partial^2 U}{\partial l^2}(l,s,q_o)\frac{\partial^2 U}{\partial s^2}(l,s,q_o) - \left(\frac{\partial^2 U}{\partial l \partial s}(l,s,q_o)\right)^2 \\ &= \frac{\partial^2 U}{\partial l^2}(l,s,q_o)\left(\frac{\partial^2 U}{\partial s^2}(l,s,q_o) - \frac{\left(\frac{\partial^2 U}{\partial l \partial s}(l,s,q_o)\right)^2}{\frac{\partial^2 U}{\partial l^2}(l,s,q_o)}\right) \end{aligned}$$

The right term in the round brackets is bounded for all (l, s, q_o), and this bound goes to 0 as R grows. The left term in brackets goes to $-\infty$ as R grows. It follows that if R is large enough, then $D_2(l, s, q_o) > 0$ for all (l, s, q_o). Finally, the third leading principal minor of $\mathbf{H}_U$ is simply its determinant, which can be seen as a polynomial of order 3 in R. Its limit as $R \to +\infty$ is determined by the sign of its highest degree term. Thus, in all the following calculations, I only consider the terms that feature third powers of R. To find the sign of the determinant of $\mathbf{H}_U$, I expand this matrix according to its first row. Inspecting Equation (1.5.6) reveals that the only terms containing third powers of R are given by

$$\left(\frac{\partial^2 U}{\partial l^2}\right)\left[\left(\frac{\partial^2 U}{\partial s^2}\right)\left(\frac{\partial^2 U}{\partial q_o^2}\right) - \left(\frac{\partial^2 U}{\partial s \partial q_o}\right)^2\right] - \left(\frac{\partial^2 U}{\partial s^2}\right)\left(\frac{\partial^2 U}{\partial l \partial q_o}\right)^2.$$

[47] Note that $\frac{\partial^2 c_2}{\partial l^2}(l, s, q_o) = f_w''(1-l) + P_2 f_o''(l)[(1-\iota)\theta + \iota(1-\tau)] < 0$.

The terms in the square brackets simplify to $\frac{u'(c_1)}{1+r}\left(\frac{\partial c_1}{\partial s}\right)^2 \mathrm{E}\big[u'(c_2)\left(\frac{\partial c_2}{\partial q_o}\right)^2\big]$. Given the expression for $(\frac{\partial^2 U}{\partial l^2})$ from Appendix 1.5.6, the first term of the overall difference above is thus

$$-\frac{u'(c_1)}{(1+r)^2}\left(\frac{\partial c_1}{\partial s}\right)^2 \mathrm{E}\left[u'(c_2)\left(\frac{\partial c_2}{\partial l}\right)^2\right]\mathrm{E}\left[u'(c_2)\left(\frac{\partial c_2}{\partial q_o}\right)^2\right]$$

while the second term is given by

$$\frac{u'(c_1)}{(1+r)^2}\left(\frac{\partial c_1}{\partial s}\right)^2 \mathrm{E}\left[u'(c_2)\left(\frac{\partial c_2}{\partial l}\right)\left(\frac{\partial c_2}{\partial q_o}\right)\right]^2$$

By the Cauchy-Schwarz Inequality, the sum of these two terms is strictly negative, which shows that the limit of the determinant of the Hessian $\mathbf{H}_U$ as $R \to +\infty$ is strictly negative.

By the above reasoning, there exists a sufficiently large R such that the leading principal minors of $\mathbf{H}_U$ verify $(-1)^r D_r(l, s, q_o) > 0$ for all (l, s, q_o) in the constraint set and $r = 1, 2, 3$. Therefore, it suffices that u is such that $R_a(c) > R$ for all $c > 0$ to ensure that this property will be verified (this relaxes the CARA assumption). By Theorem 2.3.2 from [Sydsaeter et al., 2008, p57], the objective function U of Problem (P') is thus strictly concave as soon as the producer is risk-averse enough. ■

Proof of Proposition 7. It is easy to verify that the constraint qualification condition for constraints (R2) and (S) is always verified, thus making the Kuhn-Tucker conditions necessary by Theorem 3.8.1 from [Sydsaeter et al., 2008, p143]. Moreover, I assumed that the producer is sufficiently risk-averse to ensure that the objective function to Problem (P') is concave (see Proposition 6). Since the production function f_o is strictly concave, the problem's Lagrangian is strictly concave. Therefore, by Theorem 3.8.2 from [Sydsaeter et al., 2008, p143], the Kuhn-Tucker conditions are also sufficient. ■

Proof of Proposition 8. By Assumption (1.11), there always exists a unique $\bar{l} \in (0, 1)$ equating the (gross) marginal revenue from wheat production with the gross marginal revenue from opium

$$f'_w(1-\bar{l}) = P_2 f'_o(\bar{l}).$$

Clearly, the number $\bar{l}$ is increasing in the relative price of opium P_2 and in the relative productivity of the opium technology. Moreover, for all $l \in (\bar{l}, 1)$, one has

$$f_w'(1-l) > P_2 f_o'(l), \tag{1.49}$$

that is, with decreasing marginal returns, the gross marginal revenue from wheat becomes larger when a share of land larger than $\bar{l}$ is allocated to opium.

Let (l^*, s^*, q_o^*) be any solution to Problem (P') such that Constraint (R2) is slack: $q_o^* < f_o(l^*)$. Suppose that $l^* \in (\bar{l}, 1)$. Then, by Condition (CS λ), one has $\lambda = 0$, while Condition (FOC l) becomes

$$\frac{\partial U}{\partial l}(l^*, s^*, q_o^*) = 0 \tag{ FOC l}$$

but since $l^* \in (\bar{l}, 1)$, by Equation (1.49), one has[48]

$$\begin{aligned}
\frac{\partial U}{\partial l}(l^*, s^*, q_o^*) &< \frac{f_w'(1-l^*)}{1+r}\Bigg[\bigg((1-\sigma(s^*))(1-\gamma)u'(\bar{c}_2^{G*}) \\
&\qquad + \sigma(s^*)(1-\tau)u'(c_2^{I*})\bigg) - \mathrm{E}[u'(c_2^*)]\Bigg] \\
&\le \frac{f_w'(1-l^*)}{1+r}\Bigg[\bigg((1-\sigma(s^*))(1-\gamma)u'(\bar{c}_2^{G*}) + \sigma(s^*)u'(c_2^{I*})\bigg) - \mathrm{E}[u'(c_2^*)]\Bigg] \\
&\le 0
\end{aligned}$$

which contradicts Condition (FOC l). One must therefore have $l^* \le \bar{l}$. ■

Proof of Result 1. Suppose that there exists a solution (l^*, s^*, q_o^*) to problem (P') such that $q_o^* > 0$. By Condition (FOC q_o), it follows that $\frac{\partial U}{\partial q_o}(l^*, s^*, q_o^*) = \lambda \ge 0$. Using Equation (1.33), this implies that

$$u'(c_1^*) \ge \frac{(1-\sigma(s^*))(1-\gamma)}{1-\Gamma(s,\gamma)}u'(\bar{c}_2^{G*}) + \frac{\sigma(s^*)}{1-\Gamma(s,\gamma)}u'(c_2^{I*})(1-\tau) \tag{1.50}$$

which is the average of the marginal utilities $u'(\bar{c}_2^{G*})$ and $u'(c_2^{I*})(1-\tau)$, with weights given by the distribution of ι conditional on $\{\theta = 1\}$. By equations (1.14) and (1.15), one has $c_2^{I*} \le \bar{c}_2^{G*} \le f_w(1) + P_2 f_o(1)$, which by concavity of u implies $u'(c_2^{I*}) \ge u'(\bar{c}_2^{G*}) \ge$

[48]The second inequality arises from the fact that $\underline{c}_2^{G*} \le \bar{c}_2^{I*} \le \bar{c}_2^{G*}$ (see Proposition 1) and that u is concave.

$u'(f_w(1) + P_2 f_o(1))$. Therefore, a necessary condition for $q_o^* > 0$ is

$$u'(c_1^*) \geq u'(f_w(1) + P_2 f_o(1))(1-\tau)$$

Then, using Equation (C1′) from the proof of Proposition 5 and the concavity of u again, the inequality above requires at the very least that

$$y_1 \leq (u')^{-1}\Big(u'\big(f_w(1) + P_2 f_o(1)\big)(1-\tau)\Big). \tag{1.51}$$

Consequently, a sufficient condition for $q_o^* = 0$ is

$$y_1 > (u')^{-1}\Big(u'\big(f_w(1) + P_2 f_o(1)\big)(1-\tau)\Big)$$

where the right hand term is increasing with τ and thus is largest when $\tau = \overline{\tau}$, the insurgents' fiscal capacity. This means that as τ decreases, the share of producers who will decide not to hold any debt increases.

Moreover, the above reasoning shows that the set $\{y \in \mathbf{R} : \forall(\gamma,\tau), \quad y_1 > y \Longrightarrow q_o^* = 0\}$ is nonempty. Therefore, one can define

$$\overline{y}_1 \equiv \inf\{y \in \mathbf{R} : \forall(\gamma,\tau), \quad y_1 > y \Longrightarrow q_o^* = 0\}.$$

Similarly, suppose that there exists a solution (l^*, s^*, q_o^*) to problem (P') such that $q_o^* < f_o(l^*)$, that is, Constraint (R2) does not bind. By Proposition 8, it must be that $l^* \leq \bar{l}$, where $\bar{l}$ is defined by Equation (1.49). Moreover, by Condition (CS λ), one has $\lambda = 0$. Using Condition (FOC q_o), one must therefore have $\frac{\partial U}{\partial q_o}(l^*, s^*, q_o^*) \leq 0$. Using Equation (1.33), this implies that

$$\begin{aligned} u'(c_1^*) &\leq \frac{(1-\sigma(s^*))(1-\gamma)}{1-\Gamma(s,\gamma)} u'(\overline{c}_2^{G*}) + \frac{\sigma(s^*)}{1-\Gamma(s,\gamma)} u'(c_2^{I*})(1-\tau) \\ &\leq \mathrm{E}[u'(c_2^*)|\theta = 1] < u'(\mathrm{E}[c_2^*|\theta = 1]) \end{aligned}$$

where the first inequality is due to $(1-\tau) \leq 1$ and the second inequality owes to the producer's risk aversion and Jensen's inequality[49]. By strict concavity of u, this implies that

$$c_1^* > \mathrm{E}[c_2^* | \theta = 1] > f_w(1 - l^*) \geq f_w(1 - \bar{l}).$$

Therefore, using Equation (C1′), a necessary condition for $q_o^* < f_o(l^*)$ is

$$y_1 > f_w(1 - \bar{l}) - \frac{P_2}{1 + \rho(s^*, \gamma)} q_o^* > f_w(1 - \bar{l}) - \frac{P_2}{1 + \rho(1, \gamma)} f_o(\bar{l}).$$

It follows that

$$y_1 \in \left(y_{\min}, f_w(1 - \bar{l}) - \frac{P_2}{1 + \rho(1, \gamma)} f_o(\bar{l}) \right)$$

is a sufficient condition to guarantee that Constraint (R2) will bind. By definition of $y_{\min}$, the interval above is never empty. And it is the tightest when $\gamma = 0$, that is, when there is no law enforcement. This means that as the government raises γ, a larger share of producers will decide to sell all of their future opium output in advance.

The above reasoning shows that the set $\{y \in \mathbf{R} : \forall(\gamma, \tau), \quad y_{\min} < y_1 < y \Longrightarrow q_o^* = f_o(l^*)\}$ is nonempty. Therefore, one can define

$$\underline{y}_1 \equiv \sup\{y \in \mathbf{R} : \forall(\gamma, \tau), \quad y_1 < y \Longrightarrow q_o^* = f_o(l^*)\}.$$

Note that whenever $y_1 < \underline{y}_1$, the fact that $\frac{\partial U}{\partial q_o}(l^*, s^*, q_o^*) > 0$ will necessarily imply $\lambda > 0$ by Condition (FOC q_o). This simply means that holding more debt would be strictly profitable to the producer.

To see that $\overline{y}_1 \geq \underline{y}_1$, simply suppose this is not the case: $\overline{y}_1 < \underline{y}_1$. Then, for given policies (γ, τ), pick any solution (l^*, s^*, q_o^*) to problem (P') corresponding to some y_1 in the nonempty interval $(\overline{y}_1, \underline{y}_1)$. By the first argument above, $q_o^* = 0$. By the second argument, $q_o^* = f_o(l^*) > 0$, which is a contradiction. ■

Proof of Result 3. Using Equation (1.32), direct computation shows that when $\gamma = 0$, one has

$$\frac{\partial U}{\partial s}(l, s, q_o) = \frac{\sigma'(s)}{1 + r}[u(c_2^I) - u(\bar{c}_2^G) - N] - c'(s).$$

[49] If Constraint (R2) is binding, then this is a weak inequality because c_2 is constant.

Therefore, given that $c'(s) \geq 0$, as soon as

$$u(c_2^I) - u(\overline{c}_2^G) - N < 0$$

one has $\frac{\partial U}{\partial s}(l, s, q_o) < 0$ and since $\mu \geq 0$, inequality (FOC s) is strict, which implies $s^* = 0$. Therefore, a necessary condition for $s^* > 0$ is

$$u(c_2^I) - u(\overline{c}_2^G) \geq N.$$

Given definitions (1.14)-(1.16), it is clear that $0 \geq u(c_2^I) - u(\overline{c}_2^G)$. ■

Proof of Result 4. Using Equation (1.32) and Equation (1.44) from the proof of Proposition 2, one has

$$\frac{\partial U}{\partial s} \geq \sigma'(s)\left(\gamma \frac{P_2}{1+r} q_o u'(c_1) + \frac{1}{1+r}\left[(\gamma - \tau)\big(u(\overline{c}_2^G) - u(\underline{c}_2^G)\big) - (N - \gamma D)\right]\right) - c'(s).$$

where the inequality is strict as soon as $\tau > 0$. Now, suppose that there exists a solution (l^*, s^*, q_o^*) to Problem (P') with $s^* = 0$ (so that $c'(s^*) = 0$) and any of the following conditions

$$(\gamma - \tau)\big(u(\overline{c}_2^{G*}) - u(\underline{c}_2^{G*})\big) \geq N - \gamma D \qquad \text{when } \gamma q_o^* > 0 \qquad (1.52)$$

$$\text{or } (\gamma - \tau)\big(u(\overline{c}_2^{G*}) - u(\underline{c}_2^{G*})\big) \geq N - \gamma D \qquad \text{when } \gamma q_o^* = 0 \text{ and } \tau > 0 \qquad (1.53)$$

$$\text{or } (\gamma - \tau)\big(u(\overline{c}_2^{G*}) - u(\underline{c}_2^{G*})\big) > N - \gamma D \qquad \text{when } \gamma q_o^* = 0 \text{ and } \tau = 0 \qquad (1.54)$$

then, this would imply $\frac{\partial U}{\partial s}(l^*, 0, q_o^*) > 0$ which, by Condition (FOC s) implies $\mu > 0$ and thus $s^* = 1 > 0$ by Condition (CS μ). This is a contradiction. Therefore, as soon as any of the above conditions are met, one must have $s^* > 0$. ■

Proof of Result 6. Suppose that $y_1 > \overline{y}_1$. Then, by Result 1, one has $q_o^* = 0 < f_o(l^*)$, where the strict equality arises from the fact that $l^* > 0$ at any solution of Problem (P') (see Proposition 5). By Condition (CS λ) it follows that $\lambda = 0$. By Condition (FOC l), this implies that at any solution $(l^*, s^*, 0)$, one has

$$\frac{\partial U}{\partial l}(l^*, s^*, 0) = 0$$

Using Equation (1.31) from Appendix 1.5.5, this is equivalent to

$$f_w'(1-l^*)\mathrm{E}[u'(c_2^*)] = P_2 f_o'(l^*)\Big((1-\sigma(s^*))(1-\gamma)u'(\overline{c}_2^{G*}) + \sigma(s^*)(1-\tau)u'(c_2^{I*})\Big), \quad (1.55)$$

which is the same as Condition (FOC-W l). Now, note that

$$\begin{aligned} f_w'(1-l^*)\mathrm{E}[u'(c_2^*)] < P_2 f_o'(l^*)\Big((1-\sigma(s^*))(1-\gamma)u'(\overline{c}_2^{G*}) + (1-\sigma(s^*))\gamma u'(\underline{c}_2^{G*}) \\ + \sigma(s^*)(1-\tau)u'(c_2^{I*})\Big) \\ = P_2 f_o'(l^*)\mathrm{E}[u'(c_2^*)] \end{aligned}$$

Therefore, since $\mathrm{E}[u'(c_2^*)] > 0$, one has

$$P_2 f_o'(l^*) > f_w'(1-l^*),$$

which says that the value of the gross marginal return to opium is strictly larger that this of wheat. But Equation (1.55) can also be re-arranged as

$$\left((1-\sigma(s^*))(1-\gamma)\frac{u'(\overline{c}_2^{G*})}{\mathrm{E}[u'(c_2^*)]} + \sigma(s^*)(1-\tau)\frac{u'(c_2^{I*})}{\mathrm{E}[u'(c_2^*)]}\right)\frac{P_2 f_o'(l^*)}{f_w'(1-l^*)} = 1$$

Given that $u'(c_2^{I*}) > u'(\overline{c}_2^{G*})$, one has

$$\begin{aligned} &\frac{u'(c_2^{I*})}{\mathrm{E}[u'(c_2^*)]}\Big((1-\sigma(s^*))(1-\gamma) + \sigma(s^*)(1-\tau)\Big)\frac{P_2 f_o'(l^*)}{f_w'(1-l^*)} \\ &> \left((1-\sigma(s^*))(1-\gamma)\frac{u'(\overline{c}_2^{G*})}{\mathrm{E}[u'(c_2^*)]} + \sigma(s^*)(1-\tau)\frac{u'(c_2^{I*})}{\mathrm{E}[u'(c_2^*)]}\right)\frac{P_2 f_o'(l^*)}{f_w'(1-l^*)} \\ &= 1 \end{aligned}$$

Therefore, by Proposition 3, if $\gamma > \tau$, then $\frac{u'(c_2^{I*})}{\mathrm{E}[u'(c_2^*)]} < 1$ and thus

$$\Big((1-\sigma(s^*))(1-\gamma)+\sigma(s^*)(1-\tau)\Big)P_2 f_o'(l^*) > f_w'(1-l^*),$$

which says that the value of the net marginal return to opium is strictly larger that this of wheat. ■

Chapter 2

Afghanistan: Did Counter-Narcotics Counter Narcotics? Not So Much

Abstract

The contribution of this paper is to estimate the elasticity of opium supply to counter-narcotics law enforcement in Afghanistan. I find that law enforcement had little impact, with a 1% increase in opium eradication causing a reduction of roughly a third of a percent in opium supply the following year. Moreover, this effect is driven by northern regions, far from the Taliban's strongholds which concentrate most of the country's production. Since law enforcement was meant to weaken the Taliban insurgency, these results should be of interest to policy-makers.

Keywords: War on Drugs, Law-Enforcement, Afghanistan, Illegal Goods, IV, GMM

Introduction

Our understanding of the effectiveness of drug control policies is still embryonic, though a pattern is already emerging. Take the Colombian case, for example. In an early study, Moreno-Sanchez et al. [2003] found evidence that, due to the incentive of farmers to overcompensate losses, crop eradication did not significantly curb the supply of coca in the country[1,2]. Various papers later confirmed this intriguing result[3] (e.g. Eduardo and Manrique [2004], Dion and Russler [2008], Ibanez and Carlsson [2010], Mejía et al. [2015] and Davalos [2016]). Interestingly, Reyes [2014] even found that eradication had raised coca cultivation.

To the best of my knowledge, no econometric evaluation of the effect of crop eradication on drug supply was ever conducted in the case of Afghanistan[4]. This is surprising as the country is the world's main supplier of opium, the base product for morphine and heroin. In 2017, for example, it accounted for 86% of the global 10,500 tons of opium production. A significant share of this value is taxed by the Taliban insurgency, who has kept America in check for twenty years. Thus, studying the effectiveness of counter-narcotics operations in Afghanistan is of primary importance, for both health and security reasons. Using the most recent data available, I measure the impact of forced opium eradication on opium supply in Afghanistan. I use three different and complementary methods. The

[1]This is what [Andersson, 2013, Proposition 1] predicts for risk-averse and resource-poor farmers. See Chapter 1.

[2]The authors raise the issue of crops displacement (between Colombia, Bolivia and Peru) following eradication. The same issue exists in Afghanistan at the local level: *"eradication, which became a more prominent threat in 2008–2009, may have served as an incentive for landowners to put their land into alternative uses and move opium cultivation from the food zone to the dasht, an area where no eradication has taken place. Even if landowners can offer bribes to the police or government officials to forestall eradication, the cost of making "tax" payments to the Taliban in the dasht appears to be lower than the cost of paying off police in the CCA"* [Greenfield et al., 2015, p23].

[3]Eduardo and Manrique [2004] further noted that if demand for coca was inelastic, then partial eradication could lead to a price increase, giving coca farmers an incentive to extent their activities. In the same spirit, Clemens [2008, 2013], who studies Afghanistan, shows that demand for opium is inelastic, and concludes that eradication efforts, being located away from Taliban territories, have probably increased the Taliban opium market share and made them richer. See Pollack and Reuter [2014] for a review of the literature on the impact of law enforcement on drug prices. See also Footnote 9 from Chapter 3 for anecdotal evidence.

[4]An interesting study is García-Yi [2017] who conducts a wide-ranging series of tests studying the resilience of Afghan farmers to opium cultivation. However, it does not address the issue of drug control explicitly.

first, dynamic panel data in the Arellano-Bond style, has the advantage of correcting for major confounders while retaining the post-control variability present in the treatment. The second method, panel data instrumentation, ensures exogeneity (under the exclusion restriction), but reduces the variability available for estimation and thus increases estimates' standard errors. Thirdly, I mix both approaches in an IV-Arellano-Bond model. Reassuringly, all methods yield comparable results.

My first finding is that counter-narcotics law enforcement had only a moderate impact on the Afghan opium industry. I estimate that a 1% increase in crop eradication leads to a decrease of roughly 0.24% in subsequent opium supply, when measured in kilograms. The effect on the surface of land allocated to opium is slightly smaller, with an estimated elasticity of roughly −0.20%. Importantly, these are local effects, measured at the district level. They do not take into account dynamics such as crop displacement, which could mitigate them.

My second finding is that the impact of law enforcement on opium supply is heterogeneous across space. I find no significant effect of law enforcement in the southern region, which is the stronghold of Taliban insurgents and which concentrates most of the country's production. Logically, the estimated elasticities are larger for the rest of the country. For example, in the north, I find that a 1% increase in crop eradication leads to a decrease of roughly 0.45% in subsequent opium supply. This discrepancy between regions is further confirmed when considering the allocation of land. This suggests that the economic incentives faced by farmers, and therefore their reaction of law enforcement, vary across locations.

The rest of this paper is organized as follows. Section 2.1 gives some background on the Afghan counter-narcotics program. Section 2.2 presents the data I used in detail. Section 2.3 discusses the empirical strategies and their justification. Section 2.4 describes the results. Section 2.5 concludes.

2.1 Background

2.1.1 Incentives to Supply Opium

By the early 2000s, years of civil conflict and drought had left Afghanistan with few resources to feed its population[5]. Political uncertainty and corruption further ensured that whatever resources were left were mismanaged[6]. Opium gradually imposed itself as a safe alternative to traditional crops. Production, which is labor-intensive, could be pursued without the use of modern technologies or infrastructures. Once grown, opium poppies are robust; They are light and can resist the long travel times imposed by the deficient Afghan roads. In most years, it is much more profitable than alternative crops, such as wheat[7]. Thanks to this high profitability and relatively low risk of crop depreciation, farmers who promise to grow opium obtain financial loans that would be inaccessible otherwise. They are known as *salaam* credit and play a central role in the opium industry[8]. Given the absence of law enforcement, it is unsurprising that individuals with few alternatives in the non-agricultural sectors turned to opium cultivation.

2.1.2 Incentives to Enforce the Law

According to David Mansfield, who conducted an analysis of three opium bans that took place in Nangahar and Helmand between 2004 and 2011, anti-narcotics law enforcement

[5]Unless quoted otherwise, the data presented in this paragraph comes from [UNODCCP, 2001, p34].

[6] See Gall [2004]. As mentioned in Chapter 3, Table 3.3, over the years, farmers consistently reported poverty as a leading reason for opium cultivation. Moreover, the survey data used in Chapter 3 (see Section 3.2) shows that between 2008 and 2018, on average, about 30% of the adult Afghan population declared having had to pay bribes to the Afghan National Police either in most cases or in all cases when they encountered it.

[7]For a recent and concise discussion of the general advantages of opium cultivation in Afghanistan, see *Reasons for the "success" of poppy cultivation in Afghanistan* in Annex B, pp58-59, of Mansfield and Fishstein [2016]. See [UNODC, 2003, Section 3.1, pp99-108] for a discussion about the use of labor in opium production. It is worth noticing that one hectare of opium crops necessitates 350 persons-day of labor to be cultivated, as opposed to only 41 for wheat. It is estimated that 60% of the Afghan road network was destroyed during the 1979-1989 occupation of the country by the Soviet Union. The lack of access to close physical markets disincentives farmers to grow traditional crops, which are perishable. For details about crop returns, see [Mansfield and Fishstein, 2016, Paragraph 4-1, pp24-27] and the older but widely cited source [UNODC, 2004, p6].

[8]For details about the salaam credit system, see the Global Informality Project. See Pain [2008] for a general review of informal credit in Afghanistan. See Chapter 1 for a theoretical treatment.

in Afghanistan was the outcome of a bargaining process between the international forces and provincial governors. The ISAF sought to secure rural areas by supporting the formation of local military forces and giving provincial governors incentives to eradicate opium. These incentives were both political and financial. Provincial governors who launched eradication campaigns gained international recognition, appearing as efficient state-builders whose interests were in line with those of the international forces (see [Mansfield, 2016, pp100-102 and pp283-285]). As an example of such political gain, Mansfield quotes the invitation of the Nangahar governor Gul Aga Shirzai to Barack Obama's presidential inauguration in Jaunary 2009 ([Mansfield, 2016, p140]).

Regarding financial incentives, [SIGAR, 2010a, p115] reports that since 2009 the US committed to reimbursing eradication costs to the Afghan provincial authorities at a rate of 135$ per hectare. Provinces also received direct financial rewards in exchange for law enforcement. In 2007, the US and the United Kingdom (UK) launched the Good Performers Initiative (GPI), which offered provinces money contingent on eradication metrics based on UNODC data[9]. Table 2.1 gives overall GPI rewards for the years 2009-2013.

2.1.3 Methods of Law Enforcement

The Governor-Led Eradication program was an incentive scheme setup in 2008 by the US government to reduce opium cultivation in Afghanistan. Through funding transferred to the Ministry of Counter-Narcotics, it supported Afghan governors who self-initiated eradication campaigns in their provinces (see below). Between 2008 and 2015, it was the main program of anti-narcotics law-enforcement in the country[10]. It led to the destruction

[9]See [Greenfield et al., 2015, p175-181] and [DOS, 2008, pp236-237]. The UNODC eradication data used to determine the amount of money received by each province under the GPI is the same data I used for this paper. Other direct financial help includes the US military's Commanders Emergency Response Programs (CERP), which precise use is unclear, but which seems to have been spent to bolster local military actions: *"[it was] designed to assist commanders in the field to build the foundations for stability. It is not meant to replace–to be in the place of the long-term reconstruction funding, which is done by the State Department and USAID."* [US Senate, 2011, p25-27]. On top of financial aid, [SIGAR, 2010b, p109] refers to the provision of transportation and logistical support for Afghan eradication forces.

[10]See [GAO, 2010, p14]. The GLE program was managed by the Ministry of Counter-Narcotics, which was dissolved in February 2019, following the reorganization of the Afghan government (see Bjelica [2019]). In 2009, about 55% of opium eradication was still conducted by the central government's Poppy-Eradication Force (PEF). This unit stopped operating the following year.

of 54,134.7 hectares of opium crops across 152 districts, which represents about 2.5% of the total area used for opium cultivation in these years (see Table 2.1).

While the exact process of eradication is unclear, some reports (like [ANSO, 2010b, p5]) suggest that once a governor had decided to initiate eradication, and had selected a given area to target, security forces were sent on the ground to identify the exact fields due for eradication. At a later date, these forces would return to the field with appropriate tools to effectively destroy the crops. Destruction took place through one of the following methods: Tractor-drawn plough, hand sticks or sickles, and (marginally) animal-drawn plough. As Table 2.1 shows, tractor-drawn plough was the most widely used method of eradication during the years studied in this work. This will play an important role in the instrumentation strategy I employ below.

2.1.4 Resistance to Law Enforcement and Associated Risks

One risk associated with manual eradication[11] is direct on-the-ground contact between eradication teams, who are protected by security forces, such as the Afghan National Police or the Afghan National Army, and individuals who oppose eradication. Such individuals can be either opium farmers, who directly suffer from eradication, or Taliban insurgents seeking to protect one of their sources of funding.

There is ample evidence that this resistance to law enforcement puts the eradication teams at risk. For instance, [UNODC, 2011, p6] reports that, in 2010, governor-led eradication teams were attacked 12 times. They were attacked 48 times in 2011. These attacks were caused by Taliban insurgents and opium farmers who opposed eradication. They took place in the form of direct assaults, mine explosion, voluntary field flooding, etc. Table 2.1 gives the number of casualties related to eradication missions. In 2013, 143 individuals died (both sides included) during eradication interventions.

[11] In this work, "manual eradication" refers to any of the three methods mentioned in Paragraph 2.1.3: Tractor-drawn plough, hand sticks or sickles, and animal-drawn plough. This allows for a clear distinction between the methods used in Afghanistan and others, such as aerial fumigation, which was used in Colombia and does not require direct on-the-ground contact. (Note: The use of aerial spraying for opium eradication in Afghanistan was proposed by former Ambassador to Afghanistan William Wood in early 2007, but was opposed by the then Afghan president Hamid Karzai. See [Katzman, 2009, p22].). The UNODC uses the appellation "manual eradication" for the hand sticks or sickles method only.

Various Afghanistan NGO Safety Office (ANSO) reports describe specific assaults on eradication forces[12]. For example, in 2010, somewhere between the end of April and early May, an Afghan National Police (ANP) convoy traveled to the Alani village of the Darayim District (Badakhshan province) to identify opium fields due for eradication. When the convoy came back a few days later to destroy the crops, it was targeted by an improvised explosive device (IED). Eight ANP officers died and one was injured. As the report states: *"ANP will likely continue to be targeted wherever poppy eradication operations are underway."*[13]

Such resistance opens a gap, for each Afghan location, between the probability of being targeted for opium eradication and the probability of being effectively subject to eradication. Beyond the physical impossibility for the eradication teams to conduct their tasks when they are under fire, violent resistance to law enforcement might also have a deterrent effect. In some southern districts of Afghanistan, for example, field reports (like [Mansfield and Fishstein, 2011, p39] for Nad-i Ali in Helmand) suggest that eradication forces were reluctant to even enter their target zones.

2.2 Data Description

The geography of Afghanistan can be stratified into five layers (in increasing order of granularity): Region, province, district and municipality[14]. The province and district levels are usually known as administrative levels 1 and 2 respectively, and they are the finest geographic layers for which data is available. This is the level at which I conduct the current research.

2.2.1 Time Frame

The focus of this study is the 2008-2015 period, which saw Afghan governors gradually take control of eradication campaigns (see Section 2.1). As Table 2.1 shows, forced

[12]See ANSO [2010a,b,c,d, 2011a,b,c,d,e,f] for such descriptions.
[13][ANSO, 2010b, p5].
[14]I use the blanket term "municipality" to designate a city, town, village etc.

opium eradication consistently took place between 2008 and 2015. After 2015, however, eradication levels dropped and no district was eradicated at level 0.2% or more (see below). I thus drop the years $2016-2018$ from the data as the propensity score is almost zero for all units in this period.

2.2.2 Opium Cultivation and Eradication

Each year, the United Nations Office on Drugs and Crime (UNODC) publishes a report on opium cultivation in Afghanistan (see, for example, UNODC [2008]). These reports give the total area, in hectares, of arable lands used for opium poppy cultivation per district in Afghanistan in a given year. They also contain eradication numbers for each district and year. I scraped these using the **Tabula** software.

Table 2.1 summarizes these numbers for the whole of Afghanistan. It shows that pre-eradication areas allocated to opium production increased steadily over the years 2008-2015, going from roughly 177,535 hectares in 2008 to 186,327 hectares in 2015, with a peak at 226,820 hectares in 2014. Eradication efforts, on the other hand, fluctuated a lot, between 2,315 hectares in 2010 and 17,595 hectares in 2012. As discussed above, from 2016 onward, eradication efforts dropped to a negligible 0.2% of total opium-cultivated area.

Table 2.2 further reveals that opium supply is heavily concentrated in the south: Helmand and Kandahar provinces alone represent about 65.3% of the cumulative area of land used for opium cultivation in the years 2008-2015. Interestingly, they compose only 54.7% of total Governor-Led Eradication efforts.

Data on opium prices and yields are extracted by hand from these reports. For detailed sources, see Chapter 3, Table 3.9. Opium supply (and eradication) in kilograms are obtained by multiplying cultivated areas (in hectares) by yields (in kilograms per hectare).

2.2.3 List of Afghan Districts

The naming and classification of districts is a long-running issue in Afghanistan[15]. From an empirical perspective, there are mainly three points to be addressed. First, different institutions operate with different district lists. Both the total number of districts and their provincial allocation vary between institutions. Secondly, even within institutions, the district list under use can change over time: Districts can be split, merged and sometimes temporarily created before being removed. Finally, there exist different districts (from different provinces) which have exactly the same name. To these general issues, one must add a problem specific to the English-speaking environment: Transliterations of names from the Arabic alphabet (Pashto or Dari) to the Latin alphabet (English) do not follow standard rules, making datasets mergers cumbersome.

To address these issues, I follow three steps. First, I convert all location names back to their original form, in the Arabic alphabet, to avoid transliteration errors. Secondly, in order to settle on a district classification, I follow the work of Roger Helms, conducted for Arcgis. I use the '399 district AGCHO' district classification. I adapt each dataset so that its locations match this list, up to one district. The final district list I use contains 398 districts. Finally, I join the different datasets I use based on the above spelling and classification. Details are given in Appendix 2.8.1.

2.2.4 Other Datasets

Administrative Boundaries.– Spatial data on the district boundaries of Afghanistan were also downloaded from the HDX wesbite[16]. They come in the form of shapefiles, that I import into **R** using the "rgdal" library.

Rainfall.– I download the GPCP Version 1.2 One-Degree Daily Precipitation Data Set from the Research Data Archive[17], which stores various meteorological and oceanographic

[15]For a recent overview of this issue, see Ruttig [2018].

[16]Available from: https://data.humdata.org/dataset/afghanistan-administrative-level-0-2-and-unama-region-boundary-polygons-lines-and-points. Accessing the data now requires a formal request.

[17]Available from: https://rda.ucar.edu/datasets/ds728.3/. Last Accessed on April 13th, 2021.

datasets for the Computational and Information Systems Laboratory. This dataset provides estimates of daily precipitations levels in millimetres around the world for the years 1996-2015. Each source of precipitations measure is localized using GPS coordinates (latitude, longitude). For each Afghan location i, I estimate the yearly precipitation in i and year t by summing the daily precipitations levels between January 1st and December 31st of year t at the source closest to the centroid of location i (locations' centroids are computed using the administrative boundaries dataset described above).

Violence.– The data on Taliban violence used in this study is the same as the one used in Chapter 3. It was extracted from the Global Terrorism Database (GTD), hosted by the University of Maryland. The GTD lists worldwide terrorist events based on media reports. For each violent event, it provides information such as date of event, location, identity of perpetrator, type of violence, number of casualties, etc. I only extract data concerning violence committed by the Taliban against public entities, such as police, military, government, NGOs, Transportation, Airports, etc. For details, see Chapter 3, Section 3.2.

2.3 Design

2.3.1 Variables of Interest

Timeline of Events.– Figure 2.1 gives the timeline of events of a typical year. [UNODC, 2008, p68] reports opium planting times. While these vary with location, they are clustered in the Fall. Eradication, by contrast, is spread throughout Spring, before harvest (see Figure 3.4 from Chapter 3 for details about eradication timing).

Outcome.– The outcome of interest is the supply of opium, denoted by $opium_{it}$ and measured in kilograms, for district i and year t. Alternative specifications also use the district area (in hectares) allocated to opium production in a given year. In that case, the out-

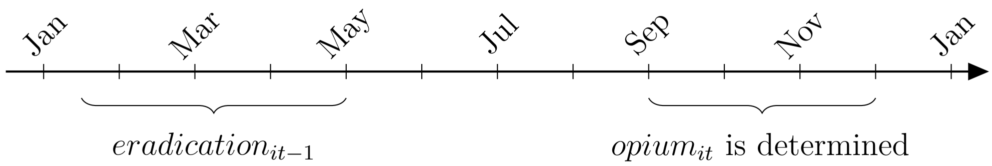

Figure 2.1: Year $t-1$ Timeline of Events.

come represents the suppliers' strategic choices[18].

Law Enforcement.– The law enforcement treatment $eradication_{it-1}$ is the volume, measured in kilograms, of opium crops eradicated in district i and year $(t-1)$. Alternative specifications also use the district area (in hectares) subject to eradication in a given year. That district i is treated at time t depends on two events: First, the governor of the province in which district i is located must have the ability to conduct eradication (that is, the material means to win over any local resistance). Secondly, they must be willing to initiate eradication (strategic choice).

Controls.– First, note that time-t opium supply $opium_{it}$ is positively correlated with its lagged value $opium_{it-1}$ (see Table 2.5(1)). Moreover, it is reasonable to assume, as in Figure 2.2, that $opium_{it-1}$, which is determined in the fall of year $t-2$ (see Figure 2.1), causally influences $eradication_{it-1}$, which is determined in the spring of year $t-1$. This is because the authorities must select target locations depending on the amount of opium cultivated there (see empirical evidence in Table 2.4). Therefore, omitting $opium_{it-1}$ in the regression of $opium_{it}$ on $eradication_{it-1}$ would cause upward omitted variable bias, thus causing an *under*estimation of the treatment effect.

To address this issue in the Arellano-Bond framework, I include $opium_{it-1}$ as a control for $eradication_{it-1}$. This feature requires the use of dynamic model methods, which I briefly discuss below. In the IV framework, the use of an instrument for $eradication_{it-1}$ which is exogenous to opium supply ensures that omitting $opium_{it-1}$ from the regression

[18] For example, for a given district×year observation (i,t) with F_i farmers, if L_{ik} is the total arable land available to farmer $k = 1, 2, ..., F_i$ and l_{ikt} is the share of it they allocate to opium production, then, in levels, the outcome would be $\sum_{k=1}^{F_i} l_{ikt} L_{ik}$. Moreover, if farmers are symmetric with land endowment $L_{ik} = 1/F_i$ and identical choice l_{ikt}, then $\sum_{k=1}^{F_i} l_{ikt} L_{ik} = l_{it}$, is the variable discussed in Chapter 1.

causes no bias (see details below).

Moreover, if law enforcement had a lagged effect on the outcome (of more than one period), and if it was persistent (so that $eradication_{it-1}$ was correlated with $eradication_{it-2}$), further lags of $eradication_{it-1}$ would be needed in the regression. I test whether the coefficient of $eradication_{it-2}$ is significant when two more lags are included in the model. Since it is not, and does not significantly change the coefficient of $eradication_{it-1}$, I leave it out.

Secondly, while the intention to enforce the law might be triggered by incentives such as those described in Subsection 2.1.2, effective eradication also depends on a governor's ability to ensure compliance with this decision. A point of concern is thus the presence of Taliban insurgents or Taliban-backed farmers who might fight law-enforcement authorities, and therefore decrease the probability of treatment (see Subsection 2.1.4). Since insurgent activity cannot be excluded from the opium supply equation[19], such effect might cause bias in the estimates. For example, if insurgent activity is positively correlated with opium production, and is negatively correlated with law enforcement, then there will be a downward bias, leading to an *over*estimation of the effect of law enforcement on opium supply. If Taliban violence is negatively correlated with opium production, and is negatively correlated with law enforcement, then the bias will be positive and the treatment effect will be *under*estimated (see Footnote 19).

Part of this insurgency is geographically entrenched and time persistent and must therefore be picked up by district fixed effects. However, there are also district$\times$year variations in violence due to the Taliban's strategic choices. To take this into account, I control for a measure of Taliban violence based on the GTD database described in Section 2.2. The variable $violence_{it-1} \in \mathbf{N}$ counts the number of fatalities due to conflict between the Taliban and public forces in location i, during the first quarter of the year $(t-1)$, that is, at the time when eradication is taking place (see Figure 2.1 for timeline and Section 2.2

[19] The link between conflict and opium production (ignoring feedback from farmers to conflict) in Afghanistan has been documented, even though research results do not yet converge. Lind et al. [2014], for example, find that conflict increases opium production through a substitution effect (from alternative crops to opium). Gehring et al. [2018] find that conditions favorable to opium production reduce conflict. Both claim causality.

for definitions). It is calculated per $100,000$ capita to correct for variations in locations' demographics. I thus interpret it as violence 'intensity'. This covariate must be treated with caution. Since it is realized simultaneously with law-enforcement, it does not have a straightforward causal interpretation. Results suggest its inclusion does not significantly change the results (see Table 2.5).

A word of caution is warranted here. A hasty interpretation of the theory presented in Chapter 1 would suggest that one should not control for violence because this would remove the indirect effect of law enforcement on opium supply given by Result 7. This reasoning is incorrect because of timing. The two effects of law enforcement for wealthy producers should be understood as follows. An increase in law enforcement at time $t-1$ increases the belief γ about law enforcement if the government is in power at time t. This is the direct effect of law enforcement. Simultaneously, this increase in law enforcement will increase $support_{it-1}$ (the same year, as shown in Chapter 3), which influences $violence_{it}$ with a lag. This, in turn, will decrease the probability $(1-\sigma(s))$ that the provincial government is able to conduct eradication at time t. The balance between the two determines the unconditional belief $\Gamma(s,\gamma)=(1-\sigma(s))\gamma$ about law enforcement in year t, which sets land allocation for year $t-1$. The violence I control for here is exerted at time $t-1$. It does not act through this mechanism.

Related to the previous point are climatic conditions. In general, heavy rains (or droughts) might affect both the supply of opium, through yields, and the law enforcement treatment, through logistics. By default, one might think that omitting rainfall from the regression would thus induce omitted variable bias. However, this is unlikely to be true as is. If rainfall has a direct effect on the law enforcement treatment because of logistics, then the channel must act during law enforcement, at the 'compliance' level, that is, in the spring of year[20] $t-1$. But such 'confounder' would need to be correlated with the outcome, which is determined one year later. Since I measure rainfall deviations[21], this

[20] From Table 2.4, one can see that there is no correlation between rainfall during eradication and eradication under OLS (Column(2)) or fixed effects panel data regression (Column (4)). A marginal (p-value= 7.6%) positive correlation arises with an Arellano-Bond approach applied to the Log of eradication area (Column (6)).

[21] In the Arellano-Bond approach, the covariates are differenced, so that one measures the year-on-year level change. In the IV panel data approach, one measures the deviation from yearly average using

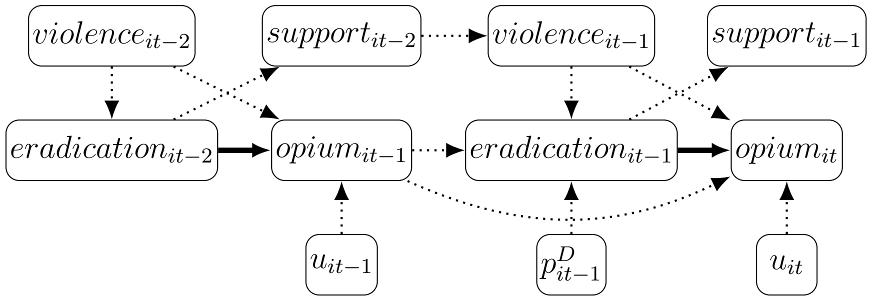

Figure 2.2: Causal Paths.

correlation seems highly unlikely. I therefore do not worry about omitted variable bias due to correlation with the treatment, when omitting rainfall from the regression.

This being said, it might still be useful to include rainfall in the regression to capture a greater variance of the outcome. In that case, one should measure rainfall in the period preceding harvests, that is, during the process of opium production. I therefore use a measure $Rain_{it-1}$ of precipitations (in mm) in the months preceding (September-January) harvests and eradication.

Finally, the probability of law enforcement depends on location-specific features, such as distance from Taliban strongholds (see Table 2.4(OLS)), total area, accessibility or ethnic composition. Another important determinant could be the historical implantation of state institutions in the territory. Therefore, I include district-specific fixed effects in the regression, which I denote by $\mathrm{FE}_i \in \mathbf{R}$. I also add time dummies δ_t, to control for district-invariant shocks that might impact the outcome.

2.3.2 Arellano-Bond Approach

Econometric Equation.– My first strategy to estimate the partial effect of law enforcement on opium supply is to use an Arellano-Bond approach through the following equation

$$\begin{aligned}\log(opium_{it}) = \beta \log(eradication_{it-1}) + \alpha \log(opium_{it-1}) \\ + \mathbf{X}_{it}\gamma + \delta_t + \mathrm{FE}_i + u_{it}\end{aligned} \tag{2.1}$$

the within transformation.

where $opium_{it} \in \mathbf{R}_+$ is the opium supply (in kilograms) in district i in year t. The covariate $eradication_{it-1}$ is a measure of the volume of eradication (in kilograms) taking place in district i and year $t-1$. Including the lagged outcome $opium_{it-1}$ as a predictor ensures that the eradication effect I measure is not due to supply persistence. The vector of controls $\mathbf{X}_{it} \equiv (Rain_{it-1}, violence_{it-1}) \in \mathbf{R}^{1\times 2}$ contains proxies for climate conditions and local Taliban activity during the law enforcement period (see 'controls' above). These variables vary both across time and space. The term FE_i is a district-level unobserved effect, while δ_t represents a time-varying intercept. Finally, $u_{it} \in \mathbf{R}$ is an observation-specific error term. The coefficient of interest is $\beta \in \mathbf{R}$, which is interpreted as the short-term elasticity of supply to law enforcement.

Estimation.– Equation (2.1) suggests at least two sources of endogeneity that might bias the estimation of β if one uses standard OLS. The first is due to the presence of the heterogeneous effect FE_i, which itself acts through two channels. First, since FE_i is present in the equation for all time t, it is *necessarily* correlated with the predictor $\log(opium_{it-1})$, thus introducing omitted variable bias. Secondly, even with $\alpha = 0$, that is, even if the lagged outcome was absent from Equation (2.1), the effect FE_i would potentially bias the estimation due to its possible correlation with the other covariates, such as $\log(eradication_{it-1})$.

The second source of endogeneity arises when $\alpha \neq 0$ *and* the error term u_{it} is autocorrelated. In that case, any shock at time $t-1$ or before will impact both $\log(opium_{it-1})$ and u_{it}, thus introducing introducing a correlation between these two variables, and endogeneity in Equation (2.1). This can be seen from the diagram presented in Figure 2.2, where one needs imagine a causal arrow from u_{it-1} to u_{it}.

To circumvent these issues, I turn to dynamic panel estimation[22] and make two key as-

[22]Without instrumentation, static panel methods, which are usually chosen to solve the first endogeneity problem, are insufficient given our second endogeneity concern. For the within estimator, for example, one sees that the transformed predictor $(\log(opium_{it-1}) - \overline{\log(opium_{i\cdot})})$ will always be correlated with the transformed error term $u_{it} - \bar{u}_{i\cdot}$ since $\log(opium_{it-1})$ depends on u_{it-1}, which is included in $\bar{u}_{i\cdot} \equiv \sum_{t=2008}^{2015} u_{it}$. For more details, see [Cameron and Trivedi, 2005, p764].

sumptions. First, I assume that, unlike in static panel estimation, the opium supply shocks u_{it} are uncorrelated over time, even within location clusters. This implies that all the time-persistent covariates (varying with location and) impacting the outcome — whether or not they are correlated with the treatment— are included in the model. In particular, this assumption implies that u_{it} excludes further lags of $\log(opium_{it})$ since this variable is autocorrelated (as shown in Table 2.5(1)). Thus, given Equation (2.1), opium supply must have at most an AR(1) time structure. I test for this by adding further lags of $\log(opium_{it})$ in the regression. They do change the results in any statistically significant way. Since $\log(eradication_{it-1})$ is time persistent after controlling for $\log(opium_{it})$, having uncorrelated shocks further imposes that u_{it} contains no further lags of eradication.

My second assumption is that the covariates in Equation (2.1) are predetermined in the sense that they are uncorrelated with current and future opium-supply shocks. This is another reason why u_{it} cannot contain further lags of $\log(eradication_{it-1})$. If it did, one would have $\text{E}[\log(eradication_{it-1})u_{it}] \neq 0$ since $\log(eradication_{it-1})$ is time persistent, which would violate my second assumption.

Thus, both my assumptions require that the level of eradication two years ago does not impact today's opium supply, except through the variables included in the model at time t, such as $\log(eradication_{it-1})$. This assumption could be violated if for example opium farmers reacted to the trend in eradication rather than to year-on-year policy. I test for this by adding further lags of $\log(eradication_{it-1})$ in the model. They do change the results in any statistically significant way.

Define $\mathbf{X}^*_{it} \equiv (\log(eradication_{it-1}), \mathbf{X}_{it})$. Then, the above assumptions[23] ensure that

$$Z_{it} \equiv (\log(opium_{i2008}), ..., \log(opium_{it-2}), \mathbf{X}^*_{i2008}, ..., \mathbf{X}^*_{it-1}, \delta_t)'$$

is a valid vector of instruments for the differenced version of Equation (2.1), that is,

[23] I also make the following two technical assumptions. 1) $|\alpha| < 1$ and 2) $\text{E}[c_i u_{it}] = \text{E}[\log(opium_{i2008})u_{it}] = 0$ for all $t = 2009, ..., 2015)$.

$E[Z_{it}\Delta u_{it}] = 0$, $t = 2010, ..., 2015$. We can thus follow Arellano and Bond [1991]'s GMM method for the estimation of β. Note that, with this method, only the years $2010 - 2015$ can be used as observations. The total sample size is thus $398 \times 6 = 2388$, as shown in Table 2.5.

2.3.3 Instrumental Variable Approach

Instrumentation.– My second strategy is to estimate the partial effect of law enforcement on opium supply using an Instrumental Variable (IV) approach. The idea is to exploit the exogeneity to opium supply of province-level fuel prices. Indeed, as discussed in Paragraph 2.1.1, opium production is labor-intensive and requires little agricultural infrastructure. Most of the tasks are performed by hand. The main production costs are labor, mostly for the lancing stage, and fertilizer[24]. Machinery, such as tractors, are not used in the Afghan opium industry[25]. I thus assume that fuel is not a significant input of opium production[26], which implies that it is excluded from the supply equation. By contrast, fuel is a major cost for law enforcement. As shown in Table 2.1, between 2008 and 2015, tractor-based eradication represented an average of 70% of total eradication efforts. While it is true that the cost of law enforcement is partially covered by the incentive schemes described in Paragraph 2.1.2, reimbursement of costs happens only after eradication verification, which is a lengthy process[27]. It is therefore reasonable to assume that, holding other factors fixed, fuel prices have a negative impact on law enforcement. Fuel price thus appears as a valid and relevant instrument for eradication when measuring the effect of law enforcement on opium supply.

This is confirmed by the results of Table 2.4, which shows that province-level petrol price has a strong negative correlation with eradication. To allow for district-level variation, I also interact petrol price with the kilometer distance from Helmand, the stronghold of the

[24] See, for example, [UNODC, 2014b, Table 6 p28]

[25] This is further confirmed by the fact that, AVIPA, an agricultural development program, subsidized the acquisition of tractors, partially in the hope that it would shift production to legal crops, such as wheat, which are more capital intensive than opium. See [Greenfield et al., 2015, p121 and p176].

[26] This assumption might be violated in select desert areas of the south, where some rich farmers can afford diesel-powered tubewell for irrigation. See [Mansfield and Fishstein, 2016, p20].

[27] For insights on verification methods, see MCN and UNODC [2010].

Taliban and the center of opium production in Afghanistan. Overall, I use the following two instruments

$$p_{it-1} \equiv \log(\text{Petrol Price}_{j(i)t-1})$$
$$p^D_{it-1} \equiv \log(\text{Petrol Price}_{j(i)t-1}) \times \text{Distance from Helmand}_i$$

where $j(i)$ is the province to which district i belong, and t indexes the years. The coefficient of the instrument p^D_{it-1} is interpreted as the differential effect of log fuel price on log eradication due to greater distance from the Taliban stronghold, which is associated with lower exposure to Taliban attacks[28]. Said differently, the coefficient of p^D_{it-1} is the change in the petrol-price elasticity of eradication across space. If its coefficient is negative, this means that the petrol-price elasticity of eradication decreases as one gets further away from Helmand.

The first stage corresponding to this instrumentation procedure is given by[29]

$$\log(eradication_{it-1}) = \eta_1 p_{it-1} + \eta_2 p^D_{it-1} + \mathbf{X}_{it}\eta_3 + \zeta_{t-1} + \text{FE}_i + u_{it} \tag{2.2}$$

where ζ_{t-1} represents time dummies and FE_i district-level fixed effects. The variable u_{it} is an observation-level error term. The results from this estimation are given in tables 2.9 and 2.9, confirming the relevant to this instrument.

Econometric Equation.– The panel-IV regression used to estimate the elasticity of opium supply to law enforcement is

$$\log(opium_{it}) = \tilde{\beta}\log(eradication_{it-1}) + \mathbf{X}_{it}\tilde{\gamma} + \tilde{\delta}_t + \text{FE}_i + v_{it} \tag{2.3}$$

where $\mathbf{X}_{it} \equiv (Rain_{it-1}, violence_{it-1}) \in \mathbf{R}^{1\times 2}$ is the exact same vector of controls as in Equation (2.1), and the terms FE_i and $\tilde{\delta}_t$ represent location and time fixed effects

[28] As Table 3.5 from Chapter 3 shows, Taliban attacks against public entities are mostly located in the South, in Helmand and Kandahar.

[29] I use the index $t-1$ to match Equation (2.3) below more closely. Note that $\mathbf{X}_{it}$ is a set of control which effect on $\log(eradication_{it-1})$ has no causal interpretation here.

respectively. The variable $v_{it} \in \mathbf{R}$ is an observation-specific error term. Under the above assumptions, the within-transformed version of the vector

$$\tilde{Z}_{it} \equiv (p_{it-1}, p^D_{it-1}, \mathbf{X}_{it}, \tilde{\delta}_t)'$$

is a valid vector of instruments for the within-transformed version of Equation (2.3). That is, $\mathrm{E}[\ddot{\tilde{Z}}_{it}\ddot{v}_{it}] = 0$, where $\ddot{\tilde{Z}}_{it} \equiv \tilde{Z}_{it} - \frac{1}{5}\sum_{\tau=2009}^{2013} \tilde{Z}_{i\tau}$ and $\ddot{v}_{it} \equiv v_{it} - \frac{1}{5}\sum_{\tau=2009}^{2013} v_{i\tau}$ are the within-transformed versions of the terms. The coefficient of interest is $\tilde{\beta} \in \mathbf{R}$, which is interpreted as the short-term elasticity of supply to law enforcement.

2.4 Results

2.4.1 Base elasticities

Opium Supply.– Arellano-Bond estimates of Equation (2.1) for the supply of opium are presented in Table 2.5. The baseline (AB1) shows a highly significant (at level 1%) and negative effect of eradication on subsequent opium supply. The estimate suggests a law enforcement elasticity of opium supply of roughly -0.24, which says that a 1% increase in opium eradication is associated with a 0.24% decrease in opium supply. As expected in Subsection 2.3.1, adding violence and rainfall controls (AB4) does not change the results. Corresponding IV estimates are given in Table 2.7. Standard IV estimation (IV1) yields highly significant and negative estimates, but with large variance, as can be expected in such cases. This gives a very large estimate for elasticity of supply, of roughly -1.3. Combining IV and Arellano-Bond (AB1) restores the figure to what was obtained above, with an estimate of -0.25, which says that a 1% increase in opium eradication is associated with a 0.25% decrease in opium supply. Here either, adding controls ((IV2) and (AB2)) does not significantly change the results.

Land Allocation.– Arellano-Bond estimates of Equation (2.1) for the land allocated to opium are presented in Table 2.8. They give comparable, but slightly lower estimates to those above, with a baseline law enforcement elasticity of opium supply of roughly −0.20, which says that a 1% increase in opium eradication is associated with a 0.20% decrease in the surface of land allocated to opium production. As we will see below, this might be due to geographic heterogeneity. Interestingly, violence does have a marginal and positive impact on land allocation. This is consistent with the mechanism proposed by Lind et al. [2014]. Rainfall, by contrast, is negatively correlated with the outcome. Since yields are have no effect on the outcome here, that might be suggestive of substitution effects in favor of water-intensive crops. For completeness, corresponding IV estimates are provided in Table 2.10.

2.4.2 Geographic Heterogeneity

Opium Supply.– Table 2.5 suggests that the law enforcement elasticity of opium supply varies with location. Indeed, columns (AB3) and (AB5) show that anti-narcotics law enforcement is much less effective in the south of Afghanistan, where the elasticity estimate is not statistically significant. As expected, the estimate for 'all regions but the south' is still highly significant and larger in absolute value (−0.254) than the one measured for the whole of the country. Symmetrically, the estimate for the northern region is very large, at around −0.45, which says at a 1% increase in opium eradication is associated with a 0.45% decrease in opium supply. Here either, adding violence and rainfall controls ((AB5) and (AB6)) does not change the results.

Land Allocation.– Table 2.8 not only comforts the pattern observed above, but adds new information to it. The estimated law enforcement elasticity of opium land allocation is not significantly different from zero in the southern region. Interestingly, moreover, the estimate for 'all regions but the south' is not only highly significant, but much larger, at −0.367, than the one estimated for the whole of Afghanistan (AB2). This is indicative that the strategic incentives faced in the south are very different than those of other regions. To confirm that, columns (AB3) shows that the estimate is even larger in absolute value of the northern region, at around −0.44, which says that in the north a 1% increase in opium eradication is associated with a 0.44% decrease in the surface of land allocated to opium production. Adding violence and rainfall controls ((AB5) and (AB6)) does not change the results.

2.5 Conclusion

Despite the large social and material costs of the counter-narcotics policy that was conducted in Afghanistan in recent years, no systematic study of its impact on opium supply had ever been conducted. This paper proposes the first rigorous evaluation of this policy, with a specific attention given to both opium supply as such, and to the amount of land allocated to opium production. This latter variable is of interest because it reflects the strategic choice of Afghan farmers, as influenced by their economic incentives (see Chapter 1). Here, law enforcement refers to the quantity, either in volume or surface, of opium fields that were eradicated in a given location in a given year.

Estimation is conducted using three methods. To address endogeneity concerns due to the time persistence of opium production, I use a standard Arellano-Bond framework, applied to the 398 Afghan districts for the years 2008-2015. I further propose an instrument for the treatment variable, which is based on the cost of conducting eradication. I then mix these two methods by using an AB-IV model. All results tend to the same conclusions.

My first finding is that the effect of counter-narcotics law enforcement is highly significant but modest in size. Various estimates suggest that a 1% increase in crop eradication leads to a decrease of roughly 0.24% in opium supply, when measured in kilograms. This estimate is slightly lower when one considers the surface of land allocated to opium production.

My second finding is that the effect of counter-narcotics law enforcement varies across space. Indeed, crop eradication does not seem to have significantly impacted either opium supply or the surface of land allocated to opium in the south of Afghanistan, which is the historical stronghold of Taliban insurgents. Since one of the official reasons for opium eradication is the need to weaken the insurgency, who benefits from opium traffic, this result should be of interest to policy-makers.

2.6 Tables

Year	*Pre-Eradication Opium Area (Ha)*	*Opium Eradication (Ha)*	*Opium Eradication (%)*	*Hand Eradication (%)*	*Tractor Eradication (%)*	*Deaths*	*GPI Rewards (millions of $)*
2008	177534.9	17594.9	9.9		88.0	78.0	38.0
2009	133124.2	5349.2	4.0	38.0	59.0	21.0	38.7
2010	126332.2	2315.2	1.8	13.0	86.0	28.0	25.7
2011	134868.4	3803.4	2.8	25.0	75.0	20.0	19.2
2012	164194.6	9759.6	5.9	33.0	67.0	102.0	18.2
2013	216796.0	7347.0	3.4	51.0	49.0	143.0	16.1
2014	226820.0	2693.0	1.2	51.0	49.0	13.0	
2015	186327.0	3760.0	2.0	38.0	62.0	5.0	
2016	201671.1	355.1	0.2				
2017	329106.3	751.3	0.2				
2018	261128.0	406.0	0.2				
Total	2157902.7	54134.7	2.5	24.1	68.9	410.0	155.9

Table 2.1: Opium Cultivation, Eradication Methods, Casualties and Incentives. Total Good Performers Initiatives funding for the years 2008-2015 comes from [DOS, 2009, 2010, 2011, 2012, 2013, 2015, p108,p95,p100,p91,p84,p95]. [DOS, 2016, p93] declares that 'The United States has put further GPI awards on hold, pending the remediation of vulnerabilities identified by a financial management assessment of the MCN [Ministry of Counter-Narcotics], as required by the U.S. Congress.' Other data was taken from UNODC Afghanistan Opium Survey reports (see Section 2.2).

Province	*Pre-Eradication Opium Area (Ha)*	*Share of Total Opium Area (%)*	*Opium Eradication (Ha)*	*Opium Eradication (%)*	*Share of Province in Total Opium Eradication (%)*
Helmand	685265.0	50.2	17938.0	2.6	34.1
Kandahar	205709.0	15.1	10819.0	5.3	20.6
Farah	140962.0	10.3	1227.0	0.9	2.3
Urozgan	79222.0	5.8	1418.0	1.8	2.7
Nimroz	75549.6	5.5	363.6	0.5	0.7
Nangarhar	55291.0	4.0	4464.0	8.1	8.5
Badghis	35602.0	2.6	585.0	1.6	1.1
Badakhshan	25756.0	1.9	9638.0	37.4	18.3
Other	62640.7	4.6	6169.7	9.8	11.7
Total	1365997.3	100.0	52622.3	3.9	100.0

Table 2.2: Opium Cultivation and Eradication Efforts over the years 2008-2015 by Province. Provinces in the bottom fifth cumulative percentile for the pre-eradication opium-cultivated area are aggregated in the 'Other' entry. Source: author's calculation based on UNODC data (see Section 2.2).

	Total	Mean	SD	Min	Max	N
2008						
Opium Area (Ha)	177,534.90	446.07	1,854.33	0.00	20,824.00	398
Opium Supply (Mt)	8,567.42	21.53	94.99	0.00	1,084.93	398
Opium Eradication Area (Ha)	17,594.90	44.21	184.50	0.00	1,814.00	398
Nb of Eradicated Villages	2,109.00	5.30	14.09	0.00	104.00	398
Nb of Taliban Violent Events	175.00	0.44	1.11	0.00	8.00	398
Nb of Taliban Fatalities	482.00	1.21	4.47	0.00	44.00	398
Rainfall (mm)	110,497.71	277.63	117.87	52.80	593.30	398
2009						
Opium Area (Ha)	132,863.23	333.83	1,457.32	0.00	19,632.00	398
Opium Supply (Mt)	7,510.68	18.87	84.67	0.00	1,148.47	398
Opium Eradication Area (Ha)	5,088.23	12.78	139.10	0.00	2,569.00	398
Nb of Eradicated Villages	412.00	1.04	5.28	0.00	68.00	398
Nb of Taliban Violent Events	123.00	0.31	0.93	0.00	8.00	398
Nb of Taliban Fatalities	282.00	0.71	3.54	0.00	36.00	398
Rainfall (mm)	168,897.89	424.37	134.63	104.78	659.05	398
2010						
Opium Area (Ha)	126,332.25	317.42	1,493.61	0.00	19,610.00	398
Opium Supply (Mt)	3,639.74	9.15	43.86	0.00	582.42	398
Opium Eradication Area (Ha)	2,315.25	5.82	53.29	0.00	964.00	398
Nb of Eradicated Villages	402.00	1.01	6.18	0.00	74.00	398
Nb of Taliban Violent Events	177.00	0.44	1.20	0.00	16.00	398
Nb of Taliban Fatalities	390.00	0.98	5.80	0.00	80.00	398
Rainfall (mm)	144,542.65	363.17	185.81	38.74	755.35	398
2011						
Opium Area (Ha)	134,868.40	338.87	1,363.41	0.00	12,844.00	398
Opium Supply (Mt)	5,999.29	15.07	63.62	0.00	617.80	398
Opium Eradication Area (Ha)	3,803.40	9.56	56.24	0.00	899.00	398
Nb of Eradicated Villages	593.00	1.49	6.20	0.00	60.00	398

Nb of Taliban Violent Events	137.00	0.34	1.02	0.00	10.00	398
Nb of Taliban Fatalities	517.00	1.30	5.91	0.00	60.00	398
Rainfall (mm)	148,489.34	373.09	117.60	85.85	676.24	398
2012						
Opium Area (Ha)	164,194.56	412.55	1,847.08	0.00	22,779.00	398
Opium Supply (Mt)	3,940.60	9.90	42.18	0.00	514.81	398
Opium Eradication Area (Ha)	9,759.56	24.52	105.82	0.00	1,182.00	398
Nb of Eradicated Villages	1,027.00	2.58	9.06	0.00	85.00	398
Nb of Taliban Violent Events	617.00	1.55	2.93	0.00	25.00	398
Nb of Taliban Fatalities	1,860.00	4.67	10.60	0.00	92.00	398
Rainfall (mm)	159,697.30	401.25	130.96	72.98	675.05	398
2013						
Opium Area (Ha)	216,796.00	544.71	2,217.57	0.00	19,645.00	398
Opium Supply (Mt)	5,736.15	14.41	54.76	0.00	455.76	398
Opium Eradication Area (Ha)	7,347.00	18.46	98.02	0.00	1,398.00	398
Nb of Eradicated Villages	814.00	2.05	8.87	0.00	135.00	398
Nb of Taliban Violent Events	613.00	1.54	2.80	0.00	18.00	398
Nb of Taliban Fatalities	2,230.00	5.60	13.36	0.00	104.00	398
Rainfall (mm)	167,314.50	420.39	168.60	73.26	822.85	398
2014						
Opium Area (Ha)	226,820.00	569.90	2,229.14	0.00	22,430.00	398
Opium Supply (Mt)	6,508.41	16.35	62.87	0.00	661.68	398
Opium Eradication Area (Ha)	2,693.00	6.77	44.15	0.00	680.00	398
Nb of Eradicated Villages	480.00	1.21	6.99	0.00	112.00	398
Nb of Taliban Violent Events	763.00	1.92	3.88	0.00	44.00	398
Nb of Taliban Fatalities	3,159.00	7.94	17.60	0.00	171.00	398
Rainfall (mm)	168,861.04	424.27	163.79	79.64	751.68	398
2015						
Opium Area (Ha)	186,327.00	468.16	1,743.71	0.00	17,544.00	398
Opium Supply (Mt)	3,436.97	8.64	29.11	0.00	282.46	398

Opium Eradication Area (Ha)	3,760.00	9.45	57.55	0.00	761.00	398
Nb of Eradicated Villages	619.00	1.56	7.37	0.00	86.00	398
Nb of Taliban Violent Events	923.00	2.32	4.56	0.00	35.00	398
Nb of Taliban Fatalities	4,052.00	10.18	22.56	0.00	186.00	398
Rainfall (mm)	175,832.74	441.79	180.83	81.95	946.83	398
Total						
Opium Area (Ha)	1,365,736.34	428.94	1,802.73	0.00	22,779.00	3,184
Opium Supply (Mt)	45,339.27	14.24	63.07	0.00	1,148.47	3,184
Opium Eradication Area (Ha)	52,361.34	16.45	103.94	0.00	2,569.00	3,184
Nb of Eradicated Villages	6,456.00	2.03	8.51	0.00	135.00	3,184
Nb of Taliban Violent Events	3,528.00	1.11	2.77	0.00	44.00	3,184
Nb of Taliban Fatalities	12,972.00	4.07	12.75	0.00	186.00	3,184
Rainfall (mm)	1,244,133.16	390.75	160.00	38.74	946.83	3,184

Table 2.3: Summary Statistics for the Years 2008-2015 (see Section 2.2).

	Dependent Variable						
	Log Opium Eradication Area						
	(OLS1)	(OLS2)	(OLS3)	(FE1)	(FE2)	(AB1)	(AB2)
Log Opium Area	0.285***	0.375***	0.153***	0.254***	-0.118	0.177***	-0.323
	(0.0230)	(0.0283)	(0.0585)	(0.0287)	(0.116)	(0.0573)	(0.278)
Distance to Helmand (100Km)	0.0746**	0.117***	0.365***				
	(0.0316)	(0.0372)	(0.0829)				
Log Petrol Price		-26.48***	12.66				
		(5.618)	(10.51)				
Log Rainfall During Erad.		0.0658	-0.101		-0.0666		-0.156
		(0.151)	(0.161)		(0.192)		(0.129)
Log Petrol Price × Dist. to Helm.			-7.565***		-7.307***		-9.879***
			(1.510)		(1.223)		(3.322)
Log Op. Area × Dist. to Helm.			0.0527***		0.104***		0.112*
			(0.0116)		(0.0201)		(0.0663)
Log Erad. Area Lag						0.0855**	-0.00172
						(0.0362)	(0.0426)
Constant	-0.596***	0.619	0.305	-0.139**	2.856**		
	(0.189)	(0.779)	(0.804)	(0.0621)	(1.283)		
Observations	3184	1976	1976	3184	1976	2388	1180
District Fixed Effects	No	No	No	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.4: Determinants of Law Enforcement for the Years 2008-2015. The outcome is the log-area (in hectares) of eradicated opium in district i and year t. The first three columns are standard OLS with standard errors clustered at the district level. Columns 4-5 are district-level fixed effect regressions with standard errors clustered at the district level. Columns 6-7 are Arellano-Bond style dynamic panel estimations with district-level fixed effects and heteroskedasticity-robust standard errors. Petrol prices are only available for years 2008-2012, so any sample using this covariate has size at most $5 \times 398 = 1990$ observations. Since the lagged outcome is unavailable for 2008, the Arellano-Bond sample of Column 6 starts in 2009 and loses one year due to differencing, so the sample size drops from 3184 to $3184 - 2 \times 398 = 2388$. For column 7, the sample size drops from 1978 to $1978 - 2 \times 398 = 1180$.

	Dependent Variable Log Opium Supply					
	(AB1)	(AB2)	(AB3)	(AB4)	(AB5)	(AB6)
Log Opium Supply Lag	0.387***	0.376***	0.412***	0.395***	0.407***	0.392***
	[0.231,0.542]	[0.224,0.527]	[0.227,0.598]	[0.257,0.532]	[0.277,0.537]	[0.241,0.543]
Log Opium Erad. Lag	-0.238***	-0.0520	-0.452***	-0.250***	-0.0613	-0.452***
	[-0.341,-0.136]	[-0.173,0.0688]	[-0.674,-0.231]	[-0.353,-0.147]	[-0.177,0.0541]	[-0.631,-0.272]
Log Opium Erad. × 'Not South' Lag		-0.254***			-0.280***	
		[-0.427,-0.0805]			[-0.449,-0.111]	
Log Opium Erad. × 'Not North' Lag			0.237**			0.243***
			[0.0433,0.430]			[0.0745,0.412]
Log Rainfall During Production Lag				-0.269	-0.0779	-0.213
				[-0.668,0.129]	[-0.510,0.355]	[-0.619,0.193]
Log Viol. Intens. During Erad. Lag				0.0543	0.0270	0.0448
				[-0.0348,0.143]	[-0.0633,0.117]	[-0.0425,0.132]
Observations	2388	2388	2388	2388	2388	2388
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.5: Arellano-Bond-Style Elasticity of Supply. Dynamic panel data estimation at the district level for the years 2009-2015. For each district and year, the outcome is the log of the opium supply (in kilograms). The treatment is the log of the eradicated volume (in kilograms). Instruments are lags from 2 back to year 2009 of the opium supply. Robust 95% confidence intervals are in brackets.

	Dependent Variable		
	Log Opium Eradication		
	(1)	(2)	(3)
Log Petrol Price	31.64	28.66	30.31
	[-12.96,76.24]	[-16.49,73.81]	[-15.70,76.32]
Log Petrol Price × Dist. to Helm.	-9.900***	-10.43***	-10.17***
	[-15.30,-4.500]	[-15.82,-5.044]	[-15.48,-4.872]
Log Rainfall During Production		-0.816***	-0.820***
		[-1.360,-0.272]	[-1.368,-0.273]
Log Viol. Intens. During Erad.			0.105
			[-0.0569,0.268]
Constant	2.477**	6.555***	6.321***
	[0.514,4.441]	[3.099,10.01]	[2.786,9.857]
Observations	1976	1976	1976
District Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.6: First Stage for IV Estimation of Elasticity of Supply. Panel data regression at the district level for the years 2008-2012. Eradication intervention is instrumented with an exogenous proxy of eradication suitability combining kilometer distance to the Taliban strongholds and petrol prices. Cluster-Robust 95% confidence intervals are in brackets.

	Dependent Variable Log Opium Supply			
	(IV1)	(IV2)	(AB1)	(AB2)
Log Erad. Lag	-1.343***	-1.318***	-0.248***	-0.292***
	[-2.230,-0.455]	[-2.159,-0.476]	[-0.360,-0.136]	[-0.404,-0.180]
Log Rainfall During Production Lag		-0.941*		-0.203
		[-2.003,0.121]		[-0.665,0.259]
Log Viol. Intens. During Erad. Lag		0.184		0.233***
		[-0.0725,0.440]		[0.0702,0.395]
Log Opium Supply Lag			0.362***	0.393***
			[0.180,0.544]	[0.227,0.559]
Constant	4.686***	8.830***		
	[3.536,5.836]	[3.324,14.34]		
Observations	1976	1976	1578	1578
District Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.7: IV Estimation of Elasticity of Supply. Instrumental variable regression at the district level for the years 2009-2013. Eradication intervention is instrumented with an exogenous proxy of eradication suitability combining kilometer proximity to the Taliban strongholds and petrol prices (see Table 2.6 for first stage). Cluster-Robust 95% confidence intervals are in brackets.

	Dependent Variable Log Opium Area					
	(AB1)	(AB2)	(AB3)	(AB4)	(AB5)	(AB6)
Log Opium Area Lag	0.352***	0.393***	0.389***	0.349***	0.410***	0.402***
	[0.173,0.531]	[0.238,0.548]	[0.238,0.539]	[0.185,0.513]	[0.263,0.557]	[0.262,0.541]
Log Erad. Area Lag	-0.200***	-0.0325	-0.437***	-0.234***	-0.0325	-0.465***
	[-0.323,-0.0776]	[-0.126,0.0607]	[-0.587,-0.288]	[-0.362,-0.106]	[-0.112,0.0465]	[-0.599,-0.330]
Log Erad. Area × 'Not South' Lag		-0.367***			-0.362***	
		[-0.543,-0.192]			[-0.547,-0.178]	
Log Erad. Area × 'Not North' Lag			0.261***			0.248***
			[0.0948,0.428]			[0.0781,0.419]
Log Rainfall During Production Lag				-0.197*	-0.125	-0.222*
				[-0.429,0.0341]	[-0.348,0.0968]	[-0.453,0.00832]
Log Viol. Intens. During Erad. Lag				0.0534*	0.0319	0.0482*
				[-0.000410,0.107]	[-0.0127,0.0765]	[-0.00307,0.0994]
Observations	2388	2388	2388	2388	2388	2388
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.8: Arellano-Bond-Style Elasticity of Land Allocation. Dynamic panel data estimation at the district level for the years 2009-2015. For each district and year, the outcome is the log of the opium area (in hectares). The treatment is the log of the eradicated volume (in hectares). Instruments are lags from 2 back to year 2009 of the opium supply. Robust 95% confidence intervals are in brackets.

	Dependent Variable Log Eradication Area		
	(1)	(2)	(3)
Log Petrol Price	17.67	16.37	18.00
	[-4.216,39.55]	[-5.758,38.49]	[-4.546,40.55]
Log Petrol Price × Dist. to Helm.	-5.829***	-6.061***	-5.806***
	[-8.740,-2.918]	[-8.958,-3.163]	[-8.641,-2.971]
Log Rainfall During Production		-0.356**	-0.360**
		[-0.660,-0.0519]	[-0.668,-0.0529]
Log Viol. Intens. During Erad.			0.104**
			[0.00663,0.202]
Constant	1.460***	3.239***	3.008***
	[0.483,2.437]	[1.371,5.108]	[1.094,4.921]
Observations	1976	1976	1976
District Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.9: First Stage for IV Estimation of Elasticity of Allocation. Panel data regression at the district level for the years 2008-2012. Eradication intervention is instrumented with an exogenous proxy of eradication suitability combining kilometer proximity to the Taliban strongholds and petrol prices. Cluster-Robust 95% confidence intervals are in brackets.

	Dependent Variable Log Opium Area			
	(IV1)	(IV2)	(AB1)	(AB2)
Log Erad. Area Lag	-0.961***	-0.996***	-0.166***	-0.210***
	[-1.665,-0.257]	[-1.718,-0.275]	[-0.291,-0.0410]	[-0.342,-0.0775]
Log Rainfall During Production Lag		-0.326		-0.0989
		[-0.803,0.151]		[-0.366,0.168]
Log Viol. Intens. During Erad. Lag		0.148**		0.103*
		[0.00286,0.293]		[-0.00922,0.216]
Log Opium Area Lag			0.287***	0.233**
			[0.106,0.469]	[0.0522,0.414]
Constant	2.476***	3.884***		
	[1.979,2.973]	[1.480,6.288]		
Observations	1976	1976	1578	1578
District Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.10: IV Estimation of Elasticity of Land Allocation. Instrumental variable regression at the district level for the years 2009-2013. Eradication intervention is instrumented with an exogenous proxy of eradication suitability combining kilometer proximity to the Taliban strongholds and petrol prices. Cluster-Robust 95% confidence intervals are in brackets.

2.7 Figures

2.8 Appendix

2.8.1 The Issue of District Classification

District Lookup Tool.– In order to address the district classification issues mentioned in paragraph 2.2.3, I use the work of Roger Helms, who built a District Lookup Tool for Arcgis[30]. This DLT provides two kinds of information: I-1) The three main district classifications under use, and the Latin-alphabet transliterations associated to them I-2) Common spelling variations that can appear in databases. In what follows, I use both.

Issues with District Names.– I use the original Arabic alphabet names of Afghan districts as a reference. This has two advantages, both linked to transliteration. First, it makes it easier to identify different words that correspond to the same district names. For example, comparing the three words Kofab, Kuf Ab or Kufab with the district name کوف آب ensures that they are all reasonable variations of the *same* name, and not different names. Secondly, using the Arabic alphabet ensures that homonyms do have the same name in either Pashto or Dari, and that they are not the result of approximations in the data entry or transliteration process. For example, the provinces of Ghazni and Helmand host districts named ناوه (Nawa) and ناوه بارکزائی (Nawa-e-Barakzaiy) respectively. Some English-written sources wrongly register both under the single name Nawa, thus generating spurious homonyms. I correct for this by restoring spelling differentiation. Note that there can exist true homonyms, like کوهستان (Kohistan), which is a district both in the province of Faryab and Badakhshan.

Using I-2 above, I build a table L of all the different English spellings corresponding to original Pashto or Dari location names. The table is "initialized" using the Lookup Tool described above. Then, for each dataset D, I look for matches between the English-written district names in D and the table L. Whenever a district name is unmatched, but has a clear correspondence, I add it as a new variation to L (all district names of all datasets were matched). The result is a table giving, for each district, all English spelling

[30] See Afghanistan District Maps. Last accessed on February 4th, 2021.

variations of its name that exist in any of the datasets I use. Finally, I pick one spelling of all locations.

District Classification.– Among the three main district classifications given by I-1), I pick the '399 district AGCHO' classification. To quote Roger Helms: *"The set was established and mapped by the Afghan government and mapped by AGCHO/AIMS in June 2005, but without Sharak-e-Hayratan. It was updated by the AGCHO in 2012 with improved borders and the addition of Sharak-e-Hayratan. The 399 set is the one most commonly used in the aid community."* Moreover, the '399 set' is the classification with the fewest districts. This means that each dataset D either uses this classification, or uses a classification with more districts. If the latter, I merge the associated districts and use the corresponding district name under the 399 set[31]. For example, in the province of Bamiyan, the district of Yakawlang (یکاولنگ) is divided into two districts, Yakawlang 1 and Yakawlang 2, under the 422 districts classification used for the CSO population estimates. In this case, I simply add the underlying two populations to obtain an estimate of the population in the district of Yakawlang. This way I map each data set D into a dataset D' with exactly 399 district names.

Miscellany.– The UNODC reports (e.g. UNODC [2008]) list a "Shamul *" district in the province of Paktia, as well as "Hisaiduwumi" and "Panjshir" districts in the province of Panjsher. I find no trace of those anywhere else[32]. Opium cultivation (and thus eradication) is zero for all the years considered. I thus remove them from the dataset.

In Balkh province, I make Sharak-e-Hayratan part of Kaldar, so that the reference number of districts is 398, not 399.

The UNODC data lists a "Kohestan" district in Kapisa. There are "Kohestan" districts

[31] Given that splitting districts entails arbitrary choices, while merging them is straightforward, settling for the 399 set was an easy choice.

[32] In particular, I find no trace of them in the ACHO Demographic Census dataset. It it worth noticing, however, that "Hisaiduwumi" means "second part." In the same province, there exists a "Khenj" district also known as "Hissa-e-Awal", which means "first part." Roger Helms moreover states that, in the same province, the district of "Onaba" is also know as "Hisa-e-Char" (without giving an Arabic-alphabet version of it), which could mean "part of the wheel."

in both Badakhshan and Faryab, but not in Kapisa. In Kapisa, there is a "Hisa-e-Awal-e-Kohestan" and a "Hisa-e-Duwum-e-Kohestan" districts. I remove the "Kohestan" from the dataset.

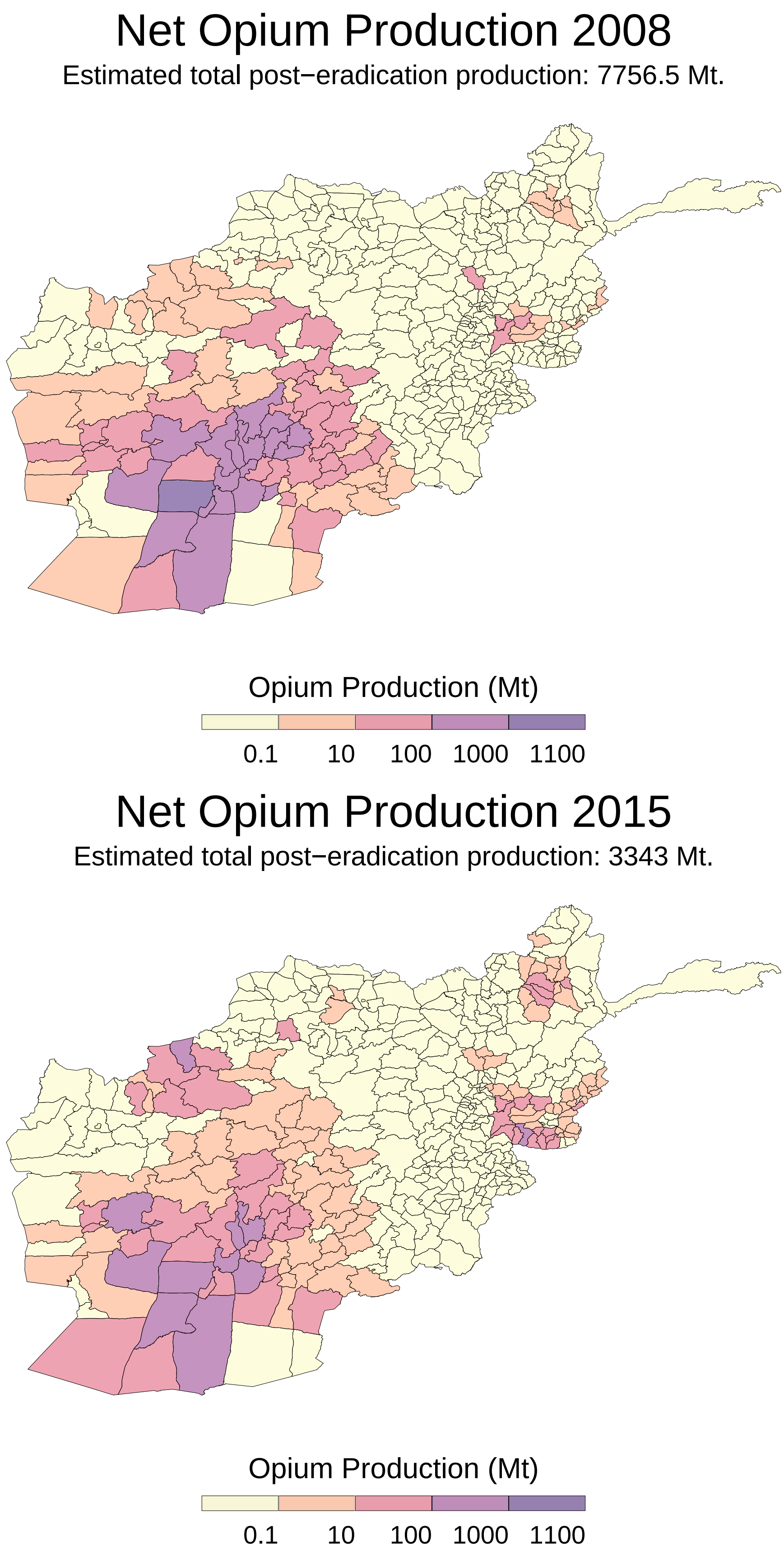

Figure 2.3: Opium Cultivation per District for the Years 2008 and 2015. Detailed summary statistics can be found for each year in Table 2.3.

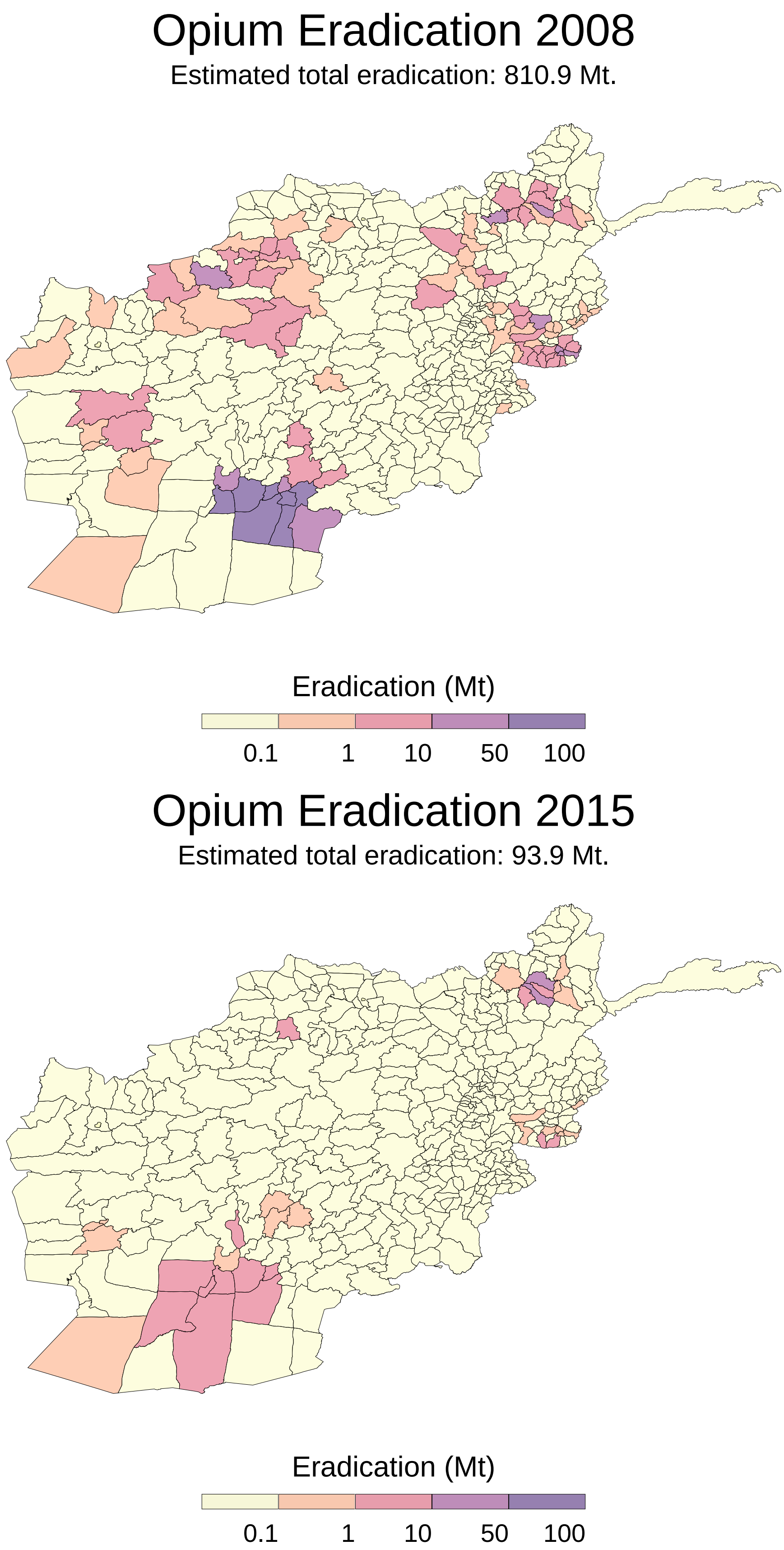

Figure 2.4: Opium Eradication per District for the Years 2008 and 2015. Detailed summary statistics can be found for each year in Table 2.3.

Chapter 3

Counter-Narcotics Operations Might Have Strengthened the Taliban Insurgency

Abstract

The contribution of this paper is to estimate the effect of anti-narcotics law enforcement on the population's self-declared support for military actors in Afghanistan. I find that those provinces where law enforcement induced the eradication of 10% or more of the total opium-cultivated area exhibit greater sympathy for opposition armed groups, and less trust in the national army. This effect is driven by the Pashtun sub-population, which agricultural sector relies more heavily on opium cultivation. These results highlight the antagonism of two aspects of state development in Afghanistan: Counter-narcotics law enforcement and counterinsurgency.

Keywords: State-Building, Law-Enforcement, Drug-Control, Afghanistan, Opium Cultivation

Introduction

Whether in the form of political preference or direct action, popular support is decisive to the outcome of civil conflict. Civilians not only provide labor force, shelter and food, but they can also facilitate access to information (or make it harder for the enemy), logistics, and other organizational resources. This role has proven crucial in Afghanistan, where the American army, equipped with more soldiers and better technology, was held back by the comparatively frugal Taliban insurgency.

It is now widely accepted that neither absolute civilian coercion nor blunt military power is sufficient to end civil wars on its own[1]. This is why relations between fighting entities and local populations are of primary interest to researchers. This is particularly true when it comes to the impact of public policies on government-civilian relations during civil conflict.

For example, in a pioneering article about the Iraq War, Berman et al. [2011] found evidence that public good provision increases information sharing from the civilians to the government, and helps reduce insurgent violence. Studying Afghanistan, Beath et al. [2011] found that populations who benefited from the National Solidarity Program (which aimed at providing infrastructure and services to the Afghan rural population) were more likely to have a positive view of their government and less likely to support insurgents, which reduced violence. Condra et al. [2010] found that civilian casualties caused by the International Security Assistance Force (ISAF) led to a 'revenge' effect increasing subsequent insurgent violence. Confirming this trend, Lyall et al. [2013] established that harm inflicted on civilians by the ISAF significantly increased support for the Taliban[2]. Finally, Condra and Wright [2019] showed that such blunders had concrete effects on information sharing and conflict: When they perceive that the government carelessly uses force against them, civilians declare to be less willing to report roadside bombs to the

[1] On the role of civilians during civil conflict, see [Kalyvas, 2006, p91-103] and [Weinstein, 2006, p163-197]. On the ending of civil wars, see Walter [1997, 2004], Fearon [2004], Collier et al. [2004], Toft [2006], and Toft [2010].

[2] Interestingly, these authors find an asymmetric effect: harm inflicted on civilians by the Taliban *does not* translate into support for the ISAF. However, Wright et al. [2017] find that victimization by the insurgents does increase the amount of information civilians share with the government.

authorities.

It is thus natural to wonder: What happens to government support when a resource which is both essential to millions of civilians and central to the funding of an insurgency, is regularly pounded, year after year, with little offered in exchange[3]?

To answer this question, I turn to the Afghan opium industry. In 2008, at the beginning of this study, the total farmgate value of opium production was of US$730 million, which represented 93% of global production. No less than 9.8% of the total Afghan population was involved in growing it. And most of this production was subject to the *ushr* tax, of roughly 10%. This money was not collected by the government (since production was illegal), but by local strongmen such as the Taliban insurgents. They also benefited from opium processing and trafficking, which is estimated to have raised their revenues by hundreds of millions of dollars[4]. The renewed opium eradication campaign that started that year was thus bound to have consequences on the relations between the Afghans, their government and the Taliban insurgents.

The objective of this paper is to document the effect of the forced opium eradication program that took place between 2008 and 2015 in the country. Using nationally representative survey data, I track civilians self-declared sympathy for opposition armed groups and trust in the Afghan national army. Each year, the survey waves took place 6-7 weeks after the end of the counter-narcotics operations. Exploiting this suitable timing, I test whether insurgent support or government trust was affected by the eradication operations that took place in the country. I present two main conclusions.

My first finding is that crop eradication had two highly significant and converging effects. First, it made the insurgents stronger by raising the support they received from civilians. I estimate that provinces that went through eradication were associated with roughly a 10 percentage point increase in self-declared sympathy for opposition armed groups. Secondly, eradication made the government weaker by deteriorating the trust civilians had in their security bodies. I find that a 5 percentage point decrease in government

[3] On rural development programs in Afghanistan see, for example, Greenfield et al. [2015] and UNODC [2019].

[4] See [UNODC, 2008, p5 and p30-32], and Table 3.1 below.

trust followed eradication.

My second finding is that this effect is almost entirely driven by the Pashtun ethnic group. This is not surprising, since this sub-population is particularly dependent on opium production. However, this is a source of concern because Afghanistan is divided along ethnic lines and since Taliban insurgents are exploiting this divide to gain support. By hurting southern Pashtuns, the government might have played into the insurgents' hand.

The rest of this paper is organized as follows. Section 3.1 possible mechanisms linking crop eradication and insurgent support. Section 3.2 presents the data used for this study. Section 3.3 discusses the empirical strategy. Section 3.4 describes the results I obtained. Section 3.5 concludes.

3.1 Mechanisms

The potential impacts of opium eradication on Afghan populations

When, in 2009, the Obama administration decided to move the focus of its Afghan opium policy away from opium eradication (while simultaneously incentivizing Afghan officials to take over), it had concerns that forced eradication turned the Afghans against their government and slowed the state-building process. To quote Richard Holbrooke, the Obama administration's special representative for Afghanistan and Pakistan: *"[Western opium policies] did not result in any damage to the Taliban, but they put farmers out of work and they alienated people and drove people into the arms of the Taliban."*[5] This statement sums up the mechanisms potentially at play behind the empirical results presented in this study. To illustrate them, we list different channels, summarized by [Coyne, 2016, pp7-14], through which eradication could impact the lives of ordinary Afghan people.

First, by increasing the marginal cost of cultivation, opium eradication directly or indirectly reduced the income of millions of Afghans. As shown in Table 3.3, for the 2008-2010 period, at least 1.5 million people were growing opium each year, and between 2008 and 2013 farmers consistently reported poverty as a leading reason for opium cultivation.

[5] Risen [2008]. First quoted by [Coyne, 2016, p11]. See also [Katzman, 2009, p21].

Moreover, due to its size, the Afghan opium industry makes a large share of the legal economy depend on it. This induces a (negative) 'multiplier effect' of opium eradication which is not captured in the above figures. Therefore, any estimate of the cost of eradication based on direct effects only would be an understatement of its total cost[6].

Secondly, Coyne argues, opium eradication might have primarily targeted vulnerable farmers and thus generated a sentiment of unfairness among the Afghan population[7]. Indeed, the effect of increased production costs might have been to drive small, less efficient producers off the market first and, consequently, to cartelize the Afghan opium market. Besides, the Taliban might have seized this opportunity to offer protection to the remaining producers in exchange for opium taxes, and these large producers might have become integrated within the Taliban[8].

Thirdly, according to Coyne, who relies on Clemens [2008, 2013], given that the demand for opium was estimated to be inelastic, the reduction in supply that followed eradication led to an increase in opium prices[9]. Since opium cultivation is concentrated in Taliban areas, this would imply that resources flowing to the Taliban increased as a result of eradication. This, in turn, can only increase insurgent violence which can hurt civilians[10] (either directly or through collateral damages).

Fourthly, Coyne writes, eradication campaigns reinforced the culture of corruption in Afghanistan. Many officials were deeply connected to the opium trade, and the financial incentives they received to fight drug trafficking were ill-conceived. After having eradicated given areas and received money for it, some Afghan governors would either use

[6] Regarding the multiplier effect of opium cultivation, see [Fishstein, 2014, Paragraph 4.2.2, p24-26].

[7] In the words of [Blanchard, 2009, p47]: *"Some field researchers report that in some areas, locally administered eradication results in the targeting of the fields of non-influential and smaller scale landowners and farmers unwilling or unable to secure political protection".*

[8] On that point, see also [Fishstein, 2014, 'Two sides of the coin: support for the Taliban and alienation from the state', p49].

[9] I am not aware of any rigorous study proving this fact (see Clemens [2008] for a first attempt). However, [UN, 2010, p12, paragraph 55] shows that the Afghan Ministry of Counter Narcotics was concerned with the impact of decreased opium supply on opium prices. See also [SIGAR, 2010b, p108]: *"According to the June 2010 report of the Secretary-General of the United Nations (UN), decreased production could lead to increases in opium prices. Higher prices could create a perverse incentive to cultivate poppy, as noted in May 2010 by the UNODC spokesman in Kabul. The Ministry of Counter-Narcotics (MCN), the UNODC, and their partners are conducting a survey to assess the situation according to the UN Secretary-General".* For a broader discussion on that topic, see Footnote 3 from Chapter 2.

[10] On that, see also Footnote 2.

the money to run their own opium cultures elsewhere or turn a blind eye on preexisting ones in exchange for farmers' payments. In either case, civilians might have suffered from generalized corruption in their country[11].

Finally, Coyne writes, changing policies have increased uncertainty, which disincentivized investment and hurt the trust people had in their government. To give one example, the US funded local militias that acted beyond the control of the government, and sometimes in opposition to it (see [Mansfield, 2016, pp100-102]). In effect, the US pitted provincial power centers against the national government, which lost credibility in the eyes of its people.

A note on the exposure of Pashtun populations to eradication

Afghanistan is a divided country, with various power centers, at times gravitating around tribal and ethnic identities[12]. Among other social divisions is the Pashtun/Non-Pashtun cleavage, which extends to economic activity. As an illustration, Table 3.2 defines agricultural dependence on opium culture as the percentage share of pre-eradication opium-cultivated area in total cultivated area for the year 2016[13]. It shows a high correlation between the share of Pashtuns in a given province and its economic dependence on opium[14]. This suggests that eradication would induce a greater cost for Pashtun populations than Non-Pashtuns.

[11]Notorious cases of corruption are reported in Risen [2008]. See also footnote 6 from Chapter 2.

[12]See [Mansfield, 2016, pp92-93 and p97].

[13]See Section 3.2 for details about the data. Land utilization figures for the other years were not available.

[14]One notable outlier is Nimroz, which population is only 26.8% Pashtun. However, this province shares its longest border with Helmand, which is one the Afghan provinces with the highest concentration of Pasthuns and the largest agricultural dependence on opium cultivation. Statistically, running a pooled regression, I find a positive and significant correlation (at level 1%) between agricultural dependence on opium cultivation and percentage share of Pashtun population.

3.2 Data Description

3.2.1 Opium Cultivation and Eradication

The opium cultivation and eradication data I use for this study is the same as in Chapter 2 (to which I refer the reader for further details). The primary sources are yearly United Nations Office on Drugs and Crime (UNODC) reports on opium cultivation in Afghanistan (see, for example, UNODC [2008]). These reports give the total area, in hectares, of arable lands used for opium poppy cultivation per district (or province) in Afghanistan in a given year. They also contain eradication numbers for each district and year. Table 3.1, reproduced from Chapter 2, summarizes this data.

3.2.2 Taliban Violence Against Public Entities

Data on Taliban violence was extracted from the Global Terrorism Database (GTD)[15], hosted by the University of Maryland. The GTD lists worldwide terrorist events based on media reports. For each violent event, it provides information such as date of event, location, identity of perpetrator, type of violence, number of casualties, etc. I only retain violent events that: 1) Were perpetrated by the Taliban[16] 2) Target "public entities": Police, military, government, NGOs, Transportation, Airports, etc.[17] 3) Have a known geo-localization.

There is a total of 3528 violent events that meet the above criteria for the years 2008-2015. Among those, 3224 (91.4%) concern direct attacks by the Taliban against the military, the police, or government institutions. The rest is composed of attacks by the Taliban against NGOs, infrastructures, etc. From this, I build a table giving for each location and year the total number of terrorist events caused by the Taliban, together with total

[15] Available from: http://apps.start.umd.edu/gtd/contact/. Last accessed on April 13th, 2021.

[16] Out of the 5053 registered violent events (all categories included) that took place in Afghanistan in the 2008-2015 period *and* which perpetrators are known, 4852 (96%) were perpetrated by the Taliban. The remaining 201 (4%) events have been conducted by various groups such as the Haqqani Network (71 events), the Khorasan Chapter of the Islamic State (58 events), or the Hizb-I-Islami group (27 events). Note that the Haqqani Network is known to militarily collaborate with the Taliban.

[17] Among others, this excludes violence against religious sites, political parties, etc.

fatalities.

Table 3.4 gives the number of Taliban-related violent events and their associated fatalities for each year between 2008 and 2015. A total of 3528 violent acts were caused by the Taliban against public entities between 2008 and 2015. They led to the death of 12972 individuals (counting perpetrators). Both the number of violent acts and the fatalities they caused increased steadily over the period, revealing the country's growing instability.

Table 3.5 gives the number of Taliban-related violent events and their associated fatalities aggregated for the years 2008-2015 by province. Helmand and Kandahar were the most the most violent provinces. Quite interestingly, for other provinces, violence is not as concentrated as one might expect.

3.2.3 Survey of the Afghan People

I use waves 3 through 10 of the Afghanistan Survey conducted each year by the Afghan Center for Socio-Economic and Opinion Research (ACSOR), a subsidiary of D3 Systems Inc., for the Asia Foundation[18]. This constitutes a total of eight survey waves executed between 2008 and 2015. For each wave, the population was stratified by province and, within each province, by rural and urban areas. For each stratum, Afghan administrative districts served as the primary sampling unit. They were selected via probability proportional to size sampling.

Cooperation rates are high; they vary between 92.7% and 95.4%. Margins of error of a 95% confidence interval for national estimates, accounting for the complex design, vary between 2.4% in 2008 (#respondents= 6593) and 1.6% in 2015 (#respondents= 9586). Further details are provided in the survey reports' appendix, under the "Methodology" section. The dataset comes in the form of an .rdata file containing survey responses for all waves.

The survey contains a wide range of questions capturing concerns regarding topics such as political institutions, the economy or security. In particular, it records attitudes towards

[18] See https://asiafoundation.org/programs/survey-of-the-afghan-people/ for the latest year report, and the tab "Resources" for previous years. The whole dataset can be accessed under the "Data" tab, following free registration. Last accessed on May 25th, 2020.

opposition armed groups (mainly, the Taliban), as well as the national army (see below for details).

3.2.4 Other Datasets

Population.– Population data comes from the Office for the Coordination of Humanitarian Affairs (OCHA) Afghanistan. It is available on the Humanitarian Data Exhange (HDX)[19] of the United Nations Office for the Coordination of Humanitarian Affairs.

Agriculture.– Table data on the area of Afghan agricultural lands and their share of utilization are taken from the Afghanistan Interactive Province-level Dashboard of the World Bank's website[20]. It compiles various datasets providing information on time-invariant variables related to agriculture, demographics, poverty, etc., in Afghanistan at the provincial level, circa 2016. To estimate the hectare area of agricultural land under utilization I multiply the square-kilometer area variable "Geography-Agriculture Area" by the percentage indicator "Geography-Cultivated Land Area" and change the measurement unit to hectares.

3.3 Design

Timeline of Events.– Figure 3.1 gives the timeline of events of a typical year. [UNODC, 2008, p68] reports opium planting times; while these vary with location, they are clustered in the Fall. Eradication, by contrast, is spread throughout Spring, before harvest. Surveys are conducted within two or three weeks in late summer. Details can be found in Figure 3.4 which gives precise time distributions for each year. For treated units, an average of 48.5 days separates the time at which Governor-led eradication reached level 10% from the time of survey completion.

[19] Available from: https://data.humdata.org/dataset/afg-est-pop. Last accessed on March 9th, 2021.
[20] Available from: https://www.worldbank.org/en/data/interactive/2019/08/01/afghanistan-interactive-province-level-visualization. Last Accessed on April 13th, 2021.

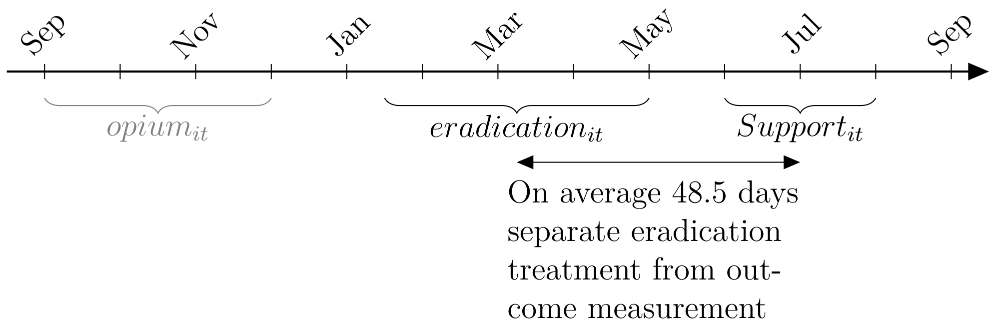

Figure 3.1: Timeline of Events. For details, see Figure 3.4.

Outcomes.– For each location and time, sympathy towards opposition armed groups is measured by the percentage share[21] of respondents who answered 'a little sympathy' or 'a lot of sympathy' to question x77a: *Thinking about the reasons the armed opposition used violence during the past year, would you say that you in general have a lot of sympathy, a little sympathy, or no sympathy at all for these armed opposition groups?* Attitude towards the Afghan National Army (ANA), by contrast, is measured by the percentage share of respondents who answered 'agree somewhat' or 'strongly agree' to question x35a: *I'm going to read a statement to you about ANA. Please tell me if you agree with it. ANA helps improve the security.* Whatever the question considered, the outcome is a percentage share $Support_{it} \in [0, 100]$ varying with both location and time.

A remark is in order. The reader might have noticed that I measure trust in Afghanistan' national security institutions through the ANA, and neither the ANP or the Afghan Local Police (ALP). There are different reasons for this. First, the ANA was the country's main security body, which constituted the backbone of what was supposed to be Afghanistan's reconstruction. Its relation with civilians was emblematic of government support. Secondly, the ANA has been consistently involved in counter-narcotics operations and in managing the interface between eradication teams and local populations[22]. Thirdly, Afghan police bodies were much less integrated within the security apparatus and widely

[21] Aggregates are computed using sampling weights.

[22] For example, [Mansfield, 2014, p39] : *"In fact, many rural communities were under the impression that the ANA commander who led these operations—appreciative that the Taliban were asked by villagers to leave the area and grateful that farmers did not take up arms themselves—announced to the district's elders that their opium crop would not be destroyed in the spring of 2013"* and [Fishstein, 2014, p43] : *"In Khogiani District in early 2013, the unravelling of the ban was confirmed when an Afghan National Army (ANA) commander essentially gave up on eradication in exchange for the local population's support in a counterinsurgency operation."*

known to be corrupt, particularly when it comes to counter-narcotics operations[23].

Figure 3.2 presents the geographical distribution of survey responses averaged over the years studied. Sympathy towards opposition armed groups appears to be particularly high in south eastern provinces such as Kandahar, Zabul and Paktika. As expected, the trend is reversed when it comes to the belief that the Afghan National Army is helping securing the country[24].

Treatment.– I think of eradication as a binary treatment $eradication_{it} \in \{0, 1\}$. Province i is defined as treated at time t ($eradication_{it} = 1$) if the UNODC declares that at least 10% of the opium-cultivated area in province i and at time t was eradicated, and it is defined as untreated otherwise ($eradication_{it} = 0$). That unit i is treated at time t depends on two events: first, the governor of province i must initiate eradication in year t. Secondly, the percentage of eradication effectively observed must reach the threshold 10%. A map of the treatment status of each province and each year is given in Figure 3.3.

Controls.– In the absence of controls, there would be endogeneity concerns. First, given that year-t crops are planted in the fall of year $t-1$ (see Figure 3.1), provincial governors observe pre-eradication levels of opium $opium_{it}$ *before* deciding on $eradication_{it}$. In fact, it is natural to assume that there is a causal link between the former to the latter. For example, governors might target locations with expansive output to curb opium supply. By contrast, they might elect to eradicate small plantations first, in the hope of decisively discouraging opium cultivation. This is why I include $opium_{it}$ in my regression. Given that it is determined before $eradication_{it}$, there is no risk that it is a so-called 'bad control'.

Secondly, as discussed in Chapter 2, while the decision to initiate opium eradication might

[23] [Mansfield and Fishstein, 2013, p9]: *"Given the fluid and opportunistic histories of many of the ALP commanders, much of the population has been ambivalent about their role, and concerns have been raised about both their loyalty and their commitment to the counter-narcotics agenda."* See also [Fishstein, 2014, Box 4, p28]. Regarding the link between the ANP and the ALP, see afghanistan-analysts.org.

[24] Interestingly, the neighbor province of Helmand displays much lower support for opposition armed groups than Kandahar (32.9% vs 63%). Average trust in ANA in Helmand is 82.7%, but it is of only 76.1% in Kandahar, 76.4% in Paktika, and 43.2% in Zabul.

be triggered by incentives such as those described in Section 3.1, effective eradication also depends on a governor's *ability* to execute this decision. In fact, I postulate the existence of an unobservable variable capturing the propensity of opium farmers to resist opium eradication, in a given location and at a given time. This variable is a determinant of treatment, but because it is unobservable, I build a proxy for it. As suggested by UNODC's survey results (see Table 3.3), I assume resistance to opium eradication mainly spurs from economic insecurity. For each location i and time t, I compute the percentage share $resistance_{it} \in [0, 100]$ of individuals who answered 'unemployment', 'poverty', 'high prices' or 'a poor economy' to survey question x8a: *What is the biggest problem in your local area?* I lag this control to ensure precedence of the proxy over treatment. It is reasonable to think that such answers do not influence the outcome once the unobservable and other covariates are controlled for. A second requirement for the consistent estimation of the treatment effect is that the unobservable variable capturing the propensity of opium farmers to resist opium eradication is uncorrelated with treatment status after controlling for the proxy. It is hard to believe that my proxy is good enough to ensure perfect uncorrelatedness, but I assume that any residual correlation is small enough to leave the sign of my estimate of interest unchanged.

A third and related point of concern is the presence of Taliban insurgents who might fight eradication forces, and therefore decrease the probability of treatment. To take this into account, I control for a lagged measure of insurgent violence based on the GTD database described in Paragraph 3.2.2. The variable $violence_{it} \in \mathbf{N}$ counts the number of Taliban-related events that took place in location i in year t. The argument for the validity of this proxy follows the same lines as above. The main assumption made here is that the residual correlation between insurgent resistance to eradication and treatment status after controlling for the proxy is small.

Fourthly, given that eradication at time t is correlated with eradication at time $t-1$, and in case the eradication treatment has a lagged effect on the outcome, I include $eradication_{i(t-1)}$ as a control for $eradication_{it}$. Note that this correlation is mostly due to the persistence of opium cultivation (as discussed in Chapter 2) and the causal link between cultivation and eradication.

Finally, the probability of eradication treatment might depend on location-specific features, such as total area, accessibility or ethnic composition. Another important determinant could be the historical implantation of state institutions in the territory. Therefore, I include location-specific fixed effects in the regression, which I denote by $\text{FE}_i \in \mathbf{R}$. I also add time dummies δ_t, to control for location-invariant shocks that might impact the outcome.

Target Populations.– As discussed in Subsection 3.1, there exists a strong divide between Pashtun and Non-Pashtun populations in Afghanistan. Since this can influence the effect of eradication on the outcome, for each outcome, I run three regressions: one for the whole population, one for the Pasthun population, and one for the Non-Pashtun population.

Estimation.– To study the partial effect of opium eradication on attitudes towards armed actors, I estimate the following equation

$$Support_{it} = \beta eradication_{it} + \mathbf{X}_{it}\gamma + \delta_t + \text{FE}_i + \epsilon_{it} \tag{3.1}$$

where $Support_{it}$ is either the percentage share of respondents who declared having sympathy for opposition armed groups, or the percentage share of respondents who declared thinking that the Afghan National Army helps improving Afghanistan's security, in province i in year t. The predictor $eradication_{it}$ is a binary variable indicating whether governor-led eradication took place at least at level 10% in province i and year t. The vector of controls $\mathbf{X}_{it} \equiv (opium_{it}, eradication_{i(t-1)}, resistance_{i(t-1)}, violence_{i(t-1)}) \in \mathbf{R}^{1\times4}$ contains opium cultivation, passed treatment status, a proxy for the propensity of farmers to resist opium eradication and a proxy for Taliban activity. These variables vary both across time and space. The term $\text{FE}_i \in \mathbf{R}$ is a location fixed effect, while $\delta_t \in \mathbf{R}$ is a time-varying intercept. Finally, $\epsilon_{it} \in \mathbf{R}$ is an observation-specific error term. The coefficient of interest is $\beta \in \mathbf{R}$, which is interpreted as the short-term effect of opium eradication on people's attitude towards armed forces, and which is common to all provinces.[25].

Econometric Assumptions.– As figures 3.1 and 3.4 show, eradication typically takes place a few weeks before surveys are conducted. Therefore, I need not worry about simultaneity issues. However, I assume that survey responses react only to the last wave of eradication, or to the one of the year before. That is, I neglect any direct (i.e. not captured by the controls) long-term treatment effect.

I further assume that the eradication treatment is uncorrelated with past outcome shocks conditionally on the above controls. This means not only that governors do not initiate eradication based on past outcome shocks, but also that such shocks do not significantly influence the ability of a governor to conduct eradication in subsequent periods. In particular, I assume that even if, in a province, sympathy for opposition armed groups increases unexpectedly, this change does not alter law enforcement the following years. This assumption relies on the validity of my proxies for farmers' propensity to resist eradication and for Taliban presence[26].

I make the assumption that the family $\{(Support_i, eradication_i, \mathbf{X}_i, \mathrm{FE}_i)\}_i$ is independent and identically distributed. Among other things, this implies that the treatment allocated to province i does not affect province j, for any $j \neq i$. This assumption could be violated for example if intervention in one province made the farmers in a neighboring province destroy their own crops in order to avoid law-enforcement.

No assumption is made about homoskedasticity or serial uncorrelatedness of ϵ_{it}, so that all estimates are presented with cluster-robust standard errors.

Sample Size.– In total, there are $N = 34$ provinces, and $T = 7$ years ($t = 2008, ..., 2015$).

[25] Note that the above model does not constrain the regression's fitted values to lie in $[0, 100]$ and, as a consequence, interpretation is subject to caution. Moreover, this model is not predictive, in the sense that it does not seek to fully capture the variation of the outcome in order to make predictions. My aim here is only to document the association between the treatment and the outcome, clearing out the most obvious confounding factors.

[26] In econometric terms, I assume that, conditionally on $\mathbf{X}_{it}$ (and this is important), there is no feedback from ϵ_{it} to $eradication_{is}$, for $s > t$, in equation (3.1). This is required by the strict exogeneity assumption as given in [Wooldridge, 2010, p301]. A logit regression of the treatment on any lagged outcome (for any subpopulation) and controls yields no significant correlation between treatment and passed outcome, suggesting that there is no feedback indeed.

To be included in a given regression, an observation must satisfy two conditions. First, it must be eligible for treatment: observation (i, t) is kept only if province i pre-eradication opium-cultivated area is strictly positive[27] in year t. Secondly, the number of responses used for the computation of the outcome (i, t) must be of at least 25. This is binding only when considering the responses of an ethnic group in a province where it is a minority, such as Pashtuns in Nimroz. In such cases, the panel will be unbalanced.

3.4 Results

Support for Insurgents.– Panel data estimates of Equation (3.1) when the outcome is insurgent support are presented in Table 3.6. The baseline (All) shows a highly significant (at level 1%) and positive effect of eradication on sympathy for opposition armed groups. The estimate suggests that provinces that have seen their opium fields eradicated at level 10% or more exhibit a 10.24 percentage point increase in sympathy for opposition armed groups, such as the Taliban. As hinted at in Section 3.1, this effect is driven by the Pashtun ethnic group. Indeed, restricting the set of respondents to this sub-population (and adjusting for sampling weights) shows that the increased sympathy for opposition armed groups following eradication is significant and of 9.43 percentage points. No significant result is found for the non-Pashtun population.

Trust in the Afghan Army.– Panel data estimates of Equation (3.1) when the outcome is national army support are presented in tables 3.7 and 3.8. In Table 3.7, the baseline (All) shows a highly significant (at level 1%) and negative effect of eradication on trust in the Afghan National Army. The estimate suggests that provinces that have seen their opium fields eradicated at level 10% or more exhibit a 4.7 percentage point decrease in army support. Here again, the effect is entirely due to the Pashtun sub-population. Restricting the survey to that subgroup shows that eradication is associated with a 4.6

[27] According to the UNODC, a province is considered poppy-free if its total opium-cultivated area is less than 100 Ha (see, for example, [UNODC, 2018a, footnote 1, p5]). In practice, however, eradication treatment has a strictly positive probability even below this threshold. In 2010, for example, Kapisa province was treated (at level 90%) despite having a total opium-cultivated area of barely one hectare. Similar patterns were observed in Kunduz and in Takhar in 2014.

percentage point decrease in army support. Table 3.8 confirms this result by showing a highly significant (at level 1%) and negative effect of eradication on the self-declared belief that the ANA is 'fair', when the sample is the Pasthun sub-population. Indeed, eradication at level 10% is associated with a decrease of 5.1 percentage point in trust. No significant result is found for either the overall population or for the non-Pashtun population.

3.5 Conclusion

The research presented in this paper is a first attempt at documenting the effect of drug control policies on insurgent support during civil conflict.

I focused on the Afghan case. In a first part, I described both the direct and indirect channels through which opium eradication impacted the Afghan population. In a second part, I identified evidence of this impact by measuring the effect of eradication on two key indicators: Self-declared sympathy for opposition armed groups, and self-declared trust in the Afghan National Army.

My first finding is that eradication led to two symmetric effects. On the one hand, it significantly increased sympathy for insurgents. Provinces that went through eradication are associated with a 10.24 percentage point increase in sympathy for opposition armed groups, like the Taliban. On the other hand, eradication significantly decreased trust in the Afghan National Army. Provinces that went through eradication are associated with a decrease of 4.7 percentage point in army support.

My second finding is that these effects are almost entirely driven by the Pashtun ethnic group. This group, which represents 40% of the Afghan population according to the survey data used in this paper, is also more dependent on opium production than others. Given that the Taliban insurgents are Pashtun, and that they were accused of supporting Pashtun supremacy, this result is a source of concern. Counter-narcotics law enforcement might have worsened the Afghan ethnic divide, which can only play into the hands of the insurgents.

3.6 Tables

Year	*Pre-Eradication Opium Area (Ha)*	*Opium Eradication (Ha)*	*Opium Eradication (%)*	*Hand Eradication (%)*	*Tractor Eradication (%)*	*Deaths*	*GPI Rewards (millions of $)*
2008	177534.9	17594.9	9.9		88.0	78.0	38.0
2009	133124.2	5349.2	4.0	38.0	59.0	21.0	38.7
2010	126332.2	2315.2	1.8	13.0	86.0	28.0	25.7
2011	134868.4	3803.4	2.8	25.0	75.0	20.0	19.2
2012	164194.6	9759.6	5.9	33.0	67.0	102.0	18.2
2013	216796.0	7347.0	3.4	51.0	49.0	143.0	16.1
2014	226820.0	2693.0	1.2	51.0	49.0	13.0	
2015	186327.0	3760.0	2.0	38.0	62.0	5.0	
2016	201671.1	355.1	0.2				
2017	329106.3	751.3	0.2				
2018	261128.0	406.0	0.2				
Total	2157902.7	54134.7	2.5	24.1	68.9	410.0	155.9

Table 3.1: Opium Cultivation, Eradication Methods, Casualties and Incentives. Total Good Performers Initiatives funding for the years 2008-2015 comes from [DOS, 2009, 2010, 2011, 2012, 2013, 2015, p108,p95,p100,p91,p84,p95]. [DOS, 2016, p93] declares that 'The United States has put further GPI awards on hold, pending the remediation of vulnerabilities identified by a financial management assessment of the MCN [Ministry of Counter-Narcotics], as required by the U.S. Congress.' Other sources: UNODC reports (see Section 3.2).

Province	*Opium dependence (%)*	*Pre-Eradication Opium Area (Ha)*	*Pashtun (%)*	*Non-Pashtun (%)*
Helmand	5.67	80270	98.1	1.9
Nimroz	4.09	5304	26.8	73.2
Urozgan	4.00	15214	87.1	12.9
Nangarhar	0.99	14347	96.4	3.6
Farah	0.95	9101	79.9	20.1
Kandahar	0.78	20479	96.8	3.2
Badghis	0.35	35235	17.2	82.8
Badakhshan	0.16	6569	0.9	99.1
Faryab	0.01	2923	1.2	98.8
Balkh	0.01	2085	17.0	83.0
Other	0.01	10144	32.0	68.0
Total	0.13	201671	39.1	60.9

Table 3.2: Opium Dependence and Ethnic Composition for the year 2016 by Province. Agricultural dependence on opium is defined as the percentage share of pre-eradication opium-cultivated area in total cultivated area. Provinces in the bottom fifth cumulative percentile for the pre-eradication opium-cultivated area are aggregated in the 'Other' entry. Source: author's calculation based on World Bank and UNODC data (see Section 3.2).

Year	*Reason for Opium Cultivation*		*# People Growing Opium*
	Main Reason	Second Reason	
2008	Poverty	High sale price of opium	2382250
2009	High sale price of opium	Poverty	1593800
2010	High sale price of opium	Poverty	1541940
2011	High sale price of opium	Poverty	
2012	High sale price of opium	High income from little land	
2013	High sale price of opium	High income from little land	

Table 3.3: Main Reasons for Opium Cultivation in Afghanistan Over the Years 2008-2013. Results from the UNODC's surveys of opium farmers. For each year, the number of opium growing opium is estimated by multiplying the number of households growing opium by the average size of a household. Source: Given in Table 3.9.

Year	*Nb Fatalities*	*Share of Total Nb of Fatalities (%)*	*Nb Events*	*Share of Total Nb of Events (%)*
2008	482	3.7	175	5.0
2009	282	2.2	123	3.5
2010	390	3.0	177	5.0
2011	517	4.0	137	3.9
2012	1860	14.3	617	17.5
2013	2230	17.2	613	17.4
2014	3159	24.4	763	21.6
2015	4052	31.2	923	26.2
Total	12972	100.0	3528	100.0

Table 3.4: Taliban Violence in Afghanistan Over the Years 2008-2015 by Year. Source: Author's calculation based on GTD data (see Section 3.2).

Province	*Nb Fatalities*	*Share of Province in Total Nb of Fatalities (%)*	*Nb Events*	*Share of Province in Total Nb of Events (%)*
Helmand	1867	14.4	381	10.8
Kandahar	1091	8.4	261	7.4
Ghazni	837	6.5	222	6.3
Farah	719	5.5	185	5.2
Nangarhar	673	5.2	209	5.9
Kabul	574	4.4	152	4.3
Kunduz	569	4.4	148	4.2
Paktika	510	3.9	81	2.3
Herat	509	3.9	215	6.1
Urozgan	503	3.9	149	4.2
Kunar	468	3.6	174	4.9
Faryab	446	3.4	129	3.7

Badakhshan	374	2.9	92	2.6
Paktia	369	2.8	68	1.9
Other	3463	26.7	1062	30.1
Total	12972	100.0	3528	100.0

Table 3.5: Taliban Violence in Afghanistan Over the Years 2008-2015 by Province. Provinces in the bottom fifth cumulative percentile for the total number of fatalities are aggregated in the 'Other' entry. Source: Author's calculation based on GTD data (see Section 3.2).

	Dependent variable:		
	Sympathy for Opposition Armed Groups (%)		
	All	Pashtun	Non pashtun
Eradication 10%	10.244***	9.434*	5.800
	(2.927)	(4.477)	(5.807)
Eradication 10% Lag-1	−0.285	10.930	−2.299
	(2.821)	(6.597)	(3.490)
Opium-cultivated area (10,000Ha) Lag-1	2.910	2.859	1.284
	(2.147)	(2.697)	(3.956)
Economic Insecurity Lag-1	0.001	−0.179	−0.005
	(0.093)	(0.131)	(0.237)
#Taliban-Related Violent Events Lag-1	−0.247*	−0.101	−0.138
	(0.121)	(0.164)	(0.197)
Location Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Observations	125	108	111
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 3.6: Impact of Forced Eradication on Sympathy Towards Armed Groups. Panel data estimation at the province level for the years 2009-2015 (data is missing for the year 2008). For each location and time, the outcome is the percentage share of respondents who answered 'a little' or 'a lot' to the question *Thinking about the reasons the armed opposition used violence during the past year, would you say that you in general have a lot of sympathy, a little sympathy, or no sympathy at all for these armed opposition groups?*. The eradication predictor takes the value 1 if eradication took place at level 10% or more. Only provinces which were eligible for treatment (Opium-cultivated area> 0) were included in the sample. Standard Errors are clustered at the provincial level.

	Dependent variable:		
	Trust in the Afghan National Army - Security (%)		
	All	Pashtun	Non pashtun
Eradication 10%	-4.699^{***}	-5.770	-4.644^{**}
	(1.347)	(3.646)	(1.900)
Eradication 10% Lag-1	1.255	1.046	4.147
	(2.042)	(1.992)	(2.629)
Opium-cultivated area (10,000Ha) Lag-1	-1.164	-3.812	-1.870
	(1.577)	(3.702)	(3.365)
Economic Insecurity Lag-1	0.138^{*}	0.108^{*}	-0.083
	(0.060)	(0.046)	(0.172)
#Taliban-Related Violent Events Lag-1	0.170	0.083	0.318
	(0.104)	(0.144)	(0.176)
Location Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Observations	125	108	111
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 3.7: Impact of Forced Eradication on Trust Towards the Afghan National Army. Panel data estimation at the province level for the years 2008-2015. For each location and time, the outcome is the percentage share of Pashtuns who answered 'strongly agree' or 'agree somewhat' to the question *Please tell me if you agree with the statement 'the Afghan National Army helps improve the security'.* The eradication predictor takes the value 1 if eradication took place at least at level 10%. Only provinces which were eligible for treatment (Opium-cultivated area> 0) were included in the sample. Standard errors are clustered at the provincial level.

	Dependent variable:		
	Trust in the Afghan National Army - Fairness (%)		
	All	Pashtun	Non pashtun
Eradication 10%	−2.327	−5.055***	−2.929
	(1.782)	(1.514)	(1.941)
Eradication 10% Lag-1	2.301	1.148	4.642
	(2.080)	(1.256)	(3.197)
Opium-cultivated area (10,000Ha) Lag-1	−1.300	−0.699	−2.086
	(1.472)	(1.837)	(2.556)
Economic Insecurity Lag-1	0.119**	0.056	−0.040
	(0.051)	(0.038)	(0.203)
#Taliban-Related Violent Events Lag-1	0.095	0.072	0.245
	(0.076)	(0.100)	(0.186)
Location Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Observations	125	108	111
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 3.8: Impact of Forced Eradication on Trust Towards the Afghan National Army. Panel data estimation at the province level for the years 2008-2015. For each location and time, the outcome is the percentage share of pashtuns who answered 'strongly agree' or 'agree somewhat' to the question *Please tell me if you agree with the statement 'the Afghan National Army is honest and fair'*. The eradication predictor takes the value 1 if eradication took place at least at level 10%. Only provinces which were eligible for treatment (Opium-cultivated area> 0) were included in the sample. Standard errors are clustered at the provincial level.

Year	*Eradication Dates*	*Farmers Survey*	*Opium Prices*	*Opium Yields*	*# Households Involved in Opium Industry*
2008	[UNODC, 2008, p78, Table 33]	[UNODC, 2008, p105, Figure 43]	[UNODC, 2009, p85]	[UNODC, 2008, p65]	[UNODC, 2008, p17]
2009	[UNODC, 2009, p52, Table 21]	[UNODC, 2009, p179, Figure 36]	[UNODC, 2009, p85]	[UNODC, 2009, p117]	[UNODC, 2009, p77]
2010	[UNODC, 2010, p45, Table 18]	[UNODC, 2010, p62, Figure 21]	[UNODC, 2010, p71]	[UNODC, 2010, p54]	[UNODC, 2010, p61]
2011	[UNODC, 2011, p38, Table 18]	[UNODC, 2011, p60, Figure 22]	[UNODC, 2011, p70]	[UNODC, 2011, p51]	
2012	[UNODC, 2012, p38, Table 17]	[UNODC, 2012, p54, Figure 23]	[UNODC, 2012, p59]	[UNODC, 2012, p41]	
2013	[UNODC, 2013, p37, Table 16]	[UNODC, 2013, p53, Figure 19]	[UNODC, 2013, p58]	[UNODC, 2013, p40]	
2014	[UNODC, 2014a, p29, Table 15]		[UNODC, 2014a, p43]	[UNODC, 2014a, p31]	
2015	[UNODC, 2015, p28, Table 14]		[UNODC, 2015, p36]	[UNODC, 2015, p30]	
2016			[UNODC, 2016, p39]	[UNODC, 2016, p33]	
2017			[UNODC, 2017, p45]	[UNODC, 2017, p40]	
2018			[UNODC, 2018a, p44]	[UNODC, 2018a, p40]	

Table 3.9: Various secondary sources for data used in this study.

3.7 Figures

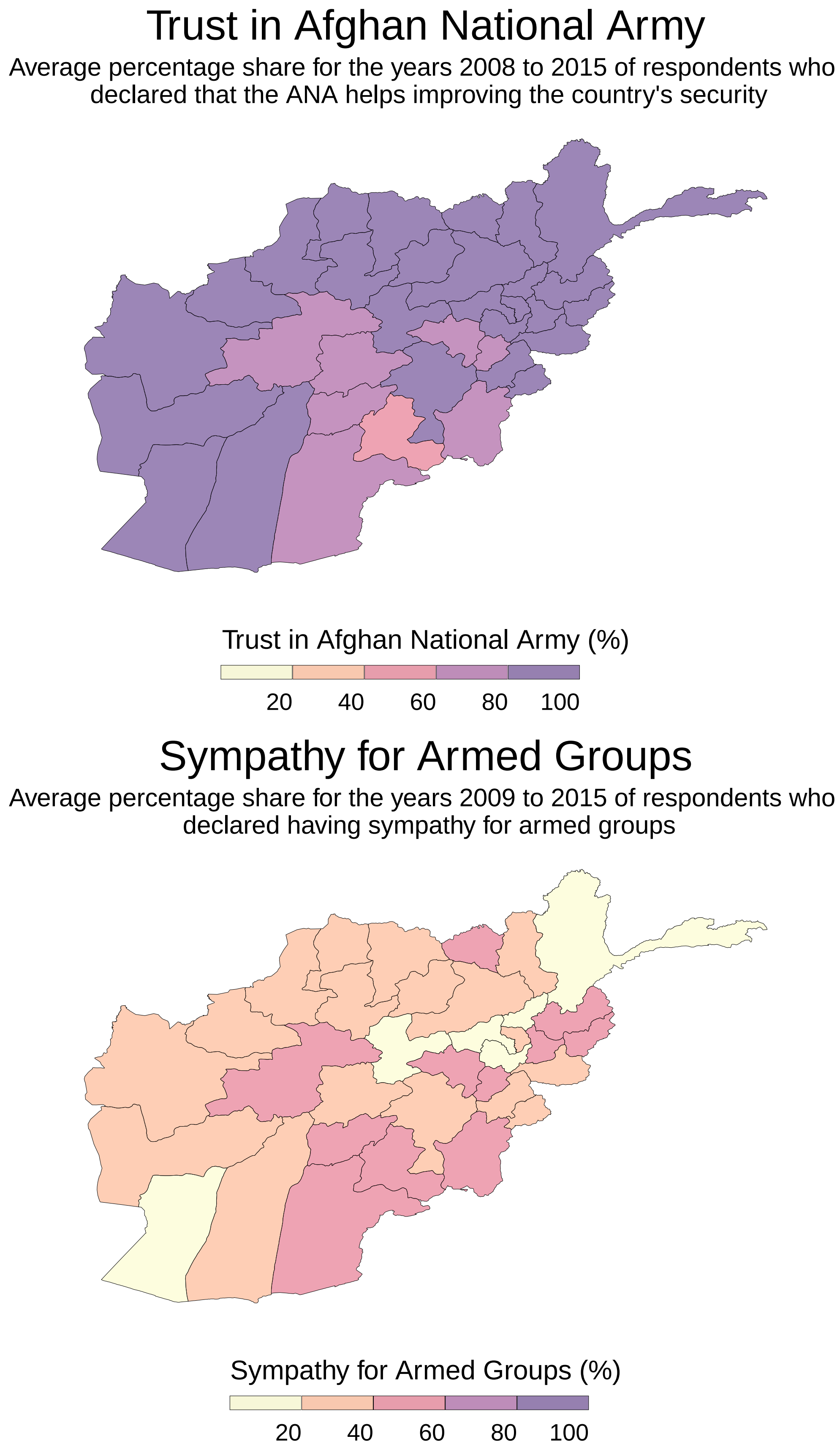

Figure 3.2: Outcome Mapping. These map give, for each province, the average percentage share of respondents who declared having trust in the Afghan National Army (top panel) or sympathy for opposition armed groups (bottom panel) over the years 2008-2015 (2008 missing for bottom panel).

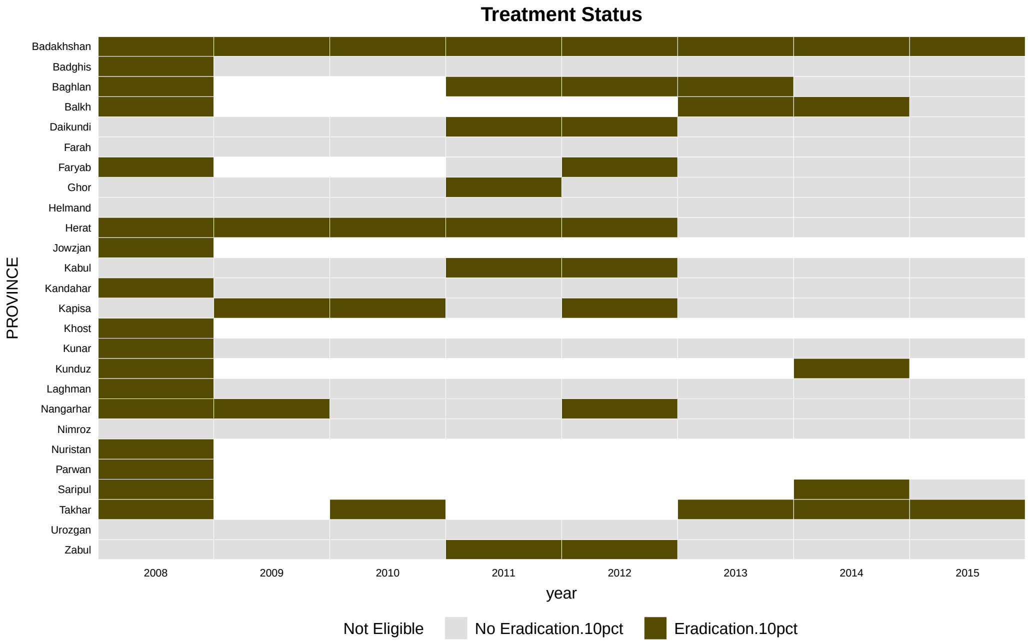

Figure 3.3: Treatment Status. Province i is defined as treated at time t if the UNODC declares that at least 10% of the opium-cultivated area in province i and at time t was eradicated through provincial order, and it is defined as untreated otherwise. Only provinces which are eligible for treatment in at least one year are displayed.

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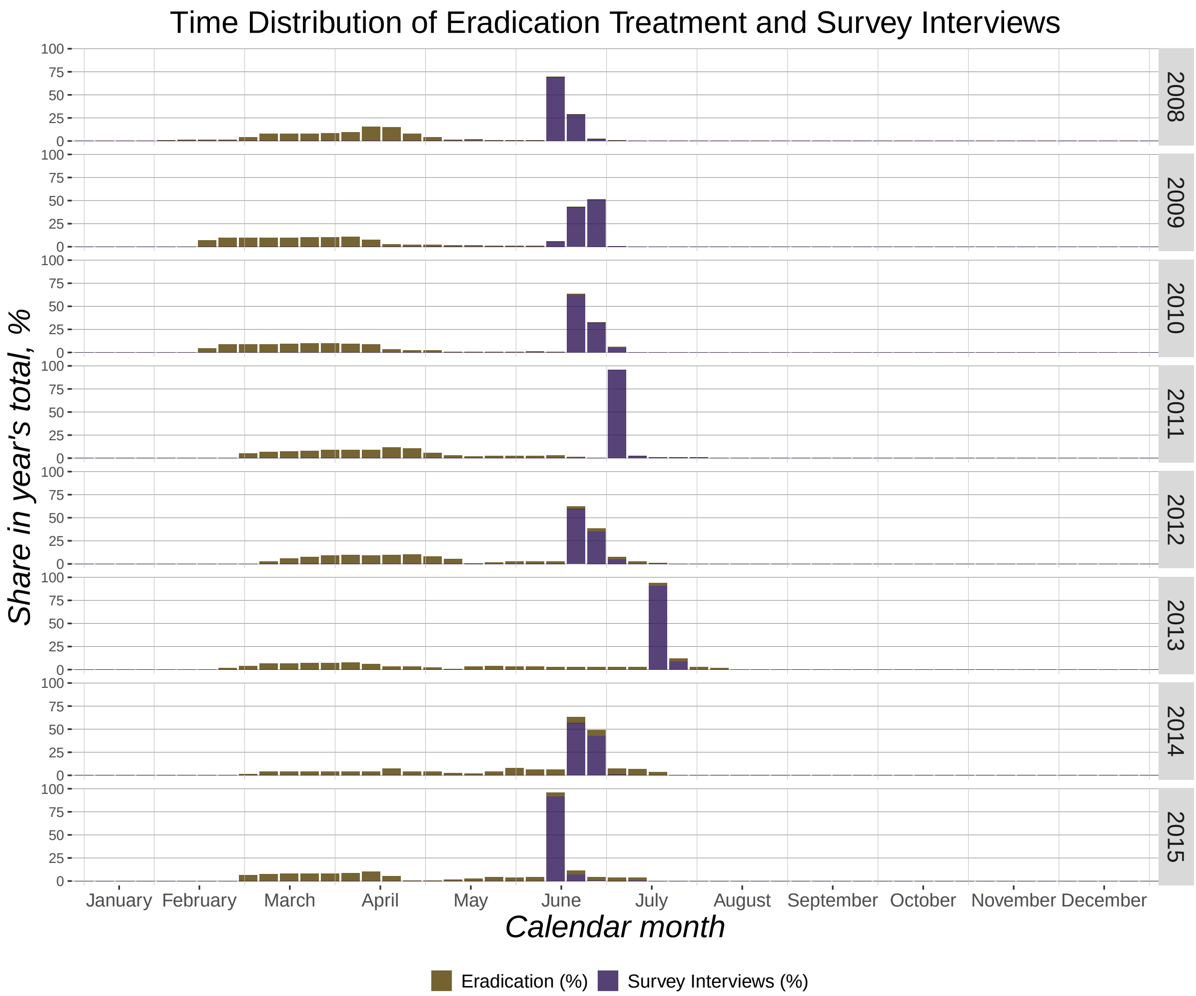

Figure 3.4: Timeline of Events. This figure gives, for each year, and each type of event (opium eradication or population survey), the percentage share of the year's total that was executed in a given week. Therefore, for each year and intervention, percentages sum up to 100. It shows that eradication typically takes place during spring (February-May), while survey interviews are concentrated in summer (June-July).

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