Unraveling the Dynamic Network of Illicit/Legal Military Small Arms and Light Weapons Trade with SAOM

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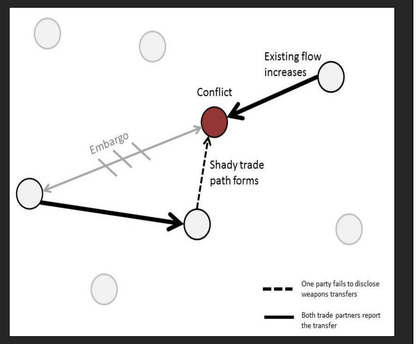
INTRODUCTION

This research uses stochastic actor-oriented modelling (SAOM) to unravel how the global trade in **military small arms and light weapons (SALW)** evolves in response to weapons embargoes. In particular, we seek to understand the interplay between legal and illicit trade.

Nations (circles) produce, resell or transship weapons and ammunition. International trade with others (lines) can be reported (legal) and some transfers are omitted from official records (illicit/shady). Various factors influence why a nation continues to ship weapons following the imposition of an embargo.



Our objective is twofold:

1. Understand the interplay between the legal and illicit flow of SALW.
2. Investigate the effects that embargoes have on trade structures.

NETWORK GENERATION

Data about weapons transfers were developed from a category of UN Commodity trade data which includes:

930100 Military weapons, other than hand guns, swords, etc.
930111 Self-propelled artillery weapons (e.g., guns, howitzers & mortars)
930119 Artillery weapons other than self-propelled
930120 Rocket & grenade launchers; flame-throwers; torpedo tubes
930190 Military weapons, other than revolvers, pistols
930591 Parts & accessories of military weapons of 93.01
930690 Bombs, grenades, torpedoes, mines, missiles & parts/accessories

MODELLING PROCESS

SAOM examines how networks change from the current observation to the next time interval. Applied to SALW transfers, we ignore trade relations that are constant (trade activity that continues from one year to the next or does not occur in either year) and focus only on situations wherein nations decide to initiate a trade relation or terminate a prior trade relation.

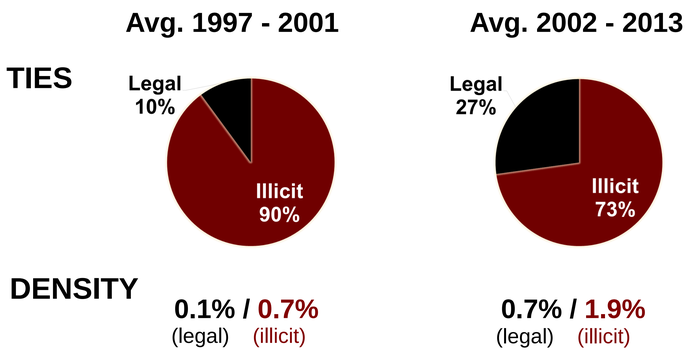
ACTORS

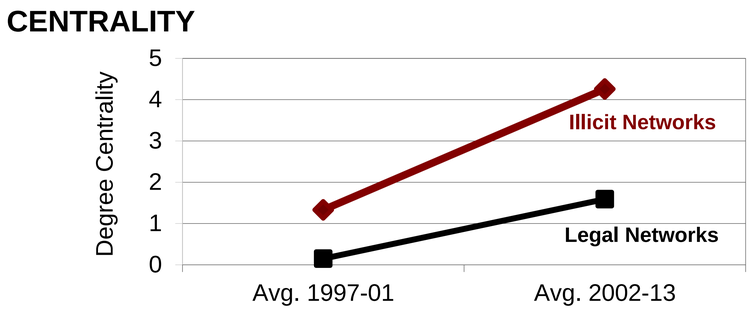
224 nations/territories reporting arms trade at least once 1997-2013.

Model assumptions about actors:

- Nations can change their trade partners for both legal and illegal activity.
- Observed annual trade decisions (0 = no trade and 1 = trade) accrue from many micro-step decisions that occur between each observation.
- There are no lag effects: current observations (T_0) inform future observations at T_1

DESCRIPTION OF NETWORKS





BASELINE MODEL CHARACTERISTICS

Several structural statistics help us to understand how the weapons transfer networks evolved (1997 – 2013). The baseline model results reported below include only structural characteristics, the next phase of analysis involves adding dynamic (time variant), static (constant variables), and dyadic (other network) covariates. Our primary interest is to investigate the effects of embargoes on the observed change in weapons flow, specifically, pre-implementation, during embargoes, and 2 years post-sanction.

Observed Stability in Evolutionary Tendencies

Before 2002, trade networks exhibited similar evolutionary tendencies.

Jaccard coefficients suggest that between 25-35% of the transfer networks were the same from one year to the next. Post 2002, legal transfers became stable and illicit transfer networks continued to vary.

The significant change in network properties 2001 – 02 is linked to a modification of UN commodity trade recording practices and the global escalation in military spending observed in the post 9/11 era.

Comparison of Evolutionary Tendencies, 2007 – 2013*

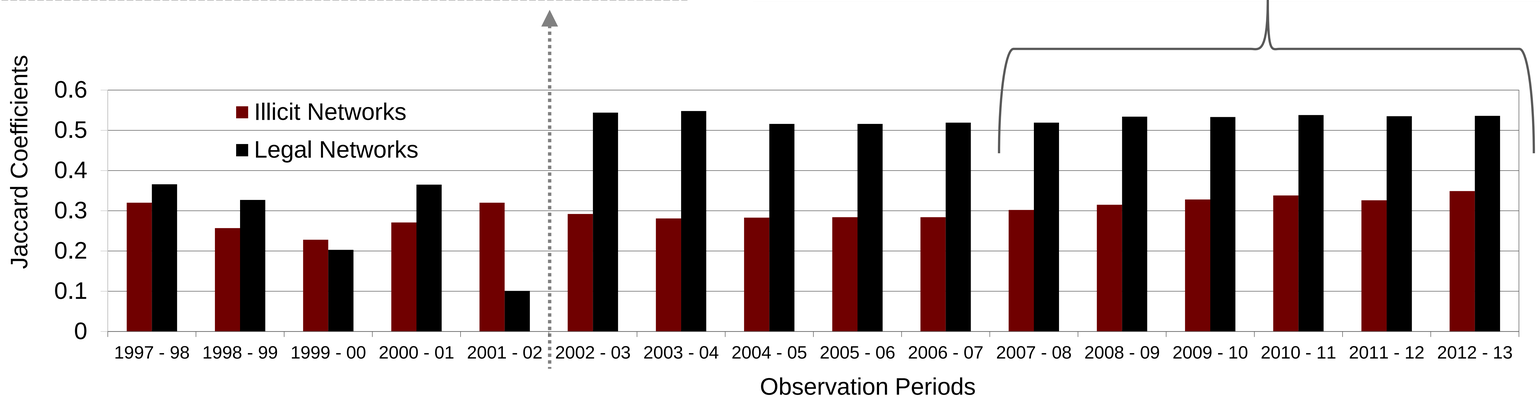
	Legal Model			Illicit Model		
	Coef.	S.E.	Exp.	Coef.	S.E.	Exp.
outdegree (density)	-5.57	0.12	0.00	-3.62	0.15	0.03
reciprocity	1.82	0.15	6.16	0.58	0.06	1.78
transitive mediated triplets	1.07	0.04	2.91	0.39	0.03	1.48
3-cycles	-0.44	0.03	0.64	-0.15	0.02	0.86

* All tests are significant at p<.001.

Tendency for changes to be:

- away from taking on more trade partners (outdegree) or forming trade chains (3 cycles)
- favors reciprocity and mediated roles (new brokers to existing direct trade)

Substantive difference in effect sizes.



The model is implemented in RSiena.[1] Siena performs multivariate, dynamic network analysis. Using a method of moments maximum likelihood estimation process, the model runs a logistic regression to explain change in ties (formation or dissolution) across successive time periods. These models generate parameter estimates with an initial value of gain set at 0.2. Deviation values were calculated from 1,000 iterations. Estimates are stable if convergence occurs and t-ratios are near a value of 0.1. All reported estimates had satisfactory t-ratios.

[1] For an explanation of the SAOM application used see: R. Ripley, T. Snijders, and P. Preciado Lopez, *Manual for RSiena*, (University of Oxford, Department of Statistics and Nuffield College, 2011); T. Snijders, 'Network dynamics', in *The SAGE Handbook of Social Network Analysis*, ed. J. Scott and P.J. Carrington (Thousand Oaks, CA: SAGE, 2011), 501-513; and, T. Snijders, G. Van De Bunt, and G. Steglich, 'Introduction to stochastic actor-based models for network dynamics', *Social Networks*, 32 (2010), 44-60.

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