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TECHNICAL REPORT

Using Pattern Analysis and Systematic Randomness to Allocate U.S. Border Security Resources

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Cover image: A border patrol agent surveys the U.S. border in Montana. U.S. Customs and Border Protection photo by Gerald L. Nino.

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Summary

The U.S. Department of Homeland Security (DHS) has the responsibility to protect and control U.S. borders against terrorist threats, criminal endeavors, illegal immigration, and contraband. Unfortunately, due to budgetary and other resource constraints, DHS cannot "see and be" everywhere at once along America's long and porous border. As a result, DHS officials continually face the question of where, when, and how to position people and technology on the border.

Confronting this problem in the context of the land-based border between ports of entry, agents from the Office of Border Patrol (OBP) are investigating how *pattern and trend analysis* and *systematic randomness* can be used to position border security personnel and equipment in the places and at the times they will be most effective. *Pattern and trend analysis* refers to predictive methods that can identify regularities in the times, places, or tactics that interdicted border crossers have historically employed. For example, methods or tools of pattern and trend analysis may identify "hot spots"—i.e., border zones or times of high or increased border activity—to ascertain where more resources could increase interdiction rates. *Systematic randomness*, in a sense the antithesis of pattern and trend analysis, refers to the insertion of unpredictability into planning with the hopes mitigating adversary adaptation by introducing uncertainty into smuggler decisionmaking.

These two tools have potentially significant benefits, as demonstrated by their productive application in other homeland security and law enforcement contexts. But the tools come with risks: Pattern and trend analysis can mislead rather than guide decisionmakers if historical apprehension data do not represent what "we don't know we haven't seen." And randomness can waste precious resources if applied carelessly or in excess. Moreover, no two OBP stations are the same, and we would expect the productive application of these tools to vary accordingly, based on the number of zones at a particular border station, the amount or capability of resources available there, and the local rate of illegal flow.

Research Questions

This report investigates how pattern and trend analysis may be productively coupled with systematic randomness to increase interdiction rates and mitigate smuggler adaptation. We shed light on these issues by addressing three research questions:

- How can OBP leverage pattern and trend analysis and systematic randomness to increase its interdiction rate?

- Under what circumstances would OBP stations benefit from using comparable approaches? Under what circumstances would approaches differ?
- How should OBP start implementing approaches to pattern and trend analysis and systematic randomness?

Approach

Our analysis draws on three data sources. First, we conducted interviews and field studies and gathered feedback on preliminary results through interim briefings to stakeholders at DHS and OBP headquarters. These interviews and field studies provided an understanding of how OBP approaches problems of resource allocation, and they provided opportunities to gather feedback during the early phases of our research.

Second, we developed an agent-based simulation model of the interaction of border patrol agents and illegal smugglers. The model allows us to explore how interdiction rates differ across thousands of scenarios that vary by the number of patrols, the rate of illegal flow, the size of the border, and the approach OBP takes to using pattern and trend analysis and systematic randomness.

Finally, we collected historical data from OBP on interdictions, seizures, and patrol and station configurations. These data provide a basis comparing OBP stations based on metrics suggested by our modeling.

Findings

Several findings emerged from our analysis. First, our model suggests that, in nearly all cases, coupling pattern and trend analysis with systematic randomness yields greater interdiction rates than using either approach alone. The relative benefit of coupled approaches appears particularly strong in circumstances in which the number of available patrols is high relative to the rate of illegal flow but low relative to the size of the border. Such circumstances would seem to resemble those confronted by many OBP stations along the U.S. border.

Second, our analysis further suggests that coupled approaches can yield interdiction rates that are competitive with expensive alternatives, such as surveillance that affords "perfect hindsight" of all historical crossings. This suggests that appropriate combinations of pattern and trend analysis and systematic randomness could, in some cases, mitigate the need for expensive investments in technology and infrastructure.

Third, our analysis suggests that relative measures (e.g., coverage, capacity) are more important than absolute measures (e.g., the rate of illegal flow, the size of the border) in predicting interdiction rates. In fact, we show that some lower-activity, lower-resourced northern border stations are similar to higher-activity, higher-resourced southern border stations when compared using relative measures.

Finally, we offer an implementation plan that OBP could use to experiment with new approaches to using pattern analysis and systematic randomness.

Recommendations

These findings support several recommendations. First, OBP should catalog detections, even those that do not result in interdiction. These data should then be integrated with historical apprehension data to improve the overall representation of illegal flows in pattern and trend analysis.

Next, OBP should institute a plan to schedule patrols based on daily pattern and trend analysis and systematic randomness. As described later, this plan should allow OBP to strike a balance between exploiting existing assessments of border risks and exploring for risks that have yet to be characterized. This plan should include a phase of experimentation using randomized control trials. We outline one approach to experimentation in Chapter Six of this report. A crucial feature of our experimental design is that it does not require knowledge of successful border crossers.

Finally, we recommend that OBP develop a management tool to compare its stations based on relative measures, such as coverage and capacity. We developed a data visualization tool to facilitate these comparisons based on measures that our analysis suggests influence interdiction rates. Such a tool may be useful to OBP sector and station chiefs in comparing stations on operational grounds and in tracking changes over time.

Other Research Outputs

This report also describes products of our research that may hold interest independently of our findings. We present an agent-based simulation model of patrol-smuggler interaction; a data visualization tool for comparing and contrasting OBP stations; and a model of how OBP conceptualizes resource allocation at the headquarters, sector, and station levels.