

Persistence in the Political Economy of Conflict: The Case of the Afghan Drug Industry

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Abstract

Links between licit and illicit economies fuel conflict in countries mired in irregular warfare. We argue that in Afghanistan, cultivating poppy and trading drugs bring stability to farmers who face the unintended consequences of haphazard development efforts while lacking alternative livelihoods and security necessary to access markets. Drug trafficking funds the crime-insurgency nexus and government corruption, in turn foiling attempts to establish a unified governance body. We show how individual rationality, market forces, corruption and opium stocks accumulated at different stages in the supply chain counteract the effects of poppy eradication. To that end, we use initial results from a multiagent model of the Afghan drug industry. We define physical, administrative, social and infrastructural environments in the simulation, and outline objectives and inputs for decision making and the structure of actor interactions.

Statement of the Problem

We start by casting the post-2001 insurgency in Afghanistan as a complex adaptive system (CAS) and outline a country-scale, multiagent model that captures the persistence of the Afghan drug industry when outside forces intervene and its resilience against government policy perturbations.

Post-2001 Conflict in Afghanistan as a CAS

The current insurgency in Afghanistan, like that in 1979–1989 against the Soviet occupation, is rooted in resistance to *external* intervention, unlike conflicts before the Soviet invasion that generally stemmed from *internal* ethnic and economic divisions. The country is populated with rural and urban households, a medley of opportunist armed groups and criminal gangs led by local strongmen, the government and International Security Assistance Force (ISAF), and insurgents. Adaptive and “strategic” interactions among actors that have determined the *emergent* course of the current conflict are informed by individual attitudes, kinship considerations and tribal affiliations on multiple scales through weakly-coupled, nested systems enabled by the remoteness of population settlements, lack of transportation and communication infrastructure and scarcity of manpower.

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Questions

We have built a multiagent model of the Afghan drug industry that can answer the following policy, operational and analytic questions inspired by (Flynn, Pottinger, and Batchelor 2010) and (Hartley 2009):

Policy How important is drug trade to the livelihood of the Afghan population? How can we decrease drug trade in Afghanistan? How can we decrease its significance to the population?

Operations How many men and for how long are needed to eradicate poppy fields, interdict drug shipments in a given province and prevent poppy cultivation from shifting to neighboring or other provinces? How do we manage money-for-work programs such that they do not disappear due to corruption and end up fueling organized crime and insurgency? Which roads and how much will have to be improved so farmers in a given district can think of alternative crops?

Analysis How much bribes and protection money is gathered from drug traders frequenting a given route? By whom?

Addressing these questions requires modeling links between farmers’ livelihood and the quality of governance. It also constrains the scalability, flexibility and taxonomy of entities and environments in the model. Moreover, since many players in the Afghan drug industry cannot be modeled as fully rational, understanding the short-term dynamics of the industry that are shaped by boundedly rational agents is key to answering our questions; hence a multiagent model (Axtell 2000).

Objectives

We use our multiagent model of the Afghan drug industry to show that engaging in poppy cultivation and drug trade provides stability to farmers who lack alternative livelihoods and security necessary to access markets and face the unintended consequences of haphazard development efforts. In particular, we will demonstrate the following empirical patterns that highlight the resilience of the Afghan drug industry to external intervention:

1. Short-term poppy eradication can at best make temporary inroads into the Afghan drug industry. Market forces, corruption and opium stocks accumulated at different stages in the supply chain defeat eradication.
2. Opium funds the crime-insurgency nexus and government corruption. Policy interventions do not fundamentally alter the value of the drug industry, although they may redistribute the drug revenue stream among the players, for example, some policies may force traffickers to bribe government officials more.

The resilience of the Afghan drug industry stems from the fact that the decision to participate in the drugs supply chain at any stage is rational from the point of view of risk averse, but boundedly rational individuals who react to the changes in the constraints they face and the environment they operate in. In the next section, we outline the physical, administrative, social and infrastructure environments; objectives and inputs for actors' decision making, and the structure of actor interactions.

Modeling the Afghan Drug Industry

Poppy cultivation and opium trafficking have since 2001 influenced the course of conflict in Afghanistan (Buddenberg and Byrd 2009) by financing insurgent operations and sustaining rural, Afghan households. Although detailed field studies show that lack of security and alternative economic opportunities drive Afghan farmers to cultivate poppy (Mansfield 2007; 2008), multiagent models of drugs supply chain (Watkins, MacKerrow, and Merritt 2010) and macroeconomic structural equation models of drug exports (Buddenberg and Byrd 2009; Lind, Moene, and Willumsen 2009) have failed to incorporate the objectives that players in the Afghan drug industry pursue and the biophysical, geographic and resource constraints they face. These failures are partly inherent to reasoning about interactions among heterogeneous groups with dynamic memberships on multiple scales and contexts and partly caused by available data produced by sources with varying credibility. The model we present in this paper includes both physical and behavioral layers of the Afghan drug industry.

Method

To address the problems mentioned above, we have pursued the following work flow:

1. Produce a unified dataset of rural Afghanistan by merging remote sensing data and local surveys.
2. Initialize a multiagent simulation model with 1.5 million rural households, 40,000 small-scale traders, 1,000 drug traffickers and 50 major traffickers.
3. Introduce government and ISAF counternarcotics policies.
4. Define behaviors and reactions of farmers and traders to changes in the local market and security conditions.
5. Validate the model with historical data on climate, security and policy against a spatial panel dataset of trade volumes and prices of selected crops.

Source	Data	Description
CSO	Population	Rural household population
AIMS	Population	Urban household population
NGIA	Villages	Distribution of rural population
AIMS	Land quality and irrigation	Distribution of rural population
FAO	Land surveys	Properties of rural households
USGS	Elevation and roads	Transportation costs

Table 1: Data layers fused into initial conditions for the drug industry model.

In this paper, we report the results of steps 1–4.

Model Architecture

Figure 1 presents the UML structure of the multiagent model of the drug industry in Afghanistan. In particular, we represent high-resolution land properties and ownership, transportation and infrastructure in the biophysical layer; crop markets and customers, labor markets, access and cost of energy in the social layer, and how these two layers influence farmers' production and trade decisions. At this stage we have assumed that the Afghan government and ISAF have exogenously chosen crop eradication as their counternarcotics policy. However, corruption in implementing eradication is endogenized in the model.

Recovering Data for Model Instantiation

The first challenge to modeling the Afghan drug industry is to unify disparate datasets to inform model building. In order to create a population of rural households and fill in their attributes, we implemented a procedure described in (Rizi, Latek, and Geller 2010). Our approach takes open-source data listed in Table 1; creates a population of farmer households; assigns each household a particular size and a set of land lots by an iterative preferential attachment procedure through which a village is more likely to receive a new household if it has a higher percentage of unassigned land. This procedure preserves (a) district-level population counts; (b) regional availability of land and land types; and (c) the joint distribution of household size and wealth, conditioned on village wealth.

We have validated our procedure with the LANDSCAN dataset (Oak Ridge National Laboratory 2009) and showed that it guarantees remarkable fidelity to actual data (Rizi, Latek, and Geller 2010). The key properties of rural households and their placement in villages are shown on Figure 2. Adopting a similar approach to creating agricultural traders, we turned adjacent villages into sets of markets and assigned them to agricultural traders. We use the transportation time layer to ensure that traders do not exceed realistic time constraints required to visit the markets they are assigned to. The transportation time layer also helped us to design different classes of traders and the markets that traders monitor: small-scale, sedentary traders monitor a cluster of neighboring villages; medium traders a set of clusters and a city

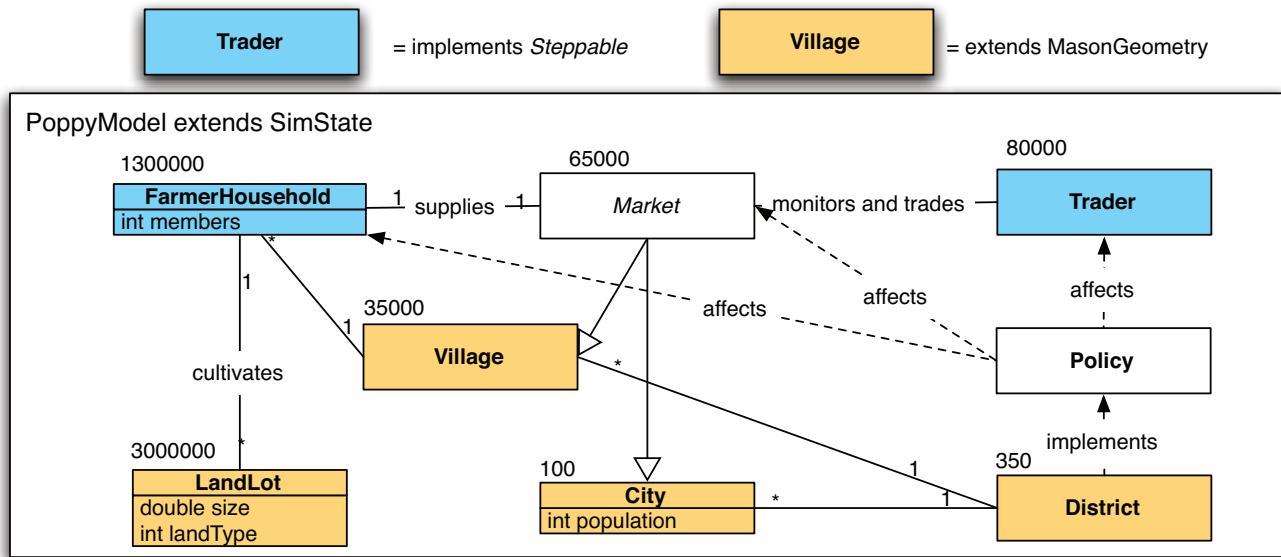


Figure 1: UML class diagram of the static structure of the Afghan drug industry model based on entities and aggregations recovered from data provided by the U.S. National Geospatial Intelligence Agency (NGIA), the U.S. Geological Survey (USGS), the United Nations Office on Drugs and Crime (UNODC), the United Nations Food and Agriculture Organization (FAO), Afghanistan Central Statistics Organization (CSO), Afghanistan Information Management Services (AIMS) and Oak Ridge National Labs (ORNL).

or two; large-scale opium traffickers and wheat wholesalers cities, provincial capitals, and international markets. This process situates a mixture of traders in a hierarchy of markets that provide lateral liquidity.

Agency in the Model

In addition to representing the physical environment explicitly, the model consists of three main agent types of farmers, traders and the government. The ISAF and insurgents are absent in the computational experiments whose results we are reporting in this paper.

Farmers Farmers choose what crops to cultivate and when to sell and buy more of crops they have cultivated and buy those they have not. Each farmer household is endowed with plots of land chopped into *jeribs*, a traditional measure of land in Afghanistan equal to 0.2 of a hectare. Each lot is characterized by a land type that has a specific yield for any combination of potential crops and climate conditions. Some land types are irrigated, so climatic conditions do not influence their yield much. Some crops, for example poppy, are quite resistant to weather conditions regardless of whether they are cultivated on irrigated land or not. Farmers allocate crops to the land they cultivate in order to maximize their expected annual income, satisfying the following constraints:

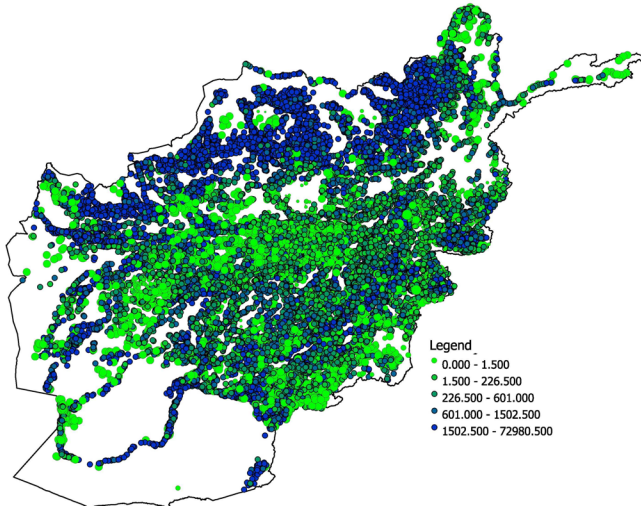
- Historically smoothed local prices of different crops;
- Expectation of climatic conditions;

- Government policy: if farmers choose to grow poppy, they account for eradication risk and bribes to avoid it;
- Availability of farm labor provided by family members or rented out from locals;
- Household food consumption.

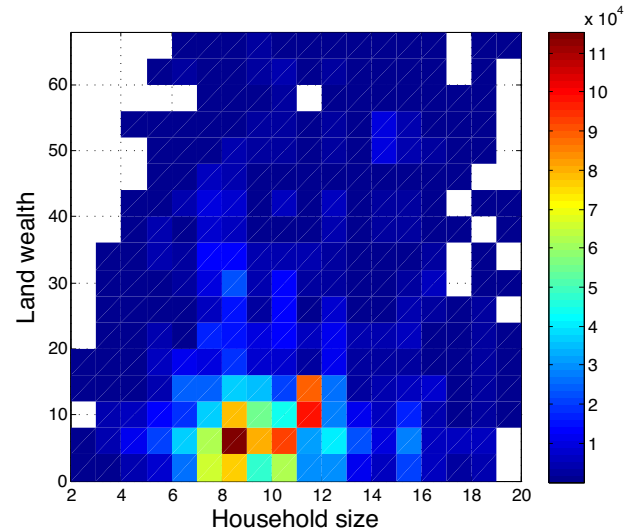
For example, if a farmer with a large family expects imminent drought when poppy prices are high enough, he may decide to forgo grain cultivation and plant only drought-resistant, labor-intensive poppy, hoping to buy wheat from the market with opium income later. Similarly, some farmer households may decide to fallow some of their land lots and offer accessory labor for farm wages to other households. (Maletta and Favre 2003; Mansfield 2004; Kuhn 2009), and (Chabot and Dorosh 2007) provide detailed accounts of farmer behavior that we used to create farmer methods in the model.

Traders Traders are households themselves: farmers are traders. Each trader has a desired stock of each crop. Minimally, this corresponds to grains needed to sustain the household for a year. By adjusting the vector of desired stocks of crops, we differentiate between opportunist, small-scale traders and the more specialized opium traffickers and wheat wholesalers. Traders's decision cycle unfolds as follows:

1. Monitor a set of markets. Collect available buy and sell offers and determine the most lucrative trade opportunities.



(a) Rural settlement points colored by total land wealth



(b) Country-wide correlation between household size and wealth

Figure 2: Snapshots of synthetic rural population of Afghanistan. Village locations and district populations shown in panel (a) and household size and wealth correlations in panel (b) closely match real data as discussed in (Rizi, Latek, and Geller 2010).

2. Post a buy or sell offer depending on the level of the household stock of crops.

The offer consists of a price and a volume. The offer price is based on risk-adjusted, historically smoothed prices for a crop in the markets monitored by the trader. The volume is based on the household budget constraint and a trader's reluctance to risk too large a portion of the household total wealth in a single trade.

Farmer households adjust risk based on the following factors:

- Transportation costs;
- Risk perceptions: losing crop shipments to bandits or government interdiction and the necessity to pay bribes if caught with illicit crops;
- Urgency to replenish the stock of each crop to the desired level.

Markets clear via a double-auction mechanism that represents all physical shipments. The detailed surveys of trader behavior that have informed our assumptions can be found in (Byrd and Jonglez 2009).

Government The government allocates forces to districts and to poppy eradication and trade interdiction as counternarcotic policies. The probability that a poppy-growing farmer and poppy-shipping trader run into an eradication and interdiction team respectively depends on the relative frequency of a given illicit activity versus the manpower devoted to policy enforcement. (Clemens 2008; Goodhand 2008) and (Byrd 2008) discuss counternarcotic tools available to ISAF and the Afghan government. We model endogenous district-level bribery markets where farmers and

traders can pay for protection from policy enforcement (Starr 2010). In the version of the model presented here, fighting insurgents does not limit the government in allocating forces to counternarcotic policies.

The Effectiveness of Poppy Eradication

Figure 3 presents a dashboard for a poppy eradication scenario over a 10% sample of villages. First, we let the simulation run for 5 years in order to eliminate the effects of the initial trader and farmer wealth, crop stocks and prices used to instantiate markets. This process takes around 3 years. At first, farmers overreact to initial prices, generating a wave of ferocious trading through which farmers and traders adjust their target stock levels, recorded on Figures 3(c) and 3(e). The annual cumulated harvests of different crops are recorded on Figure 3(a).

Details of trading dynamics are recorded in Figures 3(b) and 3(f) where we plot the total volume of crops traded and the number of outstanding buy and sell orders. Oversupplied buy or sell orders create unrealized supply or demand for crops where prices demanded do not match prices offered. While unmatched orders expire after some time specific to each trader, they provide other traders information and influence what orders are placed in the meantime.

Traders and markets activate with daily frequency, the same frequency with which we gather market statistics. Given the spatial heterogeneity of prices and supply, a single large trade may bias prices for the whole country for a day, corresponding to spikes on Figures 3(d) and 3(g) that present average trade prices at different nodes in the supply

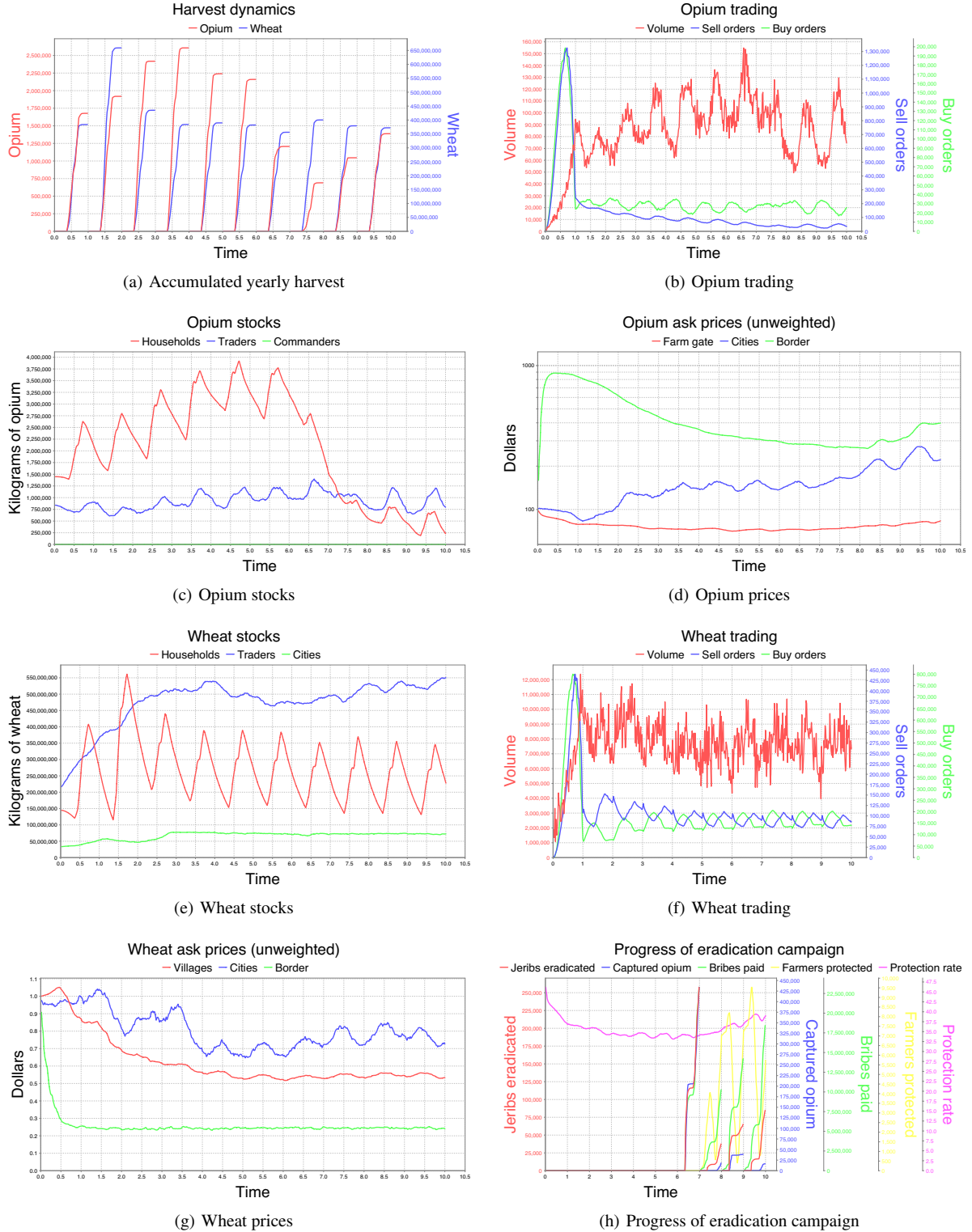


Figure 3: Country-level outputs from an eradication scenario over a 10% sample of villages in Afghanistan. All timescales are realistic where 1 simulated time unit equals 1 year. After 5 years of unperturbed dynamics, we endow the government with 20,000 people to distribute among districts to eradicate poppy. Note that the system is highly nonlinear, so country-scale estimates of the figures we present here cannot be obtained simply by extrapolation.

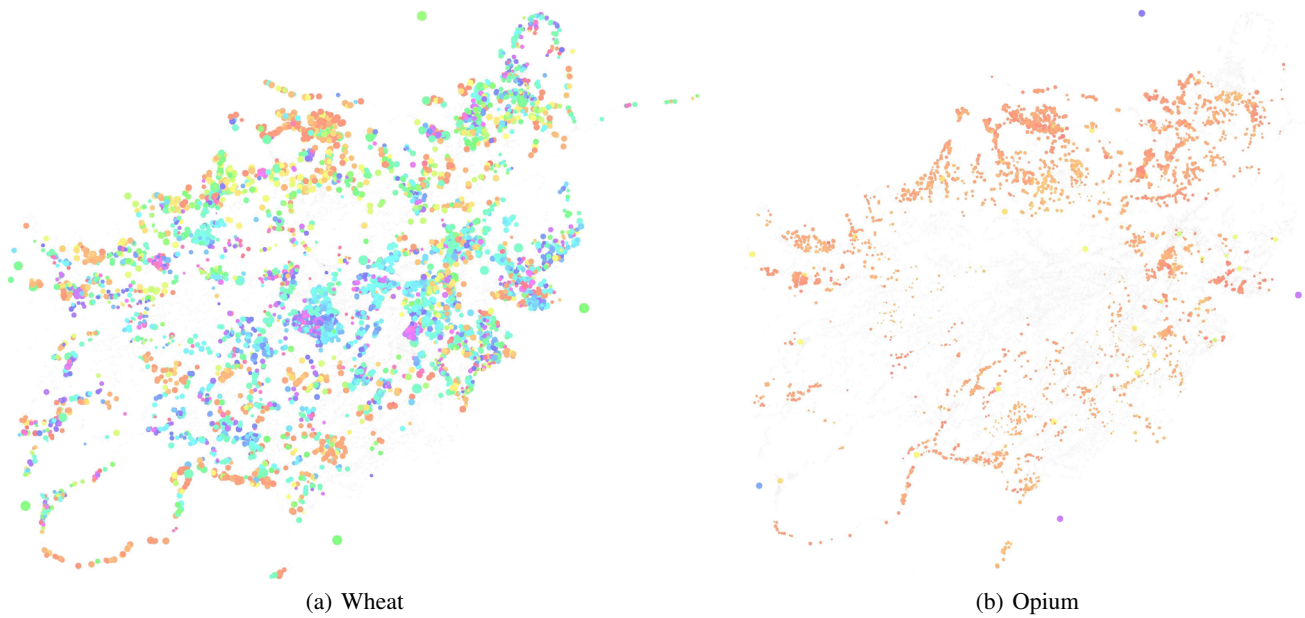


Figure 4: Spatial distribution of trades taking place in a sample summer week in year 4. The area of a dot is proportional to the logarithm of the volume of crop exchanged. Orange markets have the lowest prices while purple markets have the highest prices.

chain. We record prices at the farm gate, urban and international markets for wheat and poppy. International prices correspond to four main clearing markets for opium and heroin in Quetta and Peshawar in Pakistan, Dushanbe in Tajikistan and Zabol in Iran, and to the wheat market in Karachi in Pakistan.

Years 4 and 5 represent the default dynamics of the system before eradication policy is introduced. In-country harvest of wheat stabilizes at 0.5 million metric tons, with the deficit imported from Pakistan. Unencumbered, farmers grow enough poppy to gather 2,000 metric tons of opium. Farm gate wheat prices show annual seasonality and are higher than international prices by some 10 to 20 cents per kilogram. Seasonality is much weaker for opium, because it can be easily stored and is not consumed by farmers. The prices of opium show high differentiation depending on the level of the trader in the hierarchy. Major traffickers capture 80–90% of the whole value of the final product, charging 5 to 10 times more for the same opium-equivalent as a farmer can demand.

In addition to differentiation according to market type and season, the model output exhibits high spatial heterogeneity in what crops are grown where and traded at what price. In Figure 4, we present the spatial distribution of the properties of trades taking place in a sample summer week in year 4, where it can be seen that without eradication, poppy cultivation takes place mostly on the outskirts of major urban centers.

We introduce a massive eradication campaign after year 5. The government dispatches 5,000 specialized eradication teams, each capable of eradicating 2 to 3 poppy growing farms per week, to 328 districts. The teams are required to eradicate to their full capacity, but are free to decide the order in which they pick poppy growing farms to eradicate. In particular, the order can be influenced by bribes that farmers pay to delay or avoid eradication. Eradicated poppy fields are burned and the stock of dried poppy or opium on the farm is confiscated. Corruption causes eradication teams to primarily target poorer farmers who cannot afford to pay large bribes.

Persistent eradication campaigns alter the volume of actual harvested poppy and lead to a slight increase in local poppy prices after some time. This process incentivizes farmers to devote more land to cultivating poppy at the expense of wheat, in turn causing the volume of the actual harvested poppy rebound after 8 years and bogging cities down in a creeping inflation of wheat prices. As keeping poppy stocks on farms becomes risky with 400 metric tons captured in the first year, as shown in Figure 3(h), farmers push poppy stocks to markets faster, inducing minor seasonality in poppy prices. These changes in farmer behaviors along with bribes paid to counternarcotics teams mute the effect of eradicating around 50% of poppy acreage on prices and volumes of poppy traded. The effect of eradication policy are further offset by large stocks of poppy, equivalent to about 2 years of production, accumulated by traders. These stocks slowly deplete, as shown on Figure 3(c), but the campaign would have to continue for much more than 5 years before

this cushion is exhausted.

Summary

In this paper we presented preliminary results from a country-scale, household-resolution model of the drug industry in Afghanistan, focusing on farmers' choices between licit and illicit crops. Investigating the effects of a single eradication policy on the behavior of farmers and traders and dynamics of the whole system served as a proof of concept.

Currently, we are working on expanding the set of available interventions, adding alternative governance and performing model validation against historical data. We want to:

- Find an optimal triplet of eradication, interdiction and development efforts that yields lasting country-scale reduction in opium and heroin exports.
- Investigate ways of disrupting the drug supply chains that do away with random interdiction and focus on closing off specific border points and key markets and eliminating primary players.

Acknowledgments

Funding for this work was provided in part by the Center for Social Complexity at George Mason University and by the Office of Naval Research (ONR) grant N00014-08-1-0378. Opinions expressed herein are solely those of the authors, not of George Mason University or the ONR.

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