Modeling Sex Trafficking and Commercial Sex Work Policy in Massachusetts

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Introduction: Sex trafficking is closely intertwined with the commercial sex work (CSW) industry, but severe data scarcity makes evidence-based policy comparison difficult. In most of the United States, both buying and selling sex are criminalized; in practice, prostitution enforcement disproportionately falls on sellers, some of whom are experiencing trafficking or other forms of exploitation (Farrell and Cronin 2015). Alternatives include full decriminalization, in which buying and selling are decriminalized; partial decriminalization, in which selling is decriminalized while buying remains illegal; and variants of partial decriminalization that pair legal reform with expanded services. Because policy changes can alter buyer demand, seller entry and exit, trafficker activity, service use, and recidivism simultaneously, their effects may be nonlinear and counterintuitive. We develop a system dynamics model (SDM) of sex trafficking and CSW in Massachusetts to compare these policy regimes and identify potentially high-leverage intervention points.

Methods: The model was developed through an iterative, semi-structured subject matter expert (SME) elicitation process. The primary SME is a survivor of sex trafficking with a PhD in public policy who leads a nonprofit supporting survivors of sexual exploitation. Elicitation included an initial lecture and targeted questioning, construction of a preliminary causal model, and repeated review as the model was formalized. The resulting structure was separately compared with the literature and reviewed by a second SME. This approach follows established methods for incorporating expert mental models into system dynamics when direct empirical observation is limited (Ford and Sterman 1998; Luna-Reyes and D. L. Andersen 2003). The model was implemented in AnyLogic 8.9.3 and simulated to equilibrium for calibration, sensitivity analysis, and policy experiments.

Model structure: The model contains three interacting populations: sex sellers (SS), sex buyers (SB), and sex traffickers (ST). The seller sector is the most detailed and distinguishes vulnerable adults and youth, trafficked and non-trafficked sellers, and individuals exiting CSW with or without emergency, short-term, or long-term services. Vulnerability is represented parsimoniously through a fixed at-risk population shaped by factors such as homelessness, poverty, lack of support networks, and childhood violence. Trafficker exposure and geographic normalization of CSW affect entry into trafficking, while prosecution culture influences criminal-record acquisition. Criminal records then create barriers to leaving CSW and progressing through recovery. Buyer dynamics reflect CSW acceptance, trafficking education, arrest risk, transaction cost, and perceived benefit; trafficker dynamics reflect market incentives, recruitment, organized crime prevalence, and prosecution pressure. Policy regimes act principally by changing buyer and seller legal risk, which propagates through feedback loops linking demand, seller availability, cost, profit, and trafficking.

Calibration and sensitivity analysis: Because direct measures of the underground CSW market are scarce, calibration combines public data, literature estimates, and SME judgment. The baseline estimates include approximately 20,823 monthly sex buyers, 155,801 buyer transactions per month, and 9,529 trafficked sex sellers in Massachusetts. The trafficked-seller estimate applies Massachusetts's average 2022–2024 share of National Human Trafficking Hotline cases to a national baseline estimate. Four parameters governing buyer entry and transactions and seller transaction capacity were tuned to produce plausible equilibria without overfitting uncertain targets. The calibrated model produced 20,697 buyers, 9,920 trafficked sellers, 80% of

sellers trafficked, and 40% of sellers with a criminal record, close to the corresponding calibration estimates.

Sensitivity was assessed in two stages. First, one-at-a-time (OAT) experiments varied each parameter across 50 evenly spaced values over a plausible range. Second, a multivariate analysis used Latin hypercube sampling to generate 5,000 parameter sets in which 44 inputs varied simultaneously by ±20% around their calibrated defaults; partial rank correlation coefficients (PRCCs) then estimated each parameter's independent association with model outputs while controlling for the others (McKay et al. 1979; Marino et al. 2008). Both analyses identified buyer benefit as highly influential but difficult to change directly, and the obstacle created by a criminal record as one of the strongest policy-relevant drivers.

Policy experiments and results: We compare four alternatives with the default of full criminalization. Full decriminalization sets buyer and seller prosecution culture to zero. Partial decriminalization removes seller prosecution while retaining buyer prosecution. An "Equality Model" extends partial decriminalization by tripling short-term and long-term service capacity. A fourth experiment represents expungement by reducing the percentage of former sellers retaining a criminal record by 10%.

Full decriminalization produces a distinct pattern: total sellers increase by about 4.1%, trafficked sellers by about 2.2%, buyers by about 5.3%, demand by about 8.5%, and traffickers by about 8.5% relative to criminalization. Removing buyer risk increases both the number of buyers and their transaction frequency; the resulting market expansion is large enough that increased entry by non-trafficked sellers does not fully satisfy demand, so trafficking also rises. Partial decriminalization instead reduces trafficked sellers by about 5.7%, total sellers by 4.7%, buyers by 2.3%, and demand by 2.4%, while traffickers increase modestly by about 1.6%. In the model, lower seller risk facilitates exit and indirectly increases buyer risk, reducing demand; traffickers respond by increasing activity to replace sellers who leave. The Equality Model preserves this pattern but yields somewhat larger reductions in sellers and trafficked sellers, indicating that expanded services complement legal reform. Expungement generates smaller but consistently protective changes, including reductions in trafficked sellers, total sellers, buyers, and demand. These directional findings are broadly consistent with previous empirical and simulation studies emphasizing the role of demand in trafficking outcomes (Cho et al. 2013; Kővári and Pruyt 2014; Senft et al. 2019).

Discussion: Across the modeled scenarios, partial decriminalization and the Equality Model outperform full decriminalization on trafficking-related outcomes, despite a modest increase in trafficker counts. The simultaneous decline in trafficked sellers and increase in traffickers under partial decriminalization also illustrates why policy conclusions should not rest on a single output. Criminal-record reform is particularly notable. A comparatively modest expungement intervention produces protective effects across multiple outputs, and sensitivity analysis independently identifies criminal-record obstacles as a highly influential and policy-relevant mechanism. This convergence suggests that reducing the legal and social barriers created by prior seller arrests may be a high-leverage, relatively low-disruption intervention.

The results should be interpreted as evidence about causal mechanisms, directions, and relative effects rather than precise forecasts. Calibration targets are themselves uncertain, the model structure was developed primarily with one SME and face-validated by a second, the vulnerable population is fixed, the model is not spatially explicit, heterogeneous buyer and seller subpopulations are aggregated, and policy experiments are evaluated at equilibrium rather than along transition paths. Future work should broaden stakeholder participation, incorporate upstream vulnerability, youth pathways, spatial displacement and population heterogeneity, and examine transitions between policy equilibria. Better data on seller prevalence, transactions, service capacity, and recidivism would narrow uncertainty; the sensitivity analysis indicates where collection would be most valuable. Overall, the model shows how system dynamics can support policy reasoning in an underground, data-scarce system by making assumptions explicit and tracing intervention effects through feedback mechanisms.

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