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# Modeling a Victim-Centered Approach for Detection of Human Trafficking Victims Within Migration Flows

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*Disclaimer: The views expressed in this paper are those of the authors and do not necessarily reflect the views or policies of any U.S. government agency.*

## Abstract

**Human trafficking—the use of force, fraud, or coercion to compel individuals into sex trafficking or forced labor—is a global problem. It is challenging to determine the magnitude of this "hidden crime" because the detection of victims is largely dependent on establishing a sufficient level of trust between them and authorities that encourages victims to self-identify. The U.S. government promotes a victim-centered approach for the detection of human trafficking, the implementation of which is becoming widely accepted as the most effective means to detect trafficking victims, especially in scenarios of increased vulnerability such as the European migration crisis. Using the migration crisis and the networks among migrant populations as context, this paper presents human trafficking as a dynamic process whereby a victim's willingness to self-identify adapts over time both spatially (e.g., due to influence from nearby neighbors) and through networks (e.g., familial, country of origin, traveling parties). We employ an agent-based model for exploring the victim-centered approach and its effectiveness for detecting human trafficking victims in an abstract representation of migrant flows. Our sensitivity analysis over a range of initial cooperation levels among migrants finds a tipping point exists for when the victim-centered approach will achieve positive results. It also suggests minimum system conditions for the propagation and persistence of migrants' strategic intention to self-identify. We also discuss our findings with respect to tradeoff considerations for balancing immigration policy objectives, with the need for allowing sufficient time for positive cooperation among the migrant population to develop.**

**Keywords: agent-based model, human trafficking, migration, social network analysis, preferential attachment network, transnational organized crime**

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摘要

贩卖人口—使用武力、欺骗或强迫的方式让个体被迫参与性贩卖或强制劳动—是一个全球问题。确定这种"隐藏的犯罪"规模具有挑战性，因为受害者的侦测很大程度上取决于其和权威机构之间建立的信任是否充分，后者需要鼓励前者进行自我认同。美国政府鼓励使用一项以受害者为中心的方法侦测人口贩卖。该方法的实施十分有效，因此正在被广泛接受（例如欧洲移民危机时，人口贩卖的可能性增加，此法尤其在这类场合发挥了重要作用）。以移民危机和流动人口网络为背景，本文将人口贩卖作为一个动态过程进行呈现。在该动态过程中，受害者进行自我认同的意愿会随着时间的推移而产生空间变化（例如受到附近人的影响）和网络变化（例如家庭、出生国家和同行的人）。本文运用一项基于主体的建模（AGENT-BASED MODEL），探索了以受害者为中心的方法和该方法在人口迁移流动中侦测人口贩卖受害者的有效性。针对不同移民初次合作的一系列水平，本文运用敏感性分析发现，需要满足一定条件才能让以受害者为中心的方法实现积极的结果。该分析还建议，应创造最低的系统条件，让移民持续支持并宣传自我认同的战略意图。本文还讨论了有关平衡移民政策目标的取舍问题，并认为移民人口的积极合作需要充足的时间来发展。

关键词：基于主体建模，人口贩卖，移民，社交网络分析，择优连接网络，跨国有组织犯罪

El tráfico de personas— el uso de la fuerza, fraude o coerción para obligar a individuos a ser parte del tráfico sexual o trabajo forzado— es un problema global. Es un reto determinar la magnitud de este "crimen escondido" porque la detección de víctimas depende más que todo de establecer un nivel suficiente de confianza entre ellos y las autoridades que anime a las víctimas a auto identificarse. El gobierno de los EEUU promueve un acercamiento centrado en las víctimas para la detección del tráfico de personas, cuya implementación está siendo generalmente aceptada como una de las formas más efectivas para detectar a las víctimas de tráfico, especialmente en situaciones de alta vulnerabilidad como la crisis migratoria europea. Al utilizar la crisis migratoria y las redes dentro de las poblaciones de migrantes como contexto, este artículo presenta el tráfico de personas como un proceso dinámico en el que la disposición de auto identificarse de una víctima se adapta espacialmente con el tiempo (por ejemplo, debido a la influencia de los vecinos) y a través de las redes (por ejemplo, familiares, de país de origen, de grupos de viaje). Empleamos un modelo basado en agentes para explorar el acercamiento centrado en víctimas y su efectividad para detectar el tráfico de personas en una representación abstracta de flujos migratorios. Nuestro análisis de sensibilidad sobre un rango de niveles de cooperación inicial entre los migrantes encuentra que un punto de quiebre existe cuando el acercamiento centrado en víctimas tiene resultados positivos. También sugiere condiciones mínimas del sistema para la propagación y persistencia de la intención estratégica de los migrantes para auto identificarse. También discutimos nuestros hallazgos respecto a consideraciones de balancear los objetivos de la política de inmigración, con la necesidad de permitir suficiente tiempo para que se desarrolle la cooperación positiva en la población migrante.

Palabras clave: modelo basado en agentes, tráfico de personas, migración, análisis de redes sociales, red de conexiones preferenciales, crimen organizado transnacional

# Introduction

Human trafficking is a global problem. The 2016 Trafficking in Persons Report published by the U.S. Department of State (U.S. DOS) documents victims of human trafficking in 188 countries (U.S. DOS, 2016), while the International Labor Organization estimates 21 million victims worldwide in an illicit trafficking economy worth $150 billion per year (International Labor Organization, 2016). Vulnerability to human trafficking increases significantly in situations of mass migration, such as the current European migration crisis, because migrants lack legal status, may be socially marginalized, and may be unaware of local languages or laws. This results in individuals becoming more vulnerable to exploitation by others, including smugglers, unscrupulous labor recruiters, and corrupt border officials, on whom they often rely (U.S. DOS, 2016). The European migration crisis is a large-scale problem; according to the International Organization for Migration (International Organization for Migration, 2015a), nearly 1 million migrants entered the European Union in search of safe haven and economic opportunity in 2015. The migration crisis carries a high risk for exploitation by human traffickers, and effective methods for detecting victims are critically needed. The U.S. government (U.S. DHS, 2016a) promotes a victim-centered approach as the most successful means of detecting human trafficking. Although this approach is viewed as an effective way forward, its implementation challenges are exacerbated in the European migration crisis because of complex interactions with strained government resources, anti-immigration sentiment, and the geopolitical significance of migrant flows.

# Combating Human Trafficking

The international legal definition of "trafficking in persons" is the use of force, fraud, or coercion in the exploitation of individuals in commercial sex or forced labor (United Nations OCHCR 2016). Instances of human trafficking are composed of three elements: the acts (e.g., abduction, recruitment, transportation); the *means* (e.g., violence, threats, deception); and the *purpose* (e.g., domestic service, prostitution). Combating human trafficking is a major challenge, even for governments with the political will and adequate capacity. The U.S. Department of Homeland Security describes human trafficking as a hidden crime because victims are often unwilling to self-identify for reasons that include "language barriers, fear of the traffickers, and/or fear of law enforcement" (U.S. DHS 2016b). Instances of human trafficking may be further obscured by other crimes—such as drug and weapons trafficking, prostitution, and immigration violations—which contribute to the significant challenge of detecting trafficking victims. Consequently, successful victim identification requires authorities to investigate beyond initial crimes, such as illegal immigration and prostitution, and recognize indicators of human trafficking to determine whether the perpetrator is actually a victim.

Combating trafficking is further complicated by the fact that trafficking is often a transnational crime, and jurisdictions within the international system operate under different definitions. For example, the Cuban government defines human trafficking as sex trafficking and does not criminalize forced labor (U.S. DOS 2016). In addition, although the vast majority of governments are committed to combating some form of the crime, some governments perpetrate the crime directly or otherwise facilitate or incentivize trafficking (U.S.

DOS 2016). Other governments may be inhibited by a lack of capacity, such as the government of Lebanon, which has an underfunded and untrained law enforcement community that applies its anti-trafficking law "unevenly" (U.S. DOS 2015).

## Limitations of Predominate Approaches

There are generally two predominate perspectives for understanding human trafficking (Salt 2000)—an economic perspective that emphasizes "trafficking as a business," and a law enforcement perspective that focuses on trafficking as criminal activity. Although both approaches are important for understanding human trafficking as a phenomenon, neither has proven effective for combating the practice. Both perspectives maintain an underlying assumption that human trafficking is a function of cohesive, coordinated transnational networks. This often leads to approaches that treat human trafficking like other forms of transnational crime, such as trafficking weapons, organs, and drugs (Bhabha, 2006). This is problematic because it effectively dismisses the agency of victims, and implies that strategies for combating the trafficking of inanimate objects are also effective for combating the trafficking of humans. Prosecutions of human trafficking cases often hinge on the cooperation of victims who are frequently the sole source of evidence. The interception of potential trafficking victims does not yield the same evidence as seizing drugs or weapons. Victims must be willing to cooperate to provide the necessary evidence, but are often reluctant to do so because they may be involved in criminal activity themselves (e.g., illegal immigration, prostitution), under duress due to being forced into the situation by their trafficker, fearful of harm or losing their jobs, or in situations of debt bondage in which they or their family

face the loss of collateral if they fail to fulfill certain commitments (e.g., employment contracts, debts to labor recruiters).

## Victim-Centered Approach to Human Trafficking

The U.S. Department of Health & Human Services (U.S. HHS) (2016) identified two primary reasons victims of human trafficking are not detected; victims do not identify themselves as victims, and others do not view them as such. The U.S. DHS and Department of State both follow and promote the victim-centered approach, which is based on the assumption that victims do not often self-identify and therefore require incentives to cooperate. This approach requires law enforcement knowing the dynamics of human exploitation and then leveraging that understanding to search for indicators of trafficking, such as physical abuse, the use of labor recruiters, and imbalanced labor contracts. Recognizing that victims may have been compelled to commit crimes such as prostitution, authorities using a victim-centered approach are encouraged not to penalize victims for crimes they commit as a result of being trafficked. This approach then makes accommodations for providing victims with needed services, such as shelter, psycho-social help, or repatriation assistance, which act as incentives for self-identification and cooperation with authorities. The overall premise is that, if an individual victim believes authorities are more interested in pursuing human traffickers and helping victims than persecuting her for her coerced crimes, she will be more willing to self-identify and cooperate (U.S. DHS, 2016a).

# Human Trafficking in the Context of Migration

## Defining Migrant Motivations

The motivations of migrants generally fall into two categories: those seeking *economic* opportunity to improve their quality of life, and those *fleeing* persecution and conflict (International Organization for Migration, 2015b). For this research, we refer to these motivations respectively as "seeking" and "fleeing." Figure 1 shows 2015 migration data that describe the top countries from which European Union asylum applicants originate. The top three origins—Syria, Afghanistan, and Iraq—are countries in active conflict (assumed to have a "fleeing" motivation), while the others suffer from significant poverty as well as political instability (assumed to have a "seeking" motivation). We recognize this is a broad simplification for the complex concept of migrant motivation, but we suggest it is a reasonable abstraction for this research given sparse availability of relevant data.

According to BBC News (2016), Germany received the highest number of 2015 asylum applicants in the European Union, around 36% of all applications. This does not include other forms immigration (e.g., student and work visas) or illegal immigration. Of this population, approximately half of these individuals come from conflict countries—27.2% from Syria, 13.2% from Afghanistan, and 9.5% from Iraq—with the remainder being migrants seeking economic opportunity (Singleton, Heiermann, & Kierans, 2016).

## State Immigration Policies

Immigration policies are generally a balance between state economic interests and humanitarian objectives (Facchini & Mayda, 2009). With respect to the former, immigration policies often focus on maximizing the economic benefits of the receiving country. This can take several forms. For example, governments may look to fill gaps in the labor market, at all skill levels, or take on a protectionist posture by limiting
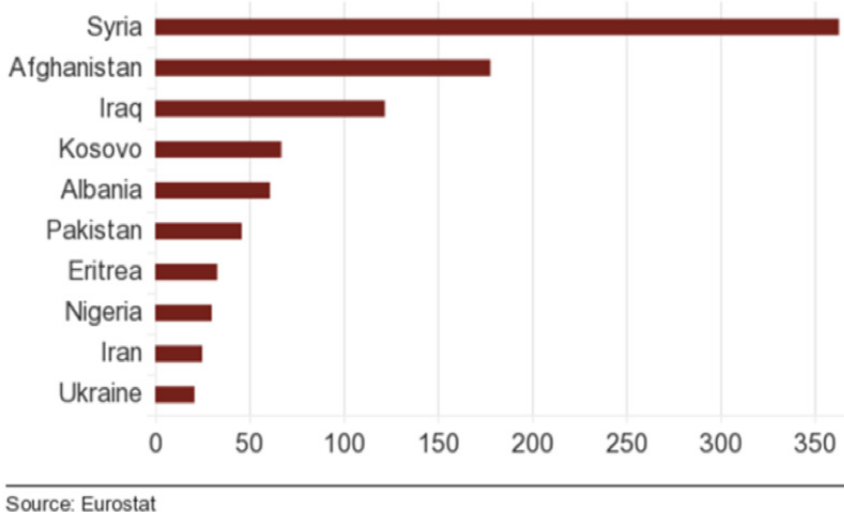


Source: Eurostat

*Figure 1.* Top 10 origins of people applying for asylum in the European Union. Data show first-time applicants in 2015, in thousands. Source: Eurostat data, BBC News 2016.

migrants' access to labor markets. A 2009 UN Development Programme research paper found that over 80% of surveyed governments had policies to maintain or increase the number of skilled migrants accepted into their countries while five others reported having policies designed to reduce the arrivals of skilled workers (Facchini & Mayda, 2009). With respect to humanitarian objectives, governments may use immigration policy to provide safe haven to individuals in need. Unlike with economic interests, humanitarian programs most often target specific demographics largely determined by a combination of international events, domestic sensitivities, and geopolitics.

In reality, few immigration policies are purely one or the other. Germany, for example, has distinct economic and humanitarian components to its immigration policy. Its 2002 immigration law built a point system by which it considers migrants for admittance. The point system places an emphasis on demand-driven economic factors such that the demographics of admitted migrants are specified by the immediate needs of the labor market; the law overtly favors "skilled workers" and entrepreneurs (Oezcan, 2002). Germany's policy also has a humanitarian element. For example, the Federal Ministry of the Interior issued a reception order in 2014 providing special treatment to refugees fleeing the conflict in Syria (Federal Office for Migration and Refugees 2014). In response to the European migration crisis, while initially declaring Germany a quota-free country, domestic politics and the burden of increasing migrants led President Angela Merkel to shift policy (Wagstyl & Rachman, 2016). In accordance with the European Commission's quota system, Germany established a policy of accepting 27,000 migrants per year, although this number is much larger in practice when one

accounts for the various other forms of immigration (BBC News, 2016).

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# Approach

## Research Question

In the context of the migration crisis, the complex dynamics of stakeholder interactions—shaped by fear, mistrust, vulnerability, and political considerations—have significantly influenced the behavior of state authorities and migrants. This paper introduces an agent-based model that explores the conditions in which a victim-centered approach to human trafficking is implemented in the context of the current European migration crisis. It seeks to answer the following questions, given the scenario of migrants at a country border and assumptions for the communication channels across the migrant population:

- Does a victim-centered approach improve detection of trafficking victims?
- How does a state's immigration policy affect the willingness of human trafficking victims to self-identify (i.e., cooperate) and, in turn, the state's ability to identify those victims?
- Does a tipping point exist with respect to initial cooperation levels at which the victim-centered approach will be effective, given spatial and network influences?

## Prior Modeling Approaches

Human trafficking has garnered some attention in the academic and research community, although few computational modeling applications to the problem exist. A notable exception is the extensive systems dynamics model of forced labor human trafficking (Parakh, 2016), although it does not address the vulnerability of migrant populations. A systems dynamics modeling approach also does not address the complexity of the system with respect to interactions between individuals (Amin, 2010). However, the authors have not seen an implementation of such models. Some like Gutierrez-Garcia, Orozco-Aguirre, and Landassuri-Moreno (2013) use agent-based models to explore the emergent qualities of crime by focusing on the conditions and interactions that lead individuals to perpetrate crimes. Pint, Crooks, and Gellar (2010) go a step further to explore the emergence of organized crime and criminal networks. Neither of these efforts addresses victims of crime, and both focus on crimes like gang activity or drug dealing and use that are fundamentally different from human trafficking for reasons noted previously. With respect to migration modeling, some research has been published, but the instances we found were not in the context of human traffick-

ing (Bagherpour, Donaldson, & Scharpnick, 2016). Our research seeks to fill this gap through the modeling and computational exploration of human trafficking, with a particular focus on the vulnerable populations of migrant flows and the role of trust in detecting trafficking victims.

**Model**

Agent-based models are increasingly recognized as an effective tool for simulating systems that are characterized by complex interactions among their components. The success of the victim-centered approach is strongly dependent on the evolving dynamics of trust between migrants and authorities. We use an agent-based model that accounts for heterogeneous characteristics of migrants who interact spatially and over networks for scenarios of state immigration policies. Our model instantiates a migrant population and seeds the agent set with some number of interspersed trafficking victims. We measure the effectiveness of the victim-centered approach by its detection success of these seeded victims.

The model is a highly stylized and abstract representation of a migrant population. The model is developed on a grid, with each cell holding an agent object that represents migrants. The grid dimensions are 41×41; thus, all model runs are executed with a total migrant population of 1,681. The motivation for using a grid layer was to use the Moore neighborhood (Gilbert & Troitzsch, 2005) as a representation of spatial neighbor influences within the densely packed migrant population on the country borders of a state—an individual is assumed to have greater word-of-mouth communication opportunities with those who are directly adjacent to them. For this research, our model will be in context of the European migration crisis and will attempt to calibrate model parameters to represent a migrant population on the German border.

In the context of migration flows, networks play a key role in the problem of human trafficking. Of particular note are the local kin- and community-based migration networks which migrants rely on to identify potential destinations based on economic opportunity and/or greater safety and security (Salt, 2000). We also wanted to capture network-based communications for these migrant populations (e.g., familial networks, country of origin networks), and we approximate these relationships by linking all of our migrant agents in the population to each other on an underlying preferential attachment network. We assume that the clustering characteristics for this class of networks provide a sufficient proxy in this research to represent real-world migrant networks—some individuals have greater connectivity within the population than others do.

Figure 2 shows a screenshot of our model interface, which features user controls for adjusting population sizes and model parameters for the migrant agents and policies of the state. The underlying preferential attachment network is not visualized. Colors represent the cooperation strategy of each agent—to cooperate (yellow) or deceive (red). For example, from a trafficking victim agent's perspective, we perceive "cooperate" as representing an intention to self-identify, and "deceive" as the intention to not. Shapes indicate if they have interacted with the state yet, and the interaction outcome (accepted or rejected). Using colors and shapes, the researcher may observe a visual representation of the evolution in the system over time and how cooperation may build and/or erode over time. The example realization depicted in Figure 2 shows clustered communities of cooperators persisting among a larger system population of deceivers.
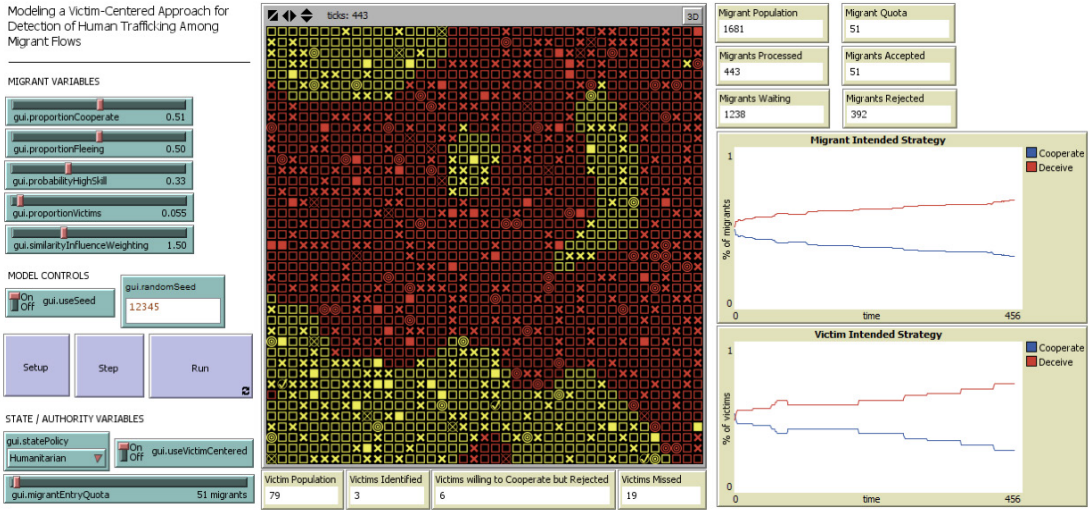
*Figure 2.* Model screenshot for a sample realization.

## Agents

There are two agent types in the model—migrant agents and one state agent.

## Migrant Agent

Migrant agents are the primary agent objects of the model and make up the population of individuals, whom we assume for the context of this research as a migrant population congregated awaiting to be processed by the border authorities of the state. We denote a migrant as $m_i \in M$, where $M$ is the agent set of all migrants in the population.

### *Migrant Agent Instance Variables*

Each migrant $m_i$ is heterogeneous and characterized by the instance variables shown in Table 1. Instance variables for $s_i$, $k_i$, and $v_i$ were meant to be calibrated to real-world data if possible, with $s_i$ representing whether the migrant is one of our seed-ed trafficking victims. This may be directly calibrated to existing data. For example, Germany reported that 5.5% of trafficking victims were self-identified in 2015; thus, we may seed a similar proportion of the migrant population as victims that need to be identified. The variable for skill level $k_i$ may be "high" (represents the migrant having a high school degree) or "low" (as not having a degree), and v_i represents the country of origin and the circumstances of that country. Using Figure 1 as an example, we assume that migrants arriving from Syria, Afghanistan, and Iraq are fleeing, while migrants from all other countries of origin are seeking.

Cooperation intention $y_i$ is randomly assigned to each migrant agent during instantiation as per a user-specified parameter for proportion of initial cooperators—agents are preassigned with an intention to cooperate or deceive.

Table 1. Instance variables for the migrant agents

| Variable | Variable name | Description |
|---|---|---|
| $s_i$ | Victim status | Boolean indicator if the migrant agent $m_i$ is a "seeded" trafficking victim in the population. |
| $k_i$ | Migrant skill level | The "marketable" skill/education level of migrant agent $m_i$ that would be of interest to the state agent employing an "economic"-based immigration policy. Levels are "high" or "low." |
| $v_i$ | Migrant motive | The motive of migrant agent $m_i$ for being a migrant, assumed as either "fleeing" (escaping conflict) or "seeking" (seeking economic gain and stability). |
| $y_i$ | Cooperation intention | The intended strategy of the migrant agent $m_i$ *prior* to interacting with the state agent, to "cooperate" or "deceive." |
| $x_i^S$ | Interaction status | Boolean indicator if the migrant agent $m_i$ has or has not yet interacted with the state agent. |
| $x_i^O$ | Interaction outcome | The outcome from the interaction of $m_i$ with the state agent; accepted/granted entry, or rejected/denied entry. |

## *Migrant Agent Behaviors*

The migrant agents have two behaviors: (1) interact with the state agent, and (2) update their cooperation strategy to cooperate or deceive. For the interaction with the state, the migrant agent $m_i$ simply engages with the state agent and updates their interaction status $x_i^S$ and outcome $x_i^O$ variables accordingly. The logic for whether $m_i$ is allowed entry past the border is controlled by the state agent.

For the updating of the cooperation intention $y_i$, this behavior is executed at each tick of the model but handled differently for two different subsets of the migrant population $M$. Note that only migrants who have not yet interacted with the state agent will go through this process of updating their intention. The cooperation intention $y_i$ is meant to reflect the strategy that the migrant will follow if and only if they are randomly selected to interact with the state agent. An agent will keep updating their cooperation intention for each time step of the model

that they are not interacting with the authorities.

We denote the set of migrants waiting to be processed as $M^X$, where migrants $m_i^X \in M^X$ have a first-order connection to the migrant agent, $m_0$, who just completed their interaction with the state agent. This is, in effect, an abstraction of the individuals that an agent will relate their recent interaction experience to. We either define a first-order connection as being either a member of a Moore neighborhood or linked via the underlying preferential attachment network to the migrant $m_0$.

For each $m_i^X M^X$, the agent will count their own first-order connections and imitate the majority strategy of "cooperate" or "deceive." Each agent $m_i^X$ will also compare themselves to $m_0$ and employ a user-defined similarity multiplier weight to have the cooperation strategy of $m_0$ count more if $m_i^X$ has a similar attribute that could be perceived as a contributing factor to the $m_0$ being either accepted or rejected by the state. This was intended to capture an assump-

tion that migrants are aware of outcomes with their connections and may alter their perceptions of cooperation based on an empathy with the recent outcome of $m_0$. This similarity comparison is based on the specific immigration policy being employed by the state agent (described previously). If the state is using an "economic" policy, migrant $m_i$ counts cooperation strategy $y$ of agent $m_0$ with a multiplier if $m_i$ has the same skill level $k$ as agent $m_0$, making $m_0$ more influential. Similarly, if the state is using a "humanitarian" policy, migrant $m_i$ counts cooperation strategy y of agent $m_0$ with a multiplier if $m_i$ has the same migrant motive v as agent $m_0$.

We denote a second set of migrants waiting to be processed—the remainder of the migrant population that has not yet been processed by the authorities—as $\bar{M}^X$, where migrants

$$\bar{m}_i^X \in \bar{M}^X$$

have ***no*** first-order connection to the migrant agent, $m_0$. Each agent $\bar{m}_i^X$ will count their first-order connections and imitate the majority cooperation strategy $y$. Note that agent $\bar{m}_i^X$ could include agent $m_0$ in $\bar{M}^X$, but, as they are not a first-order connection of $m_0$, no multiplier is used.

## State Agent

The state agent interacts with the migrants and determines whether they will be granted entry. Therefore, in this scenario, the state agent may be described as any state authority that makes determinations on whether a migrant agent will be granted entry into the country (e.g., law enforcement, customs, or immigration officials). Our approach assumes a single instantiation of this agent type that interacts with individual migrant agents.

### State Agent Instance Variables

The state agent uses the following instance variables shown in Table 2.

The migrant entry quota $Q$ may proportionally represent real-world quota limits for migrant entries granted. For example, Germany agreed to grant up to 27,000 asylum requests, but from an overall population of more than 1 million migrants, which translates to approximately 3% of the migrant flow. In the context of our model, this is a quota limit of 51 migrants, or approximately 3% of the total migrant population.

Table 2. Instance variables for the state agent

| Variable | Variable name | Description |
|---|---|---|
| $Q$ | Migrant entry quota | Entry limit for how many migrants the state agent will accept, regardless of policy or migrant situation. |
| $P$ | Immigration policy | "Economic" (maximize the economic value) or "humanitarian" (fill quota and favor fleeing agents and then seal the border). |
| VCA | Victim-centered approach | Boolean variable for denoting whether the state agent is implementing a victim-centered approach, meaning they will favor migrants with high vulnerability if they are willing to cooperate. |

The immigration policy $P$ reflects how the state treats the acceptance process. Immigration policy is a balance between economic and humanitarian elements. If $P$ is an "economic"-focused policy, the state seeks to maximize its economic benefit to the country. This could imply a protectionist posture with a minimization of migrant access to labor markets or the admittance of migrants who fill a specific economic need. For this research, we assume that an economic policy implies the state will accept all migrants with skill level $k_i="High"$ until the quota is met. If $P$ is a "humanitarian"-focused policy, the state seeks to provide safe haven to those in need. For the purposes of this research, we assume that a humanitarian policy implies the state will accept all migrants with motive $v_i="Fleeing"$ until the quota has been met.

The victim-centered approach variable, VCA, denotes whether the state agent will first give preference to migrants of high vulnerability—we assume that seeded victims are migrants of high vulnerability.

## State Agent Behaviors

A state agent's only behavior rule relates to its interaction with migrant agents. This interaction is limited to one migrant at a time and is driven by the state's immigration policy, number of migrants allowed entry against the quota, and the individual attributes of the migrant agents. The interaction logic is shown in Figure 3.

Figure 3 also highlights the possible migrant acceptance outcomes. The key success metric we are tracking for our research is when a seeded victim is successfully identified under a victim-centered approach by the state agent. Another valuable metric is when victims are willing to cooperate but the quota has been filled, and thus they are rejected. We intend to use this metric as a proxy for estimating the persistence of cooperation through the migrant population over time.
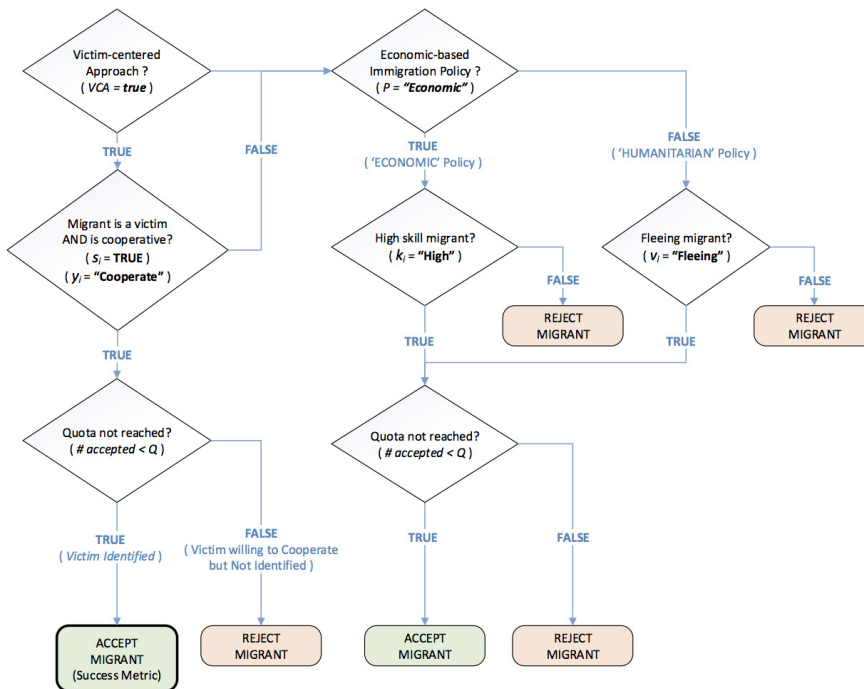
*Figure 3.* Behavior logic for how the state agent interacts with migrant agents. This logic is used by the state agent for determining whether the migrant will be accepted or rejected.

## Process Flow and Scheduling

The process flow of our model is described with the pseudocode below.

```
1    FOR EACH migrant m_i ∈ M, in a random order
2    {
3      IF the quota Q has not been reached yet
4      {
5      Interact with state agent and determine accept/reject outcome x_i^O
6      Update the cooperation strategy y_i for the 1st order neighbors of m_i
7      Update y_i for remaining agents m ∈ M with interaction status x_i^S = FALSE
8      Update migrant entries and compare to the quota Q
9      } ELSE
10     {
11     State rejects the migrant m_i
12     }
13   }
```

The process flow will continue until all migrants have interacted with the state agent, and each migrant agent m_i will only interact once per simulation run.

## Implementation

### Implementation Description

We implemented the model in NetLogo (Wilensky, 1999), an open-source, agent-based modeling platform. All agent updates are executed by default in NetLogo by using asynchronous random activation order.

## Verification and Validation

Model verification was a continuous process throughout model development. The primary way to verify that the model was running as expected was through observing how the visualization changed as we manipulated model parameter.

To help with this process, we implemented agent visual representations to clearly indicate where in the process they were. These representations are shown in Figure 4.

Figure 5 shows a panel plot for one sample realization of our model. Each plot shows the emergent pattern of migrant cooperation strategies for the given time tick t in the model. We observe that the migrant quota was reached at time *t*=51, but clustered communities of cooperation persist well into tick 500.

Following Axtell and Epstein (1994), we suggest we have achieved Level 1 validation—our model can represent stylized facts for how influence and social contagion might plausibly spread through a migrant population, but is not at a level of realism that we can achieve statistical validity. This level of validation, while not good
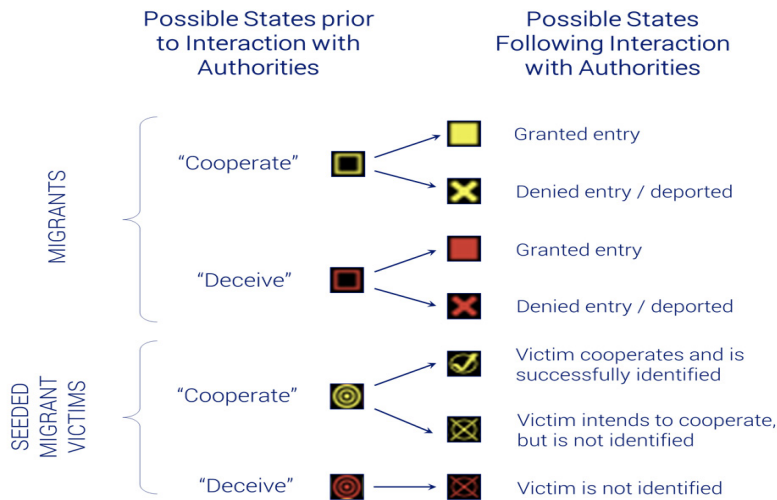


*Figure 4.* Visualization legend key for the model. For each agent type of a migrant or a seeded trafficking victim, the key shows the initial visualization for their intended strategy and the possible new state(s).
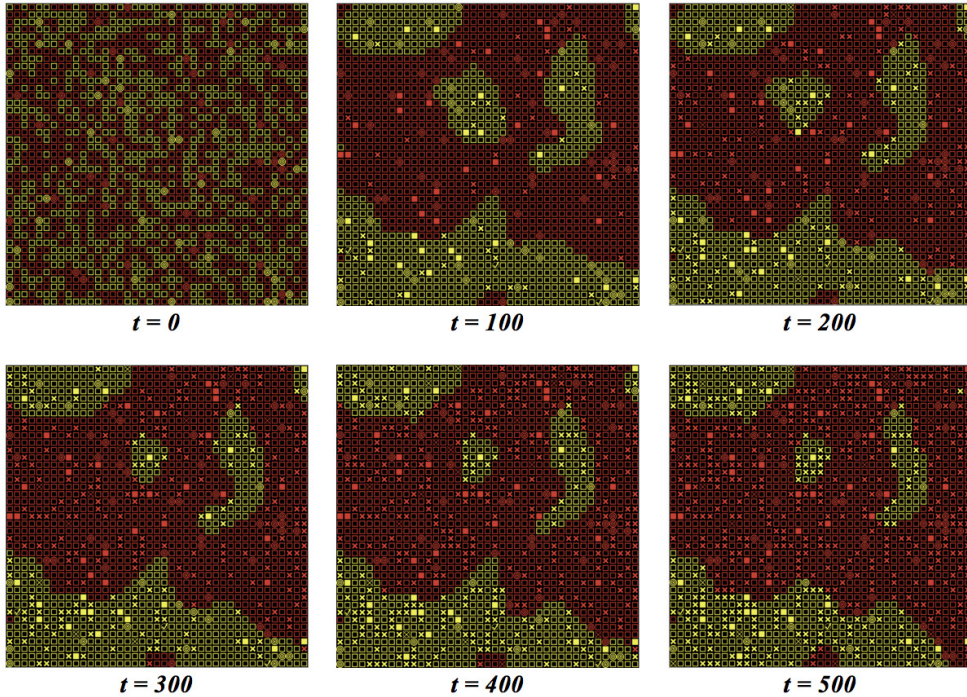
*Figure 5*. Sample model realization with system state changing over time. Shows model screen-shots over time, with the variable *t* representing the tick count.

for point prediction estimates, is still useful to evaluate potential mechanistic explanations for the role of interaction dynamics between migrants and immigration policy on the potential high-level outcomes for detection of trafficking victims.

**Experiment Results**

We conducted a parameter sweep experiment aimed to determine the sensitivity of outcomes (i.e., successful detection of migrant victims) to the initial levels of cooperation in the population.

**Assumptions**

We made the following assumptions for the experiments:

- Rules around accepting migrants will always reflect self-interest and domestic politics; a victim-centered approach will be secondary to immediate interests.
- The number of migrants a country is willing to accept is bounded by a quota.
- Under an economic policy, acceptance is based on whether a migrant's specific skill level matching the state's stated need.
- Under a humanitarian policy, acceptance is based on migrant motive (i.e., fleeing or seeking).
- Under a victim-centered approach, all victims are accepted if they are willing to cooperate.
- A victim may be granted entry based on the immigration policy, but if she does not want to "cooperate," she is still counted as an undetected victim.

## Experiment Initialization

To initialize the experiment runs, we used the following parameter ranges in Table 3 that reflect real-world representations (where possible) of the migration crisis on Germany's border.

We ran 100 replications for each parameter combination specified in Table 3, for a total of 1,100 runs, to complete the experiments.

## Results

Figure 6 shows that the detection of trafficking victims first emerges when 48% of the agent population starts with a cooperative strategy. Detection rates increase with the percentage of agents using our abstraction of cooperative strategies, stabilizing around 52%. Figure 7 measures the number of seeded victims who were denied entry, despite being willing to cooperate. Because the willingness to cooperate is a function of interactions with other migrants, the results also provide an indication for how an overall culture of cooperation persists throughout the migrant population despite a country meeting its quota and closing its border. Results suggest that when initial cooperation

intention of the population is >52%, nearly all seeded victims maintain a willingness to cooperate.

These results suggest initial treatment of trafficking victims has a significant influence on the success for victim detection, and that early propagation of a readiness to cooperate is important for sustaining victims' long-term willingness to cooperate. The more effectively the state can promote cooperation prior to interactions with state agents, the greater the contagion and persistence of cooperation in the population over time. These insights have implications for how states should proactively shape migrant perceptions and encourage self-identification. These findings can serve as a basis for further study of how state behavior influences individual strategies for interacting with authorities.

In addition to a computational exploration for the underlying mechanics of the victim-centered approach, model outcomes suggest for our abstraction of the problem, a victim-centered approach facilitates the identification of victims. Both the economic and humanitarian immigration policies performed better when paired with the victim-centered approach.

Table 3. Experiment parameter settings to represent migration into Germany in 2015

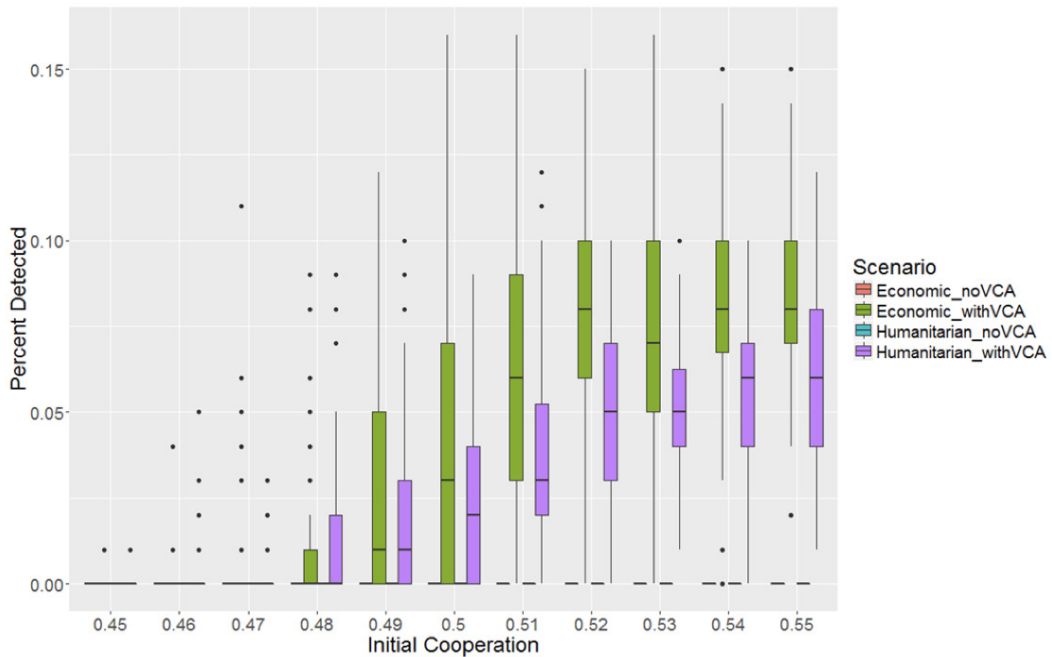| Model parameter | Experiment Value(s) |
|---|---|
| Population | 1,681 (fixed) |
| Proportion of initial cooperators | Over range [0.45, 0.55], incrementing by 0.01 (initial explorations of the data suggested this was a parameter range of interest). |
| Proportion of fleeing migrants | 0.50 (represents proportion from Syria, Afghanistan, and Iraq) |
| Proportion of high-skilled migrants | 0.33 (represents proportion with a high school degree) |
| Proportion of trafficking victims | 0.055 (represents documented self-identification rate) |
| State policy | Economic, humanitarian |
| Victim-centered approach | True, Ffalse |
| Migrant entry quota | 51 Migrants (represents 3% of the total population) |

*Figure 6.* Percent of human trafficking victims successfully detected. The plot shows the percent of the migrant population that were willing to cooperate (and the quota was not yet full) when the state agent interacted with them.

The outputs suggest however that the economic immigration policy yields more cooperation among trafficking victims and a slightly improved rate of detecting those victims. A satisfactory explanation of this outcome is still being investigated. Previously cited studies on international migration offer some theoretical basis for validation. For example, Kugler, Boussalis, and Coan (2012) suggest that migrants prioritize the opportunity for economic success over access to public goods.

This may also suggest a tradeoff between more permissive immigration policies (represented in this model by the humanitarian policy) and a victim-centered approach to human trafficking. In other words, policies that admit migrants based on broad or commonly occurring attributes (such as humanitarian suffering) might lead states to more quickly fill their immigration quotas and deplete resources, while more selective immigration policies might afford state authorities more time and resources to successfully employ a victim-centered approach.

## Conclusions

Our research aimed to provide insight into some of the tradeoffs governments must balance in the context of large migration flows. We developed and presented a proof-of-concept model to better understand of how a state's immigration policy might affect the willingness of human trafficking victims to self-identify (i.e., cooperate) and, in turn, the state's ability to identify victims among the flow of migrants. Ours is a parsimonious model that is focused on representing a population environment (i.e., migrants) where agents are sensitive to spatial and network-based communication, adaptation, and learning.

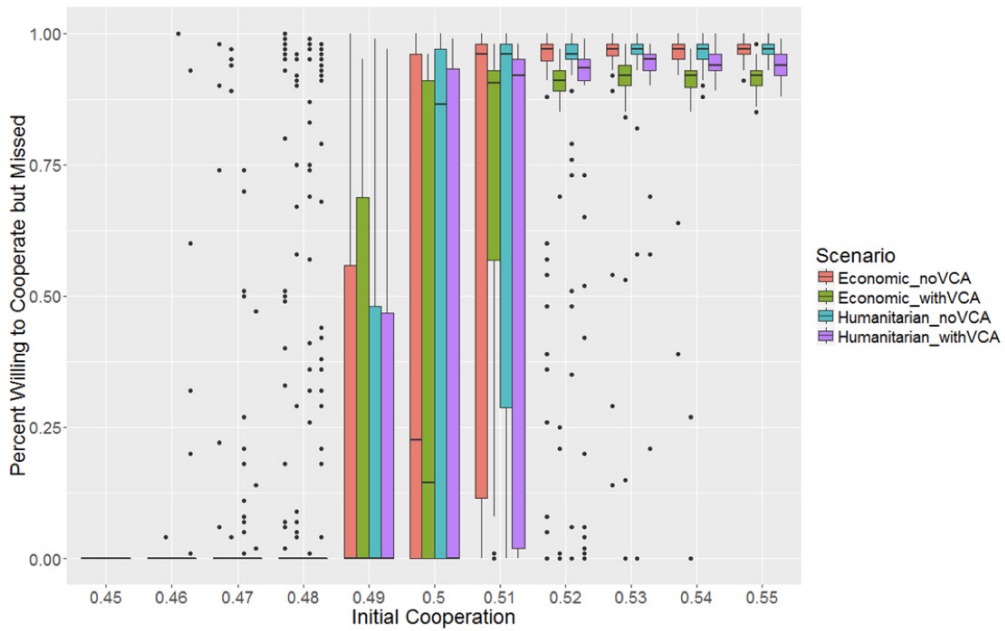Our experiments identified a tipping point of initial cooperation levels at which

*Figure 7.* Percent of human trafficking victims that were willing to cooperate but were not identified under the victim-centered approach.

the victim-centered approach became effective, given spatial and network influences. The model, as in the real-world, is sensitive to the initial cooperation of the victim population. Our results imply that modest success in the model requires a very high level of initial cooperation, nearly half of the population. This, in turn, suggests victim experiences and perceptions before interaction with authorities are very important because those experiences and perceptions lead to persistent clusters of migrants willing to cooperate even after border closure. Results also suggest state authorities need early successes for cooperative strategies to propagate across the population.

Initial findings also suggest a victim-centered approach coupled with more selective immigration policies appear to yield the most success in detecting human trafficking victims. In this model, the economic immigration policy was the more selective of the two. More research is required to determine if more selective policies are indeed more conducive to the victim-centered approach.

The results are not an indictment on humanitarian policies or a promotion of economic policies, per se, but rather it may be an indication that overarching goals of a state's immigration policy—and a state's subsequent allocation of resources and efforts—have a direct (and counterintuitive) impact on whether a victim-centered approach is successful. In other words, we suggest that less selective policies allow the migrant quota to be filled so quickly that trust and cooperation levels necessary for the victim-centered approach to be successful do not have time to propagate and influence victim beliefs. This tradeoff between policy goals and resources is exacerbated by mass migration flows, and emphasizes even more so, the critical role of initial cooperation levels and perceptions of the state among target populations.

**Future Research**

This agent-based model is an exploratory model that requires more development and validation to empirical data sets. To be

more nuanced and more useful for policy-makers, the parameters of the model could be expanded to account for more individual details among migrant populations and government policies. For example, more detail for describing migrant skill levels, more nuanced state policies (e.g., hybridization between economic and humanitarian policies), and a better definition and representation for migrant "vulnerability." These expanded data elements could facilitate a more robust consideration of migrant motivations and enhance the model representation for government efforts and the resulting ability to detect potential trafficking victims. Greater fidelity in migrant attributes is necessary for a more realistic representation of the victim-centered approach.

Furthermore, several parameters in future iterations will be calibrated to existing data. For example, the current model imposes government immigration quotas. Implementing more precise representations and estimates of Germany's migrant acceptance policies, rates, and limits may yield more representative insights. Similarly, the networks used to propagate perceptions across the agent population are highly stylized. These networks should be explored for a representation more realistic than assuming a preferential attachment network model.

Adding additional jurisdictions would also help us better understand the transnational elements of migration and human trafficking. Representing other governments would allow for a more complete exploration of the various factors that drive migrant perceptions (e.g., experiences in source and transit countries) and recreate the more realistic complexities actual migrants face as they choose where to settle. Geopolitical dynamics could also be more fruitfully explored, such as the effects of closed-border policies in countries like Hungary on more permissive policies, such as those in Germany.

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