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# HOW FAR WILL YOU GO WHEN THERE IS AN EMBARGO?A STOCHASTIC ACTOR-ORIENTED MODEL OF THE EFFECTS OF ARMS EMBARGOS ON ILLICIT WEAPONS TRADE

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A Thesis Presented to the

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California State University,

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Jennifer Ann Hagala

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# ABSTRACT

The international community routinely implements embargoes in an effort to restrict the flow of small arms and light weapons into politically unstable regions. The effectiveness of sanctions fall into question when reports indicate that weapons continue to pour into embargoed territories. Using stochastic actor-based modeling, the current study investigates how shipment patterns change over time, and how trade patterns evolve in the presence of endogenous influences, such as embargoes, while controlling for corruption levels and national wealth (e.g., gross domestic product). The analysis here indicated that embargoes did have an effect in diverting illicit weapons trade through indirect ties. This was seen highest during the embargo implementation period and post embargo implementation period. The results stand to improve our understanding of this complex illegal global market and the role national control of corruption and gross domestic product play in the enforceability of these sanctions. In the final analysis what was discovered was that embargoes do effect change in the illegal arms trade network. This effect is seen in the form of indirect ties to end user countries. This suggests that improvements to policies and regulation on transshipment points need to be highly scrutinized.

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# CHAPTER ONE

# INTRODUCTION

## Case Study

When political instability generates significant civilian casualties and human rights violations, the global outcry for intervention often leads to efforts to control the flow of weapons into the region, usually by way of embargos. As illustrated in the following example of the civil war in Sierra Leone, trade is difficult to control due to the complexity of the supply network.

The violence in Sierra Leone during its ten-year civil war against rebel fighters in the early 1990s was fueled by the diamond mines, which produced millions of dollars in profits from diamonds every year. The core rebel group that gained control over the mines through rape, murder, and other human rights violations was the Revolutionary United Front (RUF). Many of the soldiers recruited to the RUF were promised money, drugs, and sex slaves. Some soldiers were forced to fight, including children who were often given drugs before being sent out to the front lines. One of the leaders, Foday Sankoh, a former military leader within Sierra Leone, received support from countries such as Liberia, Senegal, and Burkina Faso. This support continued in the form of weapon supplies in exchange for diamonds as the conflict progressed.

Despite the use of United Nations arms embargoes against the RUF, foreign support started in the early 1990s and continued through the early 2000s. While Liberia, Burkina Faso, and Senegal were the direct suppliers of arms going into Sierra Leone, these countries were not where *all* of the shipments originated. Figure 1 shows that some of the shipments came from as far away as the Ukraine, where government officials stated in their end-user paperwork that the recipient of the weapons was not Sierra Leone or RUF rebels. This statement allowed them to deflect any responsibility when dealing with countries that had arms embargoes on them. Although several of the leaders from the RUF group have since been held responsible for human rights' violations and stood trial, security and stability within the region continues to be a problem.

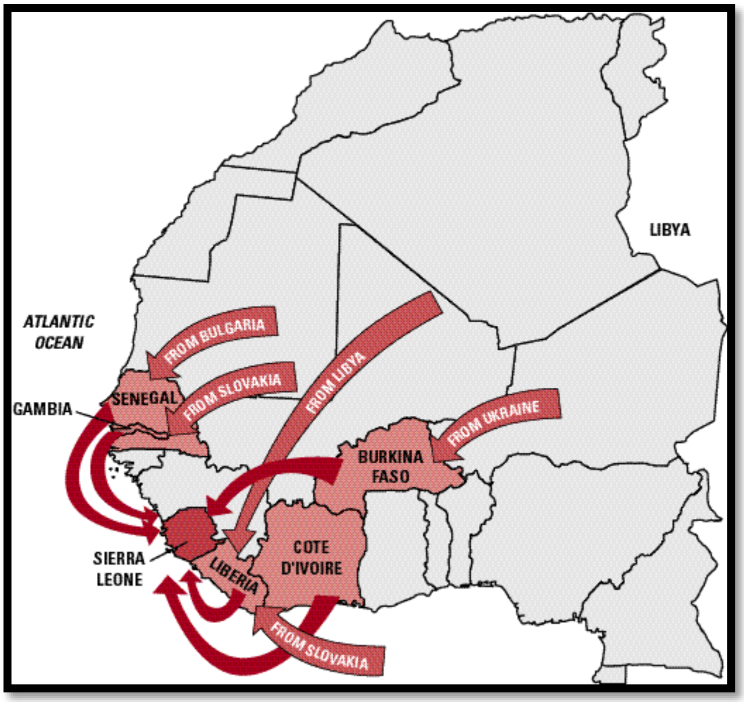



Figure 1. Map of Arms Shipments into Sierra Leone From Other Countries

The lighter areas are the initial transfers from supplier countries, while the darker red indicates the final transfers to RUF.

Transshipment, moving weapons through indirect shipping channels, changes the status of weapons from legal to illegal. For example, a weapons transfer from Ukraine to Burkina Faso can be legal when shippers file appropriate paper with the relevant authorities and the end-user is listed as being in Burkina Faso. In most cases, the weapons do arrive in Burkina Faso as intended, but they are quickly transferred to Sierra Leone through illegal means and/or through a staged robbery of the weapons. The impact that this practice has is devastating.

Small arms and light weapons (SALW) were defined by the United Nations General Assembly in August 1997 as,

> Small arms and light weapons range from clubs, knives and machetes…those covered by the United Nations Register or Conventional Arms, for example, mortars below the caliber of 100mm, which are manufactured to military specifications for use as lethal instruments of war.

Types of weapons included in this category of arms includes: revolvers, self-loading pistols, rifles, shotguns, assault rifles, sub-machine guns, mounted grenade launchers, portable anti-aircraft guns, portable anti-tank guns, recoilless rifles, portable launchers, etc.

Illicit SALW were responsible for an average of 535,000 deaths each year from 2010 to 2015. When the number of permanent physical and psychological injuries accrued from the armed conflict is considered, the number of victims is significantly higher. For every fatal injury from a firearm, there are 20 to 40 non-fatal injuries caused by firearms (WHO, 2002). We must also consider the human costs associated with armed conflict. There are currently 39 million children living in conflict areas with no access to education, health services, or proper nutritional meals (Leff & Moestue, 2009). Nations with long-standing instability and corruption can become saturated with SALW, which further destabilizes the region.

## Trade Restrictions

Weapon producing nations, such as the United States, Italy, and Belgium often discontinue shipments of military aid to conflict regions, such as Sierra Leone, when gross human rights' violations are discovered. When industry self-regulation fails, and SALW continues to flow into regions embroiled in armed conflict, nations enact arms embargoes. They occur unilaterally to prohibit weapons transfers from companies operating in the home state, regionally with multinational agreements, or globally with trade sanctions posed by the United Nations Security Council. For example, the U.S. State Department currently lists 26 countries that are under some form of weapons' embargoes. The United Nations has 15 different embargoes in place worldwide, and the European Union (EU) currently has 22 different embargoes in place for countries, states, and non-government entities.

## Embargoes

Each embargo, and the rules surrounding it, is different depending on the situation in the country at the time. For example, President John F. Kennedy enacted a 1962 economic embargo on Cuba. One of the conditions made to release the embargo on Cuba is that the Castro Regime can no longer be in power. Another example is the United Nations arms embargo placed against Iran. If Iran complies with certain restrictions to their nuclear program, this embargo may be lifted or become less restrictive. More recently, embargoes were placed on Syria. These sanctions were implemented because the Syrian government continues to support known terrorist groups, trying to procure weapons of mass destruction, and to threaten international security. With the widespread use of embargoes, the need becomes even greater to understand if these forms of behavior modification are effective.

Arms embargoes are often referred to as “smart sanctions” due to their targeted nature. Rather than prohibiting all goods and services from going into a country, arms embargoes restrict specific commerce thereby allowing the continuance of essential trade. For example, sanctions made against a particular country could stipulate that exporting arms to country A is a violation rendering the exporter liable for sanctions; however, exports of humanitarian aid would not be restricted. Arms embargos often target a particular country, territory, state, or non-state entity involved in human rights’ violations.

Why these weapons continue to reach illicit end users despite embargoes, plagues the international community. A possible explanation may come from the work of Bichler and Malm (2015). These authors combine two theoretical approaches, and in so doing, identify elements of the civic infrastructure that influence crime control, as well as entities that straddle illicit and legal trade at the transnational level, that may offer insight into why weapons continue to flow.

First, Bichler and Malm (2015) extend the work of Sampson, Eck and Dunham, (2010) to the international arena. Sampson et al (2010) argued that the set of crime controllers identified by routine activities theory (Cohen & Felson, 1979; Eck, 1995, 2002; Felson, 1995, 2006; Felson and Cohen, 1980), required rethinking. These authors introduced the idea that super controllers create the framework within which the primary crime controllers operate—the primary controllers being intimate handlers, guardians, and place managers. At the national level, through private and civil regulatory infrastructures super controllers provide the incentive for primary controllers to be more effective. Various mechanisms of influence exist--economic, social, political, formal justice—that can exert pressure on primary controllers.

Insight also comes from the lock model. Bichler and Malm (2015) argue that the transnational commerce is not dichotomized into legal and illicit activity, rather, commerce exists on a continuum of legality. Drawing upon the lock model proposed by Tijhuis (2006, 2011), they explain that illicit and legal trade is fused through individuals, companies, and nations positioned to exploit asymmetries between nations, routinely moving commodities through an illicitization process or cleaning product, through a laundering process. At any one time, trade brokers can be engaged in both legal and illicit transactions. Goods can move from illegal goods to legal markets and vice versa.  These brokers are also subject to the influence, or the lack of attention, of super controllers. This theoretical approach will be discussed further in the discussion to explain network change and how that change is influenced by the presences of embargoes.

## The Current Study

The purpose of the current study is to understand how the structure of illicit weapons' trade changes in response to the imposition of embargoes. Using stochastic actor-based models, the primary objective is to isolate the effect of embargoes on the local weapons trade network while controlling local conditions (e.g., control of corruption) and evolution in trade activity at the global level (e.g., reciprocal trade agreements). Embargoes are modeled as a stochastic shock to the trade system with three phases: Phase 1 is the period two years before an embargo is enacted, Phase 2 is during the embargo, and Phase 3 is the two years following the lifting of the weapons trade sanction.

In addition to capturing how the trade network evolves with structural statistics (i.e., will it become denser with more connections or will relationships dissolve or become stronger over time?) (Kinsella, 2003; Moore, 2010), several explanatory variables and interaction terms will be included. Two indicators, control of corruption and GDP will be used to evaluate a country's willingness to comply with an embargo. To advance the field, this research uses a unique data source. The data used in this study were compiled from several different sources including investigative reports by the Small Arms Survey, United Nations Commodity Trade database, as well as a systematic search for news articles from LexisNexis for reports of weapons seizures.

The results of this study will contribute to a growing body of work investigating the complexity of illicit markets, particularly SALW trade (e.g., Bichler & Franquez, 2014; Kinsella, 2004; Kinsella, 2008). Dynamic modeling will allow for one to not only evaluate the effectiveness of the arms embargoes, but will show researchers specifically how trade is shifting over time due to embargoes. This data should bring to the forefront the issue of how corruption and GDP effect decisions on arms trading at the state level. Network modeling of the illicit small arms trade will equip policy makers with a new evaluation tool so that effective policies can be implemented that make enforcement possible.

## Outline

The remainder of this paper is organized as follows: Chapter Two provides a primer about embargoes and their effectiveness. Then, the discussion turns to how illicit and licit markets relate to each other, and how political relationships can feed into a country's willingness to trade in the illicit arms market. Next, there is a short explanation of network analysis, with terms and definitions outlined for the purpose of the study. Chapter Two concludes with a review of the prior research on weapons trade using network analysis. Chapter Three describes how the illicit trade network was mapped and validated, the structural metrics used to assess evolution in the trade network, the covariates, and analytic process. Chapter Four presents the results of the analysis and Chapter Five includes a discussion of the implications these findings have, the limitations of the current study, and directions for future research.

# CHAPTER TWO

# LITERATURE REVIEW

## Primer About Embargoes

Simply put, “arms embargoes are one type of sanction that can be used to coerce states and non-governmental actors to improve their behavior in the interests of international peace and security” (Stockhom International Peace Research Institute (SIPRI), 2016). The UN Security Council is the primary organization involved in launching initiatives to set weapons embargoes on specific nations for severe human rights’ violations and/or international peace and security issues. Although the European Union and the United States will at times implement their own arms embargos on a particular country, most begin with investigations by the UN Security Council.

Several steps must be taken before an embargo can be established. First, a peacekeeping mission of the member states’ military personnel may be sent to the region in order to obtain a better understanding of the situation in the region and to provide much needed medical and food supplies to those in the area. This may be followed by a request to the UN Secretary General to obtain a UN ceasefire directive. If these steps are not affective, then several types of sanctions may be enacted including economic sanctions, arms embargos, financial penalties and restrictions, travel bans, severance of diplomatic relations, a blockade, and/or collective military action by UN member states. The motivation behind the scheme of escalating sanctions is to induce change, especially when the human rights' violations are associated with state-sponsored or enabled violations such as rape, mass killing, starvation, or enslavement.

## Embargoes Defined

Embargoes can be unilateral or multilateral. Unilateral sanctions prohibit or control sales from one nation that imposes the embargo on another nation, group, or organization. An example of a unilateral embargo is the economic sanction the United States has had on Cuba. This sanction was put into place by President Kennedy and remains in place today. Most recently, specific trading has been opened with Cuba but on a very limited basis (Federal Registry, Vol 81, and No.17). Multilateral embargoes involve a set of nations agreeing to an embargo against one other state, group, or organization. An example of a multilateral embargo would be the embargo placed on Afghanistan, and more specifically, the embargo placed on the Taliban who reside in Afghanistan and have central control over people, movement of people and goods, and government facilities. This embargo was adopted and put into place by the UN Security Council resolution 1076 in 1996. Resolution 1076 calls all member states to cease the export of all military aid to the area and calls the warring government to ceasefire and peacefully resolve their issues through political and diplomatic means (Security Council Resolution 1076).

Prior research has examined the scope of embargoes that only restrict one type of trade compared to those prohibiting all trade. Erickson found that partial and impartial embargoes differ in their effectiveness (Erickson, 2013; Cukier, 2008; Akerman and Seim, 2014). They found that partial embargoes are more likely to decrease the flow of arms into the area. Impartial embargoes target all involved in the conflict, while partial embargoes target a very specific group or side in the conflict. Currently there are impartial sanctions for weapons and military assistance that prohibit all trade of any kind to the following countries: Burma (Myanmar), Cuba (as stated earlier some trade within the last 9 months has been opened up to Cuba), Iran, Sudan, and Syria. Partial sanctions target very specific trade. Currently only Lebanon and Libya have partial sanctions. US held sanctions are present for all of the countries listed above. In the case of Rwanda, in 1994 partial embargoes were implemented on specific state actors as well as adjacent states to keep arms from flowing through neighboring borders (Tierney, 2005).

## Enforcement

The enforcement of any embargo is partially the responsibility of the government where the violation originates. In most cases, individuals, groups or organizations violating the trade ban can be fined, individuals may receive prison terms, or both can be implemented. When the responsible party is a high-ranking official under a corrupt government, the UN can appoint judges to special criminal courts to prosecute those that commit human rights' violations. It should also be noted that trades may start off as legal shipments, but due to falsified end user papers or diversion of shipments it becomes an illicit trade through the process (Tijhuis, 2006, 2011). This means that parties that maybe involved or shady trades may not be fully aware of their participation, or use this a diffusion of responsibility.

To illustrate, according to the US Department of the Treasury, the current weapons sanction that is held against North Korea has been continually expanded since 2008 by the President of the United States through executive orders to mitigate the security threat from this country. Penalties for violating these sanctions start at $250,000 or twice the amount of the transaction or can be up to $1,000,000 and/or 20 years in prison. United States officials can enforce these executive orders. These expansion on the sanctions continue due to the receiving party non-cooperation with the first steps taken.

As previously discussed this illegal trade can be conducted in such a way that it starts to blur the lines between legal and illegal transaction. All parties involved don’t have full knowledge of what is occurring, making enforcement even more difficult. The routine activities of these traders can be leveraged to come up with passive enforcement techniques.

## Effectiveness of SALW Embargoes

Returning to the case study, illegal guns continued to pour into Sierra Leone despite the use of arms embargoes. In 2000, the UN made several new recommendations. For example, they required more inspections of planes and documentation by airport investigators. Although some private dealers had fines imposed on them for changing plane numbers and registration paperwork, this did not stop or discourage the import and export of arms. These fines appeared to be a minor inconvenience to arms dealers. The UN report also recommended freezing specific government and non-government actors' assets in order to try to stop the financial supply for weapons into Sierra Leone. The ineffectiveness of the UN recommendations may partly be due to the fact that the sanctions committee is made of junior staff members at the UN that typically have a higher turnover rate (Vines, 2007). A high turnover rate can impede follow-up on sanctions and impede continued involvement that would ensure the evolving environment is addressed as it changes. In the original resolution by the UN on the conditions in Sierra Leone, it is clearly stated that they determined "that the situation in Sierra Leone constitutes a threat to International peace and security in the region." (Security Council Resolution 1076, 1996)Yet in the resolution, the states are told to self-regulate with the UN committee acting only as a "watch dog." Functions of the committee include following up on reports of violations by states and entities, but fails to establish any consequences for violators. During a briefing in New York in 2000 by Human Rights Watch, it was stated that the committee established for the Sierra Leone arms embargo failed to even investigate any reports of violations. The briefing further stated that due to the peace talks that were occurring the committee did not want to upset the RUF by conducting investigations on allegations of weapon procurement from neighboring countries (A Human Rights Watch Press Briefing, May 15, 2000). This self-regulation was further re-enforced in a summit meeting held in New York in 2001 regarding the global illicit manufacturing and trade of small arms and light weapons, stating

Believing that Governments bear the primary responsibility for preventing, combating and eradicating the illicit trade in small arms and light weapons in all its aspects and, accordingly, should intensify their efforts to define the problems associated with such trade and find ways of resolving them. (UN Document A/CONF.192/15)

The degree to which nation-states prosecute violators varies creating loopholes for the private supply of small arms. This opens the discussion that a normalized legal approach to criminal enforcement of embargo violations. Some states like the US have specialized departments to deal with illegal import and export violations conducted by businesses when the mother corporation resides within the US. Since 1995, the US Office of Foreign Asset Control (OFAC) has prosecuted 68 criminal cases of violations of these sanctions. Sanctioning entities in violation of weapons embargos is complicated when the government itself is breaking an embargo or sanction when it should be enforcing the rules.

Who is going to enforce those violations? The monitoring committees are often made of groups that only have a 6-month lifespan, creating instability in the enforcement of the embargo. These monitoring committees have also historically lacked transparency due to confidentiality (Yihdego, Z. 2007).

Security concerns may cause a state to illegally trade with an embargoed state if their own concerns outweigh the cost of being seen as having bad behavior in the global community (Erickson, 2013). There is no international enforcement agency that is going to regulate the compliance of other states with an embargo. Simply, the “golden rule” is applied which means that everyone “agrees not to do it”. In some cases, levels of corruption or long-standing relationships with the sanctioned state may supersede any type of penalty that has been more recently imposed (Bresson-Cartier, 1997). Ultimately, embargoes are the international communities’ way to shame the behavior of a particular group or nation state in order to bring about change in that behavior.

While invoking arms embargoes is generally thought to decrease the loss of human life by controlling access to weapons, ammunition, and associated arms parts, few empirical studies exist to document their effectiveness (Erickson, 2013). Instead, the available literature paints a complex picture of globalized illegal smuggling and institutionalized corruption. For example, smart sanctions can be bypassed with weapons labeled as “humanitarian aid” or simply by counterfeiting shipping paperwork (Kinsella, 2006). As one can quickly see from the review of documents from the UN specifically pertaining to the conflict in

Sierra Leone, the UN Security Council is reliant on states as self-regulators using committees that tend to have failed to follow-up on resolutions (S/RES/1270, 1999). Research shows that there is some form of compliance with the embargoes but to what degree that compliance is achieved is still debated among scholars (Bresson-Cartier, 1997; Tierney, 2005; Moore, 2010; Erickson, 2013). Erickson found that the partial embargo was more effective than an embargo that was just a blanket of all trade restrictions (Erikson, 2013). Even that doesn't fully tell one what the embargo is doing to change the network. The question addressed here becomes if one knows that the embargo is only somewhat effective, then how are trade patterns changing that allow the flow of weapons to still enter the sanctioned areas? In this study, we examine other variables that could contribute to the effectiveness or ineffectiveness of embargoes. Obviously, in some cases the UN and other government agencies are well aware that bordering states can facilitate illegal weapons transfer allowing arms to reach sanctioned states (Tierney, 2005; Bichler & Franquez, 2014). Other important factors in that affect the flow of arms and the willingness of nation states to comply with a current embargo include corruption and GDP as stated by Bresson-Cartier (Bresson-Cartier, 1997).

Erickson conducted one of the most rigorous assessments of embargo effects (Erickson, 2013). Using a multi-variate regression and moving OLS regression analysis found that partial sanctions reduced trade by 3.4% and full sanctions reduced trade by 5.8%. An explanation for the failure of weapons' embargoes to stop flow across borders may be found in the work of Bichler and colleagues (Bichler and Malm, 2013; Bichler and Franquez, 2014). Arguing that legal and illegal markets are intertwined together, Bichler and Malm document the “grayness” of the weapons’ market (Bichler and Malm, 2013). They argue that the industry of small arms’ trade includes secondary “producers” that enable small arms to continue to be recirculated (i.e., maintenance, reassembly, and repair). Future sanctions should include actors in the secondary market to inhibit the flow of small arms into a particular area. Additionally, this “black, white, and gray” market of weapons’ trading is often the result of weapons’ stockpiles left over from previous conflicts.

Importantly, countries that are coming out of a conflict may find that they lack the funds to rebuild infrastructure and so turn to the most viable commodity that they now have available, which may be stockpiles of weapons (Bichler & Franquez, 2014). Bichler and Franquez discovered that the likelihood that trade would increase was 81% immediately following the end of a conflict (2014). This uncovers gateways which could facilitate the transfer of legal weapons into the gray or black market, if the weapons then continue to be traded illegally. In this respect, weapon stockpiles are a national commodity (Bichler and Franquez, 2014). Auditing weapon stockpiles may be a promising strategy to strengthen weapons controls. Thus, instead of trying to completely stop illicit arms trade, perhaps a more successful strategy would be to examine sanction behaviors rather than looking for the secession of all trade. Although this shows great promise for embargoes thereby decreasing the loss of human life and suffering, one must ask what additional factors may contribute to the willingness of certain countries to comply with arms embargoes compared to those that do not.

In previous research, a country's political standing was found to influence whether a particular country chose to trade and whether or not that country was willing to violate sanctions in order to maintain a trading relationship (Bresson-Cartier, 1997; Akerman and Seim, 2014). Countries that share land borders or have long-standing relationships, such as colonial ties, are more likely to continue to trade with one another (Moore, 2010; Akerman and Seim, 2014). Interestingly, the political standing of a country was found to have the highest effect on the choice of whether to trade with another country. Simply implementing an embargo was not enough to change the political landscape of a country or their willingness to discontinue what may have been a long-standing geo-political relationship. Other important factors that play a role in the willingness to comply with a sanction include the level of a corruption in the government.

Bresson-Cartier found that these long-established relationships play a major role in a country's, nations, or territory's motivation to comply with the rules and to turn in those that are willing to break the rules (Bresson-Cartier, 1997). Once the level of corruption increases in a country, sanctions no longer become a factor in the decision-making process to illegally trade with another country, state or territory. Bresson-Cartier states that the risk for illegal trading does not outweigh the benefits of the long-term relationship (Bresson-Cartier, 1997). This can also be applied to the motivation to turn in one's "friend"- the short-term benefit does not outweigh the benefits to a continued relationship. Moore (2010) used a two-step modeling approach, using maximum-likelihood and ordinary least squares (OLS), to model the decision-making process on whether or not to transfer arms and the size of a transfer. Moore states that these decisions are crucial in understanding why states are willing to violate sanctions, because he found that small transfers to embargoed states seem like less of a violation than large transfers: Active embargoes reduce the size of shipments, but weapons continue to flow into the sanctioned areas.

In sum, studies find some evidence that although embargoes have some effect, illegal trade continues (Moore, 2010; Erickson, 2013). Given the complexity of global illegal markets, and the interconnections between nations formed by long-term relations and alliances, mapping how trade patterns are influenced by embargos requires a dynamic analysis of the evolution of trade behavior.

## Brief Discussion on Network Analysis and Illegal Markets

To assist the reader, this section defines key network terms with visual examples. Then, there is a discussion on why the network approach is important to the study of illegal markets. Finally, this section explains how the dynamic environment in which arms trade occurs can be modeled better with graphs than with conventional analytic approaches.

Social network analysis (SNA), is an interdisciplinary, multidisciplinary field of study investigating how social units (e.g., individuals, groups, companies, or nations) interact with each other, and how the social structure created by these relations both constrains and enables behavior, and spreads information, resources, and other materials. SNA looks at how and why those relationships changes, and what influences those changes. Using routines activity theory to examine social network analysis has been brought to the attention of criminal justice researchers in prior arguments (e.g., Bichler and Malm, 2014). Originally routine activities was applied to what one might look at as low level crimes (Cohen and Fleson, 1979), these are the type of criminal activities such as robbery, burlgery, assault or neighborhood drug pushing. This theory was later applied to transnational crime level by Sampson, Eck and Dunham, (2010). These researchers brought the idea of super controllers to Cohen and Felson's original crime triangle, creating a leveling effect to the equation. What this also did was create better perspective on the different levels of crime. To paraphrase when one is looking at a high-level crime such as global weapons trade you must look down to gain better perspective, and when one is looking at a micro level of criminal behavior you must look up. Bichler and Malm later applied these ideas to network analysis as a way of looking at solutions to transnational criminal behavior. This idea will also be discussed more in a later chapter when policy implications are discussed.

## Network Terms and Definitions

Unlike conventional research the primary unit of analysis in network research is a dyad, comprised of two actors and the relationship between them, or a triad including three actors and the existence of relations among them. Actors, referred to as nodes, can represent any social entity. In this study, actors are nations, states, countries, or territories. Relations between actors are often called ties. Ties can represent many different types of interactions, such as a legal relationship (i.e., kinship, contracted partnership), a feeling (i.e., liking someone), or the transmission of some product or service (i.e., information flow, drug supply chain). In applying social network methods to the study of weapons markets, most researchers use ties to represent the transfer of weapons from the exporting nation to the importing nation. This means the relation is directed. When visualizing a directional relationship, an arrow is used to show the direction of the relationship. If commodities flow both ways, a double-headed arrow is used. See Appendix A for full list of definitions with illustrations.

## Matrix Explained

Relationships are represented in a matrix format, with rows and columns for every actor in the network. The rows in the matrix represent the actor that is the Ego in the relationship. The Ego in the relationship in this study is the country that is sending out weapons, while the Alter receives weapons (see Table 1). Table 1 represents the flow of weapons using the Sierra Leone case study.

Table 1. Matrix of Current Case Study

| | Bulgaria (Alter) | Senegal | Slovakia | Gambia | Sierra Leone | Libya | Liberia | Cote D'Ivoire | Burkina Faso | Ukraine |
|---|---|---|---|---|---|---|---|---|---|---|
| Bulgaria (EGO) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Senegal | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Slovakia | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Gambia | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Sierra Leone | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Libya | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Liberia | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Cote D'Ivoire | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Burkina Faso | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Ukraine | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

The “ones” and “zeroes” are binary for the existence of a trade relation. Let us first examine the trading patterns of Sierra Leone as an Ego. Sierra Leone only receives imports from surrounding countries by the presence of a “1” in the column, but does not export which is represented by the presence of “0” in the rows (Table 1). The number of direct trade connections a nation has can be measured with a statistic called degree centrality. In a directed network, the direction of a trade relation is captured. Thus, imports are the “in-degree” of the country, while rows represent the “out-degree” or export from the country. In this example, nations cannot have a trading relationship themselves, but this is not true for all networks. Recursive relationships, a nation shipping to itself, exist in a trade network if a nation re-imports and re-exports to themselves (i.e., a country sends out military aid to another country and then some weapons are returned later due to defect or not used.

## Network Oriented Study of Illicit Weapons Trade

Network analysis examining the weapons trade confirms that global weapons’ markets consist of complex, business, social, and political relationships (Kinsella, 2003). In some cases these weapons trades go from legal to illegal trade and back again within the same transaction (Bichler and Malm, 2013; Tijhuis, 2006;Tijhuis, 2011). It has been argued that out of $4 billion dollars in annual trading in small arms about 10-20% of that trading occurs in the black and gray markets (Kinsella, 2008). These underground markets are not only controlled by supply and demand but also by trust and loyalty (Kinsella, 2008).

Kinsella quantified how relationships could influence the interactions of state actors when looking at weapons trade over a 50-year period after the cold war (Kinsella, 2003). What he found was that the network significantly changed over this period. Kinsella found that the suppliers became less centralized: The amount of weapons increased, as more suppliers entered the market. This decentralization may be attributed to globalization changes in world markets during the 50-year study period. Some of Kinsella's earlier work suggested that trading behavior could also be examined from a rational-choice perspective, with the actors taking the benefits and consequences into consideration with each trading partner (Kinsella, 1998). Kinsella also looked at the influence that small arms trade had on particular actors' foreign policies (Kinsella, 1998). What he found was that the more weapons the actor was able to obtain the more aggressive the policies became. Just as Kinsella was able to make this connection between weapons procurement and foreign policy, the current study looks to examine weapons trading in a way that will allow policy makers to more effectively implement rules and regulations, which should help to curve the flow of illegal weapons.

Analysis of the black market of illegal weapons trading should not be viewed as a traditional market place where people, places, and things have a hierarchy or order to them. The illegal trade of small arms should be considered a true network (Kinsella and Carr, 2007). Kinsella states that centralized hubs may exist, with those that supply weapons and those who facilitate the exchange between two countries, and there may be those countries within the network that control more of the flow of goods or information but not have total control (Kinsella, 2007). An ever-changing environment continues to drive what has been supported in prior research. Legal and illegal markets can be thought of as interchanging relationships, so that black and white produces "gray" markets where transactions are not fully illegal but the entire “legalness” of the transaction may be questioned (Kinsella, 2007; Bichler & Malm, 2013; Akerman and Seim, 2014; Bichler and Franquez, 2014). The illicit weapons trade is an aggregated view of much smaller steps and convergence points. The routine activities of those smaller points in time and space is what creates the totality of the trade.

Routine activities theory was original presented by Cohen and Felson (1979) this theory states that when a crime occurs that there is present a suitable target, motivated offender and the lack of a capable guardian. That when these three converge in time and space that is when a potential criminal act will occur. All three of these entities are going about their normal routine activities when this convergence occurs. Cohen and Felson state that a motivated offender is not an individual that goes out seeking to commit a criminal act but during their normal routines an opportunity presents its’ self. The same is true for the suitable target, those people, places or things that lack appropriate guardian; either active or passive, that are attractive for victimization, whatever form that takes. What Cohen and Felson states is that there are preventative measure that can be implemented to create barriers to criminal acts in the routine activities. When considering a motivated offender, the term intimate handler is used to refer to those persona or agency that possesses some type of control over the motivated offender. This idea was taken a step further by Sampson, Eck and Dunham (2010), with the idea of super controllers.

Super controllers are those individuals, mechanisms, or process that have some type of influence over the three primary crime controllers. This influence comes in many forms, e.g., private sector regulations, public sector regulations, or checks and balances that will natural/passively inhibit the falsification of documents. The use of social network analysis with routine activities theory has been supported in prior research by Bichler and Malm (2014, 2015). Bichler and Malm (2015) extend the role of super controllers to the transnational arena while integrating Tijhuis' lock model (Tijhuis, 2006, 2011).

Tijhuis' lock model uses the illustration of a shipping lock to represent how legal and illegal markets have a gray area where they mix and then become legal or illegal. The brokers within the network facilitate the movement of levers in order to allow legal products to flow into this middle area and then flow into illegal markets and vice versa. Thus, investigating illegal trade activity requires integration of all market activity--legal, grey, and illicit activity (Bichler and Malm, 2013).When thinking about the global illicit weapons trade one needs to look at the smaller components as well as the larger ones that make this a criminal act. Appendix B shows the system break down for global illicit weapons trade and how different components come together and are tied to the system. Routine activities theory will be applied to the following results with policy implications that will be discussed further in the final chapter of the current study.

## The Current Study

The lock model was chosen an appropriate way to capture illicit trade activity for this study, by separating legal and illegal trading activity. In some cases no import or export was reported for one of the countries in the trade. However, this data will not capture individual dealer activity, which is something that should be examined in future research. Once all illegal trade is identified for the study period, this will become the illegal arms trading network and the change within the trade pattern will be the dependent variable for this research project. The independent variables for this study will be embargoes, corruption, and GDP.

When assessing the impact of embargoes researchers must understand the extent of legal and illegal trade of weapons interchange that occurs between countries (Bichler and Malm, 2013). Understanding the interaction of weapons trading in black and gray markets is a unique field of study. To examine this issue comprehensively requires the use of unconventional analysis such as network analysis approaches (Kinsella, 2003; Kinsella, 2007). In addition, based on the study conducted by Bichler and Franquez in 2014, when considering the post economic crash of 2008 one would expect to see an increase in tie formation. Just as the end of conflict brings about an increase in out-degree and new tie formations due to economic recovery after the conflict situation, one would expect to see these same types of changes after an economic crash that had such a profound rippling effect throughout the world economy. Controlling for expected structural evolution that occurs within most social networks, two hypotheses will be tested in this study using a multivariate model:

$H_1$ Controlling for fiscal health, GDP, and ability to control corruption, nations under embargo will exhibit greater change in trade activity with a preference towards indirect ties.

$H_2$ Controlling for fiscal health, GDP, and ability to control corruption, nations will exhibit a preference for indirect transfers when embargos are lifted (post-embargo period).

$H_3$ Nations under fiscal duress will exhibit greater change.

# CHAPTER THREE

# METHODOLOGY

## Data Sources

### Original

Much of the data used in this study (four of the five data files), were originally compiled in 2015 as part of the Weapons Trade Initiative, which is housed in the Center for Criminal Justice Research. Given the differences in study objectives, significant data manipulation and extraction was required to configure the files for use in the present study. Since this is a dynamic analysis, data were coded yearly to permit investigation of how the illegal market changes (dependent variable), how those changes are influenced by the presence of embargoes (independent variable), controlling for national fiscal health—GDP score (control variable) and impact of the economic crisis (control variable created for this thesis)—and ability to control corruption (control variable).

### Study Period

The study period extends from 2005 through 2013. This timeframe was selected to control for the effect of the economic crash that occurred in 2008. The economic crisis of 2008 had a rippling effect on the global economy, and since the focus of this project is to identify factors that could change trading behavior over time, it is critical to control for this event. Prior weapons’ trade research found that major events like the economic crash of 2008 can generate stochastic shocks in the trade system that must be controlled for, to isolate the effects of the primary independent variable. While prior weapons' trade research controlled for the introduction of conflict into a region (Kinsella, 2003), it is fair to say that the economic crash in the US influenced global legal trading, and as previously stated legal and illegal markets have a fluid relationship (Bichler and Malm, 2013). With the US controlling almost half of the import and export of weapons traded globally, as well as influencing trade patterns based on its own trading decisions (Kinsella, 2003; Bichler and Malm, 2013), economic instability in the US could have global ramifications that must be accounted for.

## Weapons Transfer Data

Weapons trade data were originally compiled from the UN Commodity (UNCOM) trade database. This is a voluntary reporting system that allows countries to report all imports and exports to other states, countries, and/or territories, and it currently collects information from 189 states, countries, and territories. There are currently 107,874 records of arms and ammunition trades located under Code 93 of the UNCOM database. Under this category "arms" includes several types of SALW. Military grade weapons will be the type of weapon used for this study with the following codes: 9301 (military weapons other than hand guns, swords, etc.), 9302 (revolvers and pistols), 9304 (spring, air, or gas guns, truncheons, etc.), 9305 (parts and parts associated with weapons), 9306 (bombs, grenades, mines, missiles, and similar munitions of war and parts thereof, cartridges, and other ammunitions and projectiles, and parts thereof including shot and cartridge wads), and 9307 (swards, cutlasses, bayonets, lances, scabbards and sheaths). This database only includes collection of data from countries/ recognized territories to countries/ recognized territories. Thus, individuals that trade within the small arms industry are not part of the database. UNComtrade also captures civilian grades weapons which was combined to capture the trading patterns of the total illicit market. Both military and civilian weapons trade was captured for an aggregated view of the illicit weapons trade.

Not all the import and export transfers will be used in the study. This source captures legal and grey market activity. Grey market activity was extracted by identifying transfers that were only reported by one of the trade parties. If for example Bulgaria reports an export to Senegal for, but Senegal does not report receiving weapons from Bulgaria then the transfer was classified as grey market activity. Due to reporting requirements associated with many of the types of SALW included in this study, failure to report shipments is a violation of international trade regulations

Additional illicit transfer information was gathered from the Small Arms Survey Reports generated by the Graduate Institute of International and Developmental Studies located in Geneva, Switzerland. This is a government-independent organization that researches and compiles studies on small arms trade and armed violence throughout the globe on a yearly basis. Sixteen reports, produced by the Smalls Arm Survey (SAS), were used to fill in the gaps that exist in reporting by UNCOM. Due to the lack of reporting for some countries the SAS includes information from national/ international documents and other research documents. SAS has been shown to be a reliable data source with many researchers using it as a source of data (Erickson, 2013; Akerman and Seim 2014). SAS reports uncovered 314 previously unidentified illicit shipping paths that were added to the current dataset.

Other data was gathered from LexisNexis, which provides news reports that documented the confiscation of illegal weapons. The search criteria for the LexisNexis search consisted of “weapons w/p seizures AND firearms OR guns w/p smuggling.” Other search criterion included the content type “All News” and geographic location was set as “World.” To avoid duplicated documents and to make the process easier for researchers the option of “remove duplicates with high-similarity” was chosen for the search. The average number of documents that were identified per year, once duplicates were removed, was reduced to 41, added 11 unique cases to the database. Using this search method, transfer chains were recorded that included transshipment locations. More cases were identified using this method from 2008 onward. These trade paths were added to UN Comtrade networks, which created an augmented trade network for the study.

## Transfer Network Construction

Generating networks for each year in the study period, involved adding information from each data source, and then, dichotomizing the matrix. RSiena, the statistical software used in this project, will not support valued networks. If a tie exists then there is a “1”, if no tie exists then there would be a “0” in that position in the matrix. Although this eliminated the strength of the tie or the valued exchange of the weapons being sent or received, this still allowed for the network’s structural trade changes to be seen over time in this project (Table 2).

Table 2 reports the basic descriptive statistics for the networks. Average degree and ties increase during the economic crisis and then average degree increase again during 2011 and 2013. Which may indicate that other factors not controlled for in this study are present.

Table 2. Network Description of Illicit Trading

| Illicit Trading Network | | | |
|---|---|---|---|
| | Density | Average Degree | Ties |
| **2005** | 0.039 | 8.804 | 1972 |
| **2006** | 0.043 | 9.482 | 2124 |
| **2007** | 0.043 | 9.562 | 2124 |
| **2008** | 0.044 | 9.808 | 2197 |
| **2009** | 0.045 | 10.125 | 2268 |
| **2010** | 0.043 | 9.634 | 2158 |
| **2011** | 0.045 | 10.134 | 2270 |
| **2012** | 0.044 | 9.893 | 2216 |
| **2013** | 0.045 | 10.036 | 2248 |

## Assessing the Completeness of Trade Data

### Benford's Law

To validate the completeness of the weapons trade data to ensure there are no significant gaps within the collected data, first significant digits for a distribution of outcome measures associated with trade activity was examined to see if it conformed with Benford's law. Benford's law originated with Simon Newcomb in 1881 when looking through a book of numerical logs he noticed that the pages for "Page 1" were worn more than those of other numbers, indicating that the first page was looked at more often than the other page numbers with the least worn being "Page 9". Fifty years later, Frank Benford revisited Newcomb's original theory by assembling 20,000 different data sources, such as street address and elevations of cities, in order to test the theory. Benford hypothesized that numbers with the leading digit of one occurred more often and continued in a descending pattern until the least occurring number would be nine. The theory states that the probability that a leading digit (d) over a large set of numbers with distributions over several orders of magnitude equals log10 (1+1/d).

$$P(d) = log_{10}\ \left(1 + \frac{1}{d}\right)$$

Benford's law is a natural occurring phenomenon that scientists have yet to fully explain. It states that naturally occurring numbers one through nine occur roughly in the following rate by percent: ones should occur about 30% of the time, twos about 18% of the time, threes about 12% of the time, fours about 10% of the time, fives about 8% of the time, sixes about 7% of the time, sevens about 6% of the time, eights about 5% of the time, and nines about 5% of the time (Benford, 1938).

Using Benford's Distribution to Validate Data

What also makes this law interesting is that the distribution will not change based on scale, meaning elevations in feet or kilometers still follow Benford's distribution pattern. Thus, this law is ideal for the current research data. Trade data should be a naturally occurring set of numbers. If some trades are over represented while others are underrepresented this will be apparent using Benford's law and allow the researcher to cite a limitation to the data. This approach has been used in the area of forensic accounting and economics to detect fraudulent behavior patterns (Gunnel and Todter, 2009). Unless an individual has an understanding of how Benford's law works, they will most likely end up with data points that do not follow the law of naturally occurring first digit or leading digit numbers. When one sees patterns that significantly deviates from this pattern there is an indication that some kind of data manipulation has occurred or that parts of the data are missing. Missing data within network analysis research is a limitation when examining network relationships. Missing data can be derived using computer simulation models (Dickinson, 2014). However, whether this data is complete or an accurate depiction of true life events needs to be validated to understand if the research performed is representative of the event the researchers wish to capture.

In the research presented here, Benford's law has been used to determine whether that the data observed contains significantly missing amounts of data and whether the data may be offset by under- or over-reporting by specific actors within the network. When Golbeck applied Benford's law to social networks (i.e. Twitter, Facebook, Google Plus, etc.) the distribution of "friend counts" showed the pattern one would expect with a Benford distribution (Golbeck, 2015). This can be further validated with a Pearson's correlation analysis to examine how closely the data adheres to Benford's distribution. Golbeck also found that when the data deviated from Benford's distribution that this can indicate, in the context of social media, anti-social behavior. The way in which this will be used in the current study is by using the in-degree and out-degree for each country for each year and then showing a frequency distribution of how often 1's appear, 2's appear and so on through 9. Figure 2 and **3** display an example of what this would look like for one year.

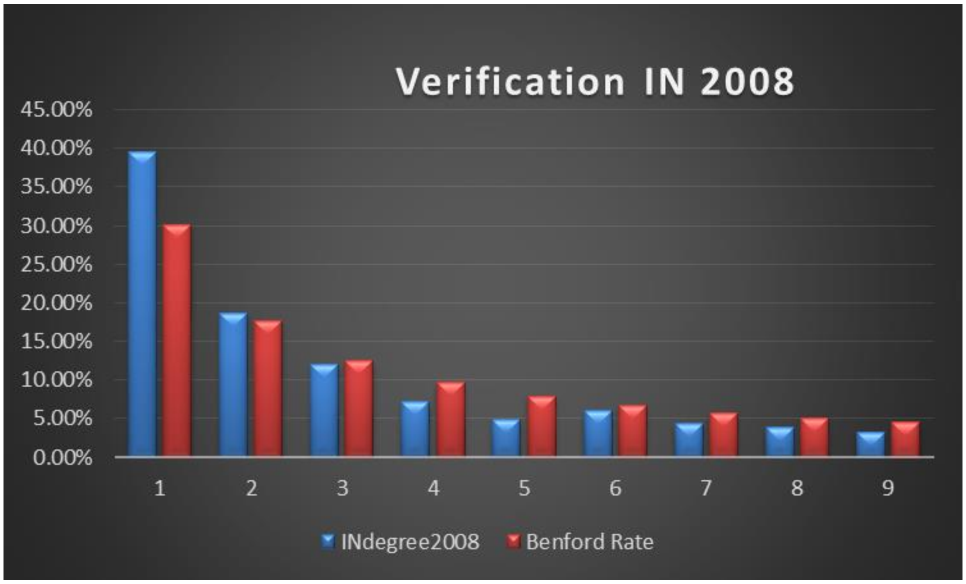



Figure 2. In-Degree Verification for 2008 Using Benford's

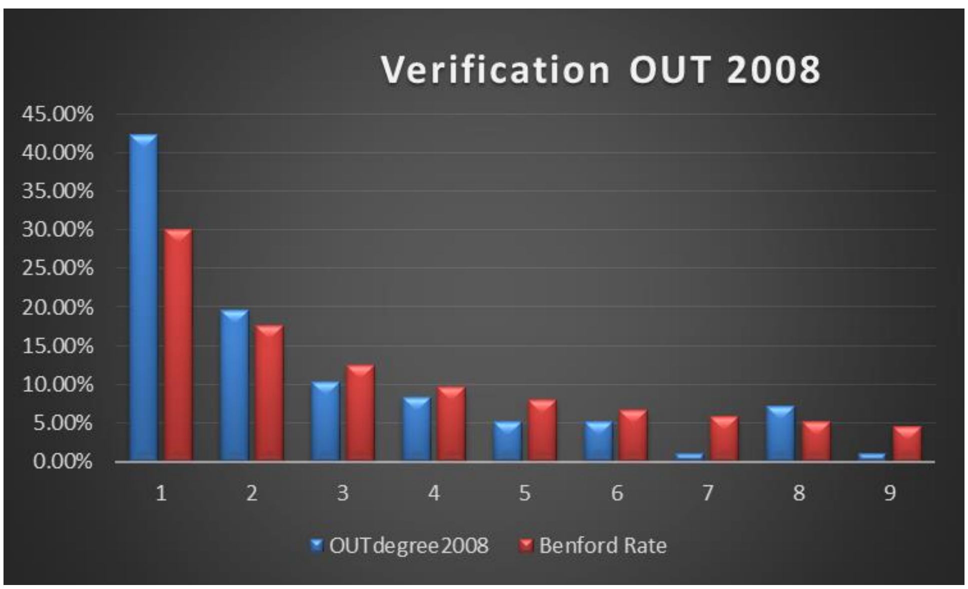



Figure 3. Out-Degree Verification for 2008 Using Benford's

## Independent Variables

## Structural Statistics

Indirect Ties

Structural change in trade activity can take many forms. This study will focus on the formation of indirect ties. Figure 2 Illustrates that two countries have a trading relationship among them. Country A sends country B weapons in time one. Country B then has an embargo placed on them. Country A wants to appear to the international community as complying with the embargo.

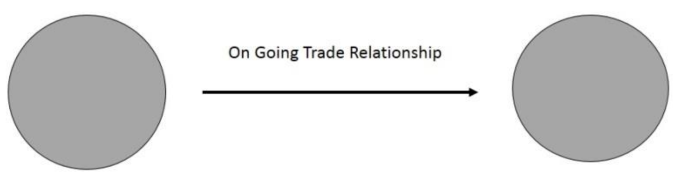



Figure 4. Illustration of Two Countries That Have a Trading Relationship

When an embargo is placed on the receiving end of this relationship, the identification of an illegal trading pattern becomes apparent as illustrated in figure 5.

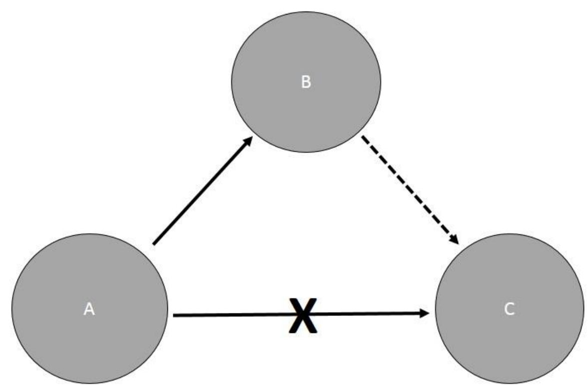



Figure 5. Indirect Tie Formation Indicating Illegal Trade Changing After An Embargo

The black “X” on the line represents the presence of an embargo and the dissolving of this direct tie relation (Fig. 5). If the exporting state has an economic or political interest in continuing to export to the embargoed state, then this indirect tie begins to form as illustrated by the dashed lines in Figure 5. As stated in the graph matrix example, if A wants to continue to send weapons to C, but wants to appear to be in compliance with the embargo, A may establish a relationship with country B (Table 1). The indirect state or broker of the exchange (i.e., country B) may have no issue with not upholding the embargo or sanction that has been put in place. Country B may share a land border with country A making the delivery of weapons easy. The indirect trade path where A sends weapons to B and B forwards weapons to C are expected following an embargo. Prior research indicated countries such as South Africa and the United Arab Emirates have facilitated these types of illicit ties (Bichler and Malm 2013; Bichler and Franquez, 2014). In the current study, this type of indirect relationship was used as an interaction effect to determine if the independent variables pre-, during and post-embargo had an effect on the formation of indirect ties in the network over the study period.

Transitivity

Transitivity measures how nodes that are connected to others through a middle node will soon form a direct connection. The general formula is

$$\sum_{j,h} x_{ih} x_{jh} x_{jh}$$

Where $X_{ij}$ represents the tie between actor i and actor j, $X_{ih}$ represents the tie between i and actor h, and $X_{jh}$ represents the tie between actor j and h. This study uses transitive triplets, which measures the connects between actors i, j, and h and the connects between them and their indirect connects as well (Veenstra, et.al., 2013).

This statistic captures the tendency consistently observed in social networks that direct relations form among actors who have a third party in common. Research finds that with longitudinal data sets, such as the one in the current study, there should be an increase in transitive tie formation over the evaluation of the network (Snijder, Van de Bunt, and Steglich, 2010). While there are different ways a group of three actors can become interconnected, Figure 6 illustrates how indirect connections may lead to the formation of a direct connection over time.

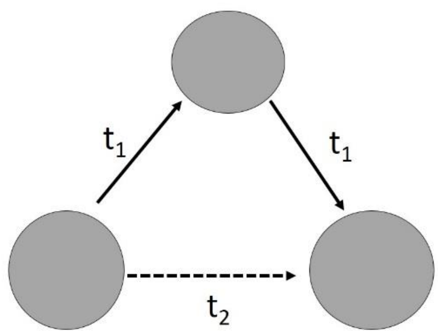



Figure 6. Transitivity Model

Out-Degree Density

$$s_{1l}(x) = x_{i+} \sum_j x_{ij}$$

This statistic capture the number of ties an actor extends as illustrated in Figure 7. In the current project, this statistic can be used to examine the reach or actors that are participating in the exporting of illegal weapons through new outgoing tie formations. Thus, out-degree density helps to identify newly formed trade relationships that were not open previously (Prell, 2012). When calculating out-degree density one looks at the out-degree of one actor for example, Sierra Leone from case study, look at Slovakia in that trade network. When one looks at out-degree you first count how many total nodes, in this case countries are in the total network. This network has a possibility of 11 choices to send out to. When one looks just at the outgoing trades from Slovakia there are 2. The out-degree density then becomes 2/11 which is .18.

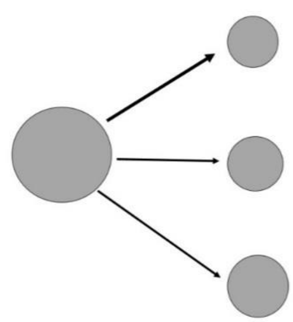


Figure 7. Out-degree looks at the number of ties a node sends out.

Reciprocity

Dynamic models of network change must include a measure of reciprocity. Reciprocity is the tendency of something to be returned through the same path. Over time networks will exhibit more reciprocation (Snijders et al., 2010) and this tendency extends to weapons trade (e.g., Bichler and Franquez, 2014; Kinsella, 2003). The general equation for reciprocity is

$$s_{i2}(\chi) = \sum_j x_{ij} x_{ji}$$

As used here, reciprocity measures that if actor A exported weapons to actor B, then at some point B will send back weapons to A (Figure 8).

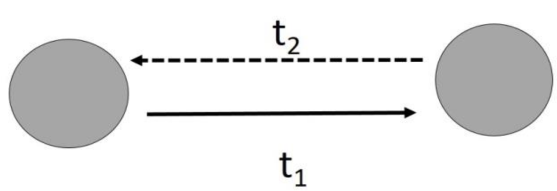



Figure 8. Reciprocity measures relationships between node A and B.

## Covariates

Embargo (Stochastic Shock)

Embargoes as a variable are dynamic and defined as any trade restriction implemented by one governing body on a country, territory, or organization. Embargoes can be implemented on states and groups due to interstate war, civil war, and/or international terrorism. The main purpose for embargoes is to improve local, national, and international peace and security. This study focuses on small arms embargoes often referred to as smart sanctions, because they specifically direct the restriction of specific goods or service rather than restricting all trade. Typically, a small arms embargo is placed on a country/ territory because of international law violations such as money laundering, human rights violations, and affiliation with terrorist organizations. This dataset was built using several different sources of information that include sanctions by the European Union, the UN, and the US. Since a country can be sanctioned by different agencies, a dichotomous coding scheme will be used to identify the years when an embargo is in place. If a country/territory had a small arms embargo from any of these agencies, then they received a 1 for that year. If the country/territory had no small arms embargo during that year then they received a 0 for that year. Because this changes over time, this will be a dynamic variable.

Control of Corruption (Dynamic Control Variable)

Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption as well as "capture" of the state by elites and private interests. This data was procured from the Worldwide Governance Indicator (http://infor.worldbank.org/governance/wgi/), which looks at how a public power uses checks and balances that will discourage corruption, decreasing illicit trade through or within their region (Cukier, 2008; Parker, 2010). This network upon initial inspection showed less than 10% of the data was missing. Average scores of similar countries or territories were used to replace missing corruption scores. Highest levels of control were ranked at 100. Each country has a score they receive each year which is compiled from different government and watch dog sources. The scores cover different attributes ranging from rule of law to political instability to come up with a total corruption score. An example of what this database looks like occurs in Table 3 below:

Table 3. Corruption Database.

| UN CODE | COUNTRY_NAME_IN_TRADE_DAT | MISSING | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | AVG | 100-AVG ( |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | AFGHANISTAN | | 2.0 | 2.9 | 1.0 | 1.0 | 1.0 | 0.95 | 1.42 | 1.91 | 1.91 | **1.3** | **98.7** |
| 8 | ALBANIA | | 25.4 | 22.4 | 28.2 | 36.9 | 38.3 | 36.67 | 28.44 | 26.79 | 25.84 | **25.8** | **74.2** |

Table 4 reports that the average score for control of corruption across all nations and the years examined (grand mean) is 53.12. This indicates that the average score for corruption is in the middle of the scale indicating most countries have a give and take with secrecy and transparency.

Table 4. Descriptive Statistics for all Covariates

| | Corruption | GDP | Economic Crisis |
|---|---|---|---|
| Mean | 53.12 | $277,790.58 | -4.02 |
| Median | 51.63 | $14,170.93 | -3.52 |
| SD | 1.93 | $1,180,364.22 | 13.11 |
| Min | 0.98 | $30.94 | -39.35 |
| Max | 99.71 | $14,886,455.56 | 84.73 |
| N | 224 | 224 | 224 |

This data was recoded using ordinal levels 1 through 3, or low, medium, and high.  This was done for easier interpretation of results. To make this data usable for the RSiena software the data points were copied into a notepad txt file without decimal points. No column or row names moved to the txt file as RSiena is not able to process this type of information. All information must be kept coded in the same order for all 224 countries so that interpretation of results is not misunderstood due to coding errors.

Gross Domestic Product (Dynamic Control Variable)

GDP is measured as the gross sum of all resident producers within an economy with values in U.S dollars. This is a dynamic variable because it can change over time due to the growth or decline of a country's economy. These data were gathered from the World Bank and the GDP was converted by dividing each country's GDP by the global total. This allowed for uniform scores to be analyzed. The purpose in using GDP levels to understand the effectiveness of embargoes is to see if those that have high GDP scores will also be more likely to comply with embargoes. Countries with high GDPs would show signs of growth within their economy. One might assume that trade would be less likely for those under an embargo, as to not disrupt their stable infrastructure. However, higher GDP scores with economic growth also places a country in the position, and means, to buy arms. Embargoes cause an increase in product price due to the unavailability through legal channels. One might assume that those countries with higher GDPs would be more likely to use this economic advantage to buy more arms. It should be noted that Bresson-Cartier (1997) found that corruption and GDP had high levels of multi-collinearity (Bresson-Cartier, 1997). The researcher in that case stated that using GDP and corruption as two independent variables may not be well suited. This was tested with the correlation analysis prior to being included in the final model. In order to simplify this data set and to load it into RSiena, an ordinal coding approach was taken. This variable is dynamic as it does vary slightly each year through the study period. Each year was coded separately and the following code was given to each country that fell into each category. Countries that had a GDP from 0 – 999 million were coded 1, 1 billion to 999 billion were 2, and 1 trillion and higher were coded at 3. Figure 4 illustrates the percentage of world's wealth over the study period. As one can see, almost three quarters of the countries studied during the time period fell into the middle GDP bracket, while only a small percentage were in the highest bracket, and 20% were in the lowest bracket (Fig. 9).

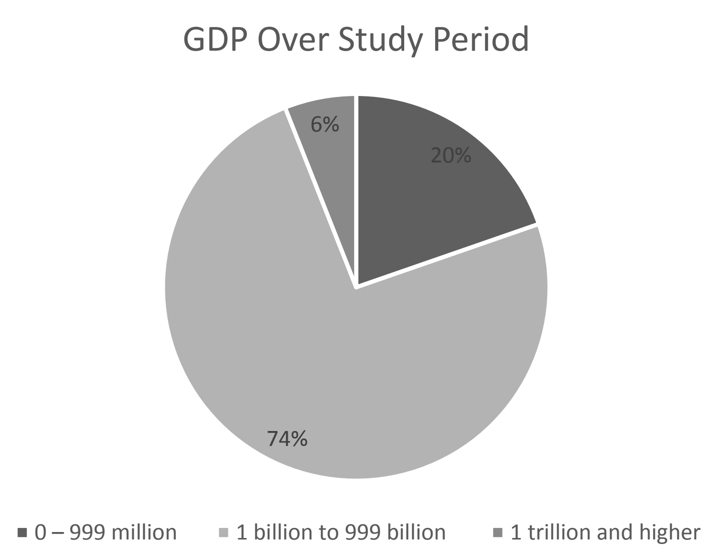



Figure 9. Distribution of GDP Over the Study Period.

Economic Crisis (Static Control Variable)

This study period included the economic crisis that occurred in the United States during 2008. The crisis was brought on by predatory lending practices, which had a rippling effect across the global economy. The purpose in using this variable as a control in this study is to acknowledge that the event occurred, and had some impact on the global market. The way in which this variable was coded is as follows: the GDP for 2008 and 2009 were used to show the percent change over time between these two-time periods. That percent change was then coded on an ordinal scale from 0 to 4. The following is the description of that scale: 0 being no effect or positive effect, 1 being low effect, 2 medium, 3 medium to high, and 4 high effect. The following graph shows the effect distribution over the time period of 2008 to 2009. Please reference table 4 for descriptive statistics.

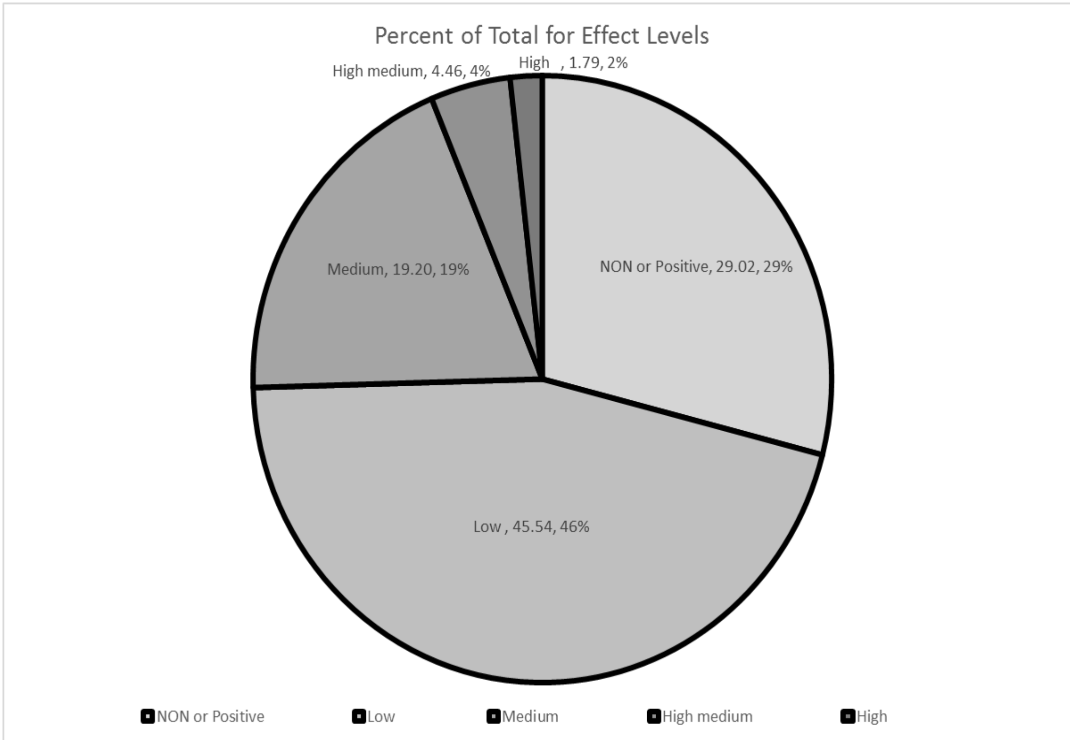



Figure 10. Distribution of Economic Effect.

## Analytic Plan Using Stochastic Actor-Oriented Models

Stochastic actor-oriented models (SAOM) give a researcher the ability to look at changes over time based on past and present observations. The appeal of SAOM is the ability to incorporate several different micro level choices that actors can make. In the current project, the decision to continue to trade arms despite the establishment of an arms embargo becomes the determining factor for illegal activity. This dynamic modeling process allows the researcher to examine not only the changes that occur over time with the illegal trading of arms (i.e., transitivity, new connects, or the discontinuation of connects), but also the variables that affect those trade relationships that are themselves time sensitive. In the current project the time frame is 2005 to 2013 so that 8 observations between years are calculated. To clarify, the model looks at the formation of new ties, the death of ties, the closure of transitive triplets, if the reciprocity of ties increases, and any other relational changes between nodes between $T_1$ and $T_2$. This is accomplished using the Markov Chain Monte Carlo method, which looks at the current state in the network in year $T_1$ and $T_2$, models that change, and builds on it based on known data. This is a maximum likelihood probability process where random selections are made from the current state of the network to model new networks and the probability of those outcomes (McDonald, Smith and Forster, 2007). This is a method that allows for probability analysis of very large sets of numbers although small sets can also be used. However, when large sets need to be examined this is the appropriate method to use.

To simplify, let's say you have a pile of black and white beans and you randomly pick half the beans for one pile and half the beans for another pile. Imagine that these two piles represent the state of the beans at two different points in time. If you pick one bean out of pile 1 the probability of the color of the bean you picked is based on the probability of the random selection from the first pick of beans when you separated them, as well as the probability of the current state of the beans, coupled with the probability of what your future picks could be. When applied to a very simple network of four friends this may start to make a little more sense. Figure 11 represents our four friends' network at a current state in time. If you want to know what the network of friends might look like over time you could randomly select different configurations of the same network of friends to see how they might be connected. Using the Markov Chain method, the program takes the probability of the choices A could make that would benefit A the most. It does the same with each node in the network, coming up with a new configuration through as many iterations as the researcher predetermines. All those networks put together are given calculated averages that allow the researcher to see the probability of network changes over time.

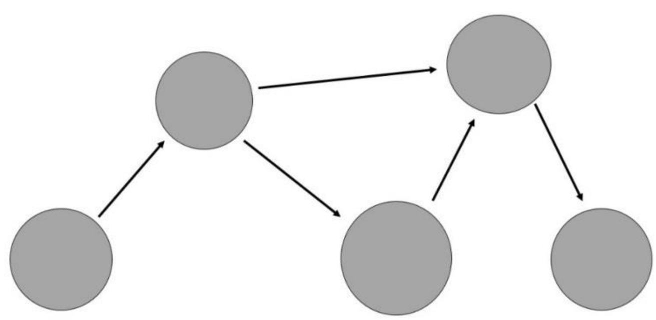


Figure 11. Basic Network of Five Counties Trade Pattern for $t_1$

Figure 11 allows researchers to understand how changes will occur when independent variables are placed into the model. In the current project one such independent variable will be embargoes. The change this project will examine is whether an embargo is not in place one year and then is placed the next and vice versa, what type of changes will be observed in trading behavior? Back to our bean example, the probability of choices is determined by the past state, current state, and future state. What was the probability of picking a black bean the first time, plus the current probability of picking a black bean, and then the probability of picking a black bean in the future from the bean pile? Changes such as alternative routes may be seen to deviate from the previous point of travel, but the weapons may still be entering the sanctioned country regardless of the embargo. These structural statistics of the previously described network are structural independent.

The fit of independent measures (data parameters) will be assessed by running t-ratios (Snijder et al., 2010). If the t-ratios are >0.1, then statistical estimates will be used to interpret changes and characteristics about the network. If the t-ratio is <0.1, then the statistical estimation will be noted and not used to make interpretations about the network. The Jaccard coefficient is used to evaluate network stability over time.

The Jaccard coefficient examines the stability of the network allowing researchers to look at the similarities between observation times. If the networks are too similar then the network is not changing enough over time. If the network has too many changes from time one to time two, then these can be thought of as two different networks. The ideal coefficient that would show the right amount of change with not too much change would be 0.2 to 0.6. The calculation is as follows:

$$\frac{x_{11}}{x_{11} + x_{01} + x_{10}}$$

Where $X_{11}$ represents the number of ties between nodes at both moments in time, divided by the number of ties present at both moments plus $X_{01}$ the number of newly formed ties, plus $X_{10}$ the number of terminated ties. As stated previously, ratios of 0.2 to 0.6 are ideal to allow researchers, in good faith, to proceed with continued analysis of the networks considering them to be the same network at two different moments in time (Kinsella, 2003).

# CHAPTER FOUR

# RESULTS

## Data Quality

Missing or manipulated data poses substantive problems for network analysis because analytics assume that networks are complete. Before beginning an analysis of the illicit trade networks involved in moving small arms, trade activity captured in this study were compared to the distribution expected for naturally occurring numbers as suggested by Benford's law of first significant digits. Comparing study data to an expected distribution provides a mechanism to assess whether the study data are complete enough to be a reasonable representation of the phenomena under investigation. Comparing distributions is a commonly accepted practice in forensic accounting and economics to detect incomplete or manipulated data that may be indicative of fraudulent behavior (Gunnel and Todter, 2009). Unless an individual understands how Benfords' law works they will most likely end up with data points that do not follow the law of naturally occurring first digit or leading digit numbers.

Out-degree centrality for each nation captures the number of observed trade partners weapons are shipped to illicitly (export). This structural statistic was calculated for each nation, for each year observed. A frequency distribution of first significant digits (non-zero digits) was compared against the expected distribution as suggested by Benford's law. Pearson's Correlation Coefficient reports the correspondence in distribution: With an r of .99 and a Chi Square of .06, there is a strong relationship. It is acceptable to conclude that the distribution of first significant digits obtained for out-degree centrality conforms to Benford's expected distribution and one can see as well how closely the two-distributions follow each other on the graph. Some variation is to be expected as unknown missing data is expected in network analysis.

Table 5. Benfords' Expected Distribution Verses Out-Degree Values Observed

| 1$^{st}$ Sig. Digit | Benford's Expected Distribution of 1$^{st}$ Sig. Digit | Distribution of 1$^{st}$ Sig. Digit for Out degree Centrality | Difference |
|---|---|---|---|
| 1 | 0.30 | 0.33 | -0.03 |
| 2 | 0.18 | 0.22 | -0.04 |
| 3 | 0.13 | 0.15 | -0.02 |
| 4 | 0.10 | 0.09 | 0.01 |
| 5 | 0.08 | 0.07 | 0.01 |
| 6 | 0.07 | 0.05 | 0.02 |
| 7 | 0.06 | 0.04 | 0.02 |
| 8 | 0.05 | 0.03 | 0.02 |
| 9 | 0.05 | 0.01 | 0.04 |

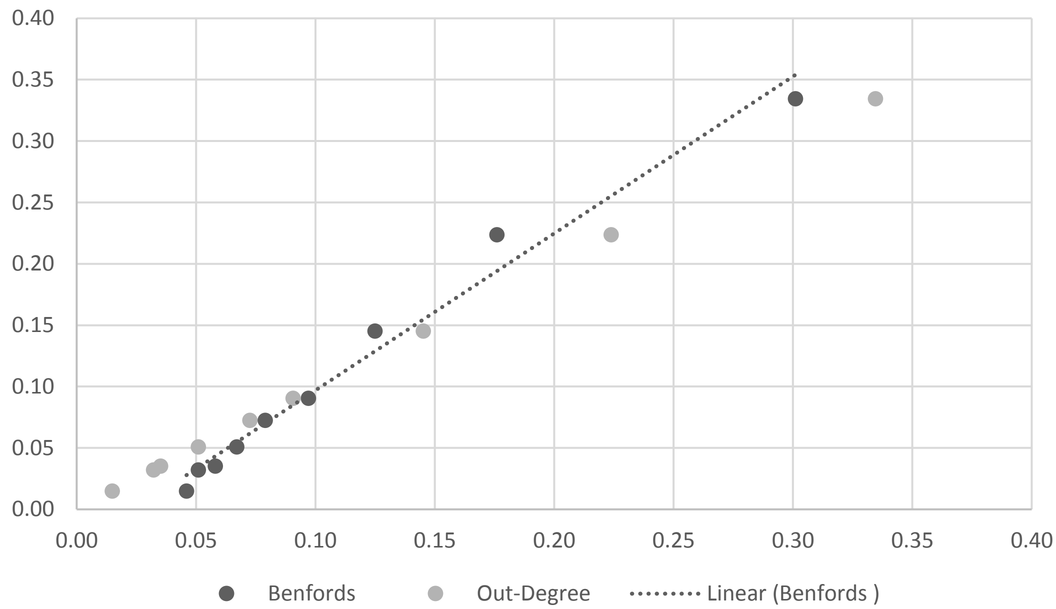



Figure 12. Linear Relationship Between Benfords' Distribution and Out-Degree

## Jaccard Coefficient

Dynamic modeling requires a certain level of change between observations to be viable. The Jaccard coefficient of similarity provides a metric for assessing change: Jaccard calculates the amount of change between each observation of a network. Values range from 0 to 1.0 and networks should exhibit scores of .3 to .6 to indicate that there is enough change between successive networks to support running a stochastic actor-oriented model. If the change were too great, beyond a .6, we would have to consider the possibility that each observation captures a different network not one simply evolving over time.

Table 6 shows the number of tie formations for each observation period. Recall that 0 indicates no trade activity and 1 indicates trading. Thus, the two types of change assessed are the formation of a trade tie (changing from no relation during the first observation, coded as 0, to a 1, indicating a trade relation in the subsequent observation) and the termination of a trade relation (1 to 0). Jaccard Coefficients are calculated as proportion of same trade ties (1 to 1) relative to all change and trade (0 to 1, 1 to 0, and 1 to 1). Non-trading relations that continue to be non-trading relations are not included in this calculation. All Jaccard Coefficients are within the expected range, suggesting that stochastic actor-oriented modeling is feasible. Notably, there is a slight increase in stability over time: From 2005 to 2006, .376 (or 37.6%) of observed relations continued, whereas from 2012 to 2013, .416 (or 41.6%) of trade continued.

Table 6. Tie Changes between Subsequent Observations

| Observation Periods | Number of Same Ties | | Number of Changed Ties | | Jaccard Coefficient |
|---|---|---|---|---|---|
| | 0 to 0 | 1 to1 | 0 to 1 | 1 to 0 | |
| 2005 to 2006 | 46976 | 1120 | 1004 | 852 | 0.376 |
| 2006 to 2007 | 46870 | 1184 | 958 | 940 | 0.384 |
| 2007 t0 2008 | 46850 | 1237 | 960 | 905 | 0.399 |
| 2008 to 2009 | 46744 | 1257 | 1011 | 940 | 0.392 |
| 2009 to 2010 | 46794 | 1268 | 890 | 1000 | 0.402 |
| 2010 to 2011 | 46813 | 1289 | 981 | 869 | 0.411 |
| 2011 to 2012 | 46767 | 1301 | 915 | 969 | 0.408 |
| 2012 to 2013 | 46800 | 1312 | 936 | 904 | 0.416 |

## Baseline Model

### Estimated Effects

The first model reported in Table 7 is the baseline model. This model includes three structural measures and two control variables. The structural measures capture out degree density, reciprocity, and transitive triplets. Due to the nature of the current study, the models are looking at how the structural measures change over time. The economic crisis variable controls for the effect that the 2008 financial crisis had on nations' trading capacity, and control of corruption, is a World Bank measure capturing the ability of nations to control corruption. Control of corruption is a proxy for the porousness of border controls.

Effects are interpreted differently than regression models. The effects reported are calculated as an evaluative function. Thus, a positive effect is a tendency of nations to exhibit a preference for something and a negative score is a tendency not to exhibit change. For example, a positive effect size for economic crisis would indicate that nations with higher scores on the economic crisis covariate would tend to exhibit greater change in the trade activity.

Out-degree density exhibited a strong and significant decline across the observation period. Show a propensity for nations to exhibit a tendency not to become more enmeshed in a dense trade network. This may be indicative of a polarization or decentralization of illicit trade activity. Examining how the illicit trade network evolves throughout the study period, we see that there is a tendency for nations to reciprocate trade activity over time, meaning country A sends to country B over time country B will start sending to country A. Recall that transitive triplet where country A and country B trade and country B and C trade. Then, country A and C decide to trade due to the trading relationship that they both have with country B. These tendencies to trade with one's trading partners increase over time, showing an indication for less branching out away from one's existing trade ties.

Model Fit and Robustness of Estimates

Estimate robustness is estimated by t ratios. When T-ratios are above .3, the model is having trouble reaching convergence. The estimate is unstable, and this suggests that the variable should not be carried forward: In the base model, corruption had a t-ratio of .44, and as such, this variable was not included in subsequent models. Examining model performance with the addition of variables and removal of covariates with high T-ratios provides some indication of subsequent models exhibit a better fit: In each model, covariates and interactions were added, and then removed, based on this ratio. The two co-variants included in the baseline model were economic crisis and corruptions. Economic crisis was coded by looking at the percent change of the GDP from 2008 to 2009. Based on the effect the crisis had on the GDP decreasing gave the country a score 1 to 4 smallest effect to largest effect. In the model, positive scores in economic crisis indicate greater for nations experiencing the most change in GDP also exhibited a tendency toward changing illicit trade activity. The descriptive statistics for economic crisis are reported below.

Control variants corruption and GDP were thought to have some type of multi-collinearity issues. One simple baseline model originally ran with the two in the model and subsequent models would fail when the two were included. These covariates also had poorly performing t ratios as well suggesting that convergence in the model was difficult. Another issue with these two variants was the min and max ranges were high, one of the reasons that economic crisis may have performed better. Although economic crisis is made up of GDP it stabilized the high range gap that was present. Another reason that economic crisis had less performance issues may have been in part, to it being a static variable. Both GDP and corruption were dynamic variables and this dynamic nature made convergence difficult in the model. If it were coded nominally or with an average score over all, better performing scores may have been seen.

## Covariate Models

### Model Estimates

Following precedent, model development progressed through three iterative phases testing sets of covariates. Covariate performance was tested, and poorly converging and non-significant covariates, were removed in subsequent models (Snijders, Van De Bunt & Steglish, 2010). This process is important to building the final, most parsimonious model as some covariates may mask the influence of others.[1]

Model 2 included all structural statistics and economic crisis, as well as pre-, during, and post embargo effects. No interaction effects were included. The structural statistics continue to show increased reciprocity and even great transitive triplets over time. The influence that an embargo has on this increase will be discussed further in the following section. Change during pre-embargo time periods seemed to decrease in this model, indicating less change during this period.  While the greatest change was observed during embargos, the parameter estimates suggest that illicit trade activity also changes post embargo. In addition, nations that experienced more effects during the economic crisis are also going to see increased changes in trading activity.

Model 3 is the full model including, structural statistics, economic crisis, embargo effects, as well as the interaction effects of embargoes and in-direct ties. Out-degree continues to decrease over time in this model. While changes in reciprocity and transitive triplets continue to increase with the highest inclination to change with transitive triplets, the direct effect of being in a pre-embargo period decreases and nations exhibit a tendency toward the use of indirect ties. Post embargo, nations also exhibit a tendency toward indirect trade ties, albeit a lesser effect than during embargo.

[1] Snijders et al. 2010 suggest trial and error of model testing to come up with the most parsimonious model possible. Notably, when there is too much covariance between covariates, convergence is difficult to reach and the model to stop running. This was the case in the current study with combination of corruption, GDP, coupled with the complex nature of the interaction effects with embargoes.

Model 4 is the most parsimonious model, including only significant covariates. Overall, nations involved in illicit trade in small arms exhibit a decline in out-degree density, an increase in reciprocal trades, and a preference for transitive triplets. Nations under embargo exhibit a preference for indirect trade activity. This is a robust finding. Post embargo, nations also exhibit a preference for indirect relations. Economic crisis in this model does have a positive significant effect on change, meaning that those more effected by economic crisis have a tendency to exhibit change more frequently over time. The highest effect for the parsimonious model was during embargo interaction on indirect ties. Stating that those that have an embargo on them will have tendency to establish more ties that are indirect; further signifying that networks exhibit a chain like structure with less density.

Table 7. Parameters Models 1 and 2

Table 7. Parameters Model 1 and 2

| Parameters | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | Est. | SE | t-Value | Est. | SE | t-Value |
| Outdegree Density | -2.16 | 0.01 | -239.62** | -2.18 | 0.01 | -290.63** |
| Reciprocity | 0.56 | 0.03 | 21.26** | 0.57 | 0.02 | 24.23** |
| Transitive Triplets | 0.09 | 0.00 | 76.92** | 0.09 | 0.00 | 94.40** |
| Pre-Embargo Ego | - | - | - | -0.11 | 0.12 | -0.91** |
| Pre-Embargo of Indirect ties | - | - | - | - | - | - |
| During Embargo Ego | - | - | - | 0.07 | 0.02 | 3.03** |
| During Embargo of Indirect ties | - | - | - | - | - | - |
| Post Embargo Ego | - | - | - | 0.12 | 0.13 | 0.92** |
| Post Embargo of Indirect ties | - | - | - | - | - | - |
| Corruption | 0.0055 | 0.0003 | 18.33333** | - | - | - |
| Economic Crisis | 0.079 | 0.0077 | 10.25974 ** | 0.084 | 0.0072 | 11.6806 ** |

The t-values are calculated by dividing parameter estimate by its standard error

*p<.05

**p<.01

**Table 8. Parameters Models 3 and 4**

Table 8.Parameters Model 3 and 4

| Parameters | Model 3 | | | | Model 4 | | | |
|---|---|---|---|---|---|---|---|---|
| | Est. | SE | t-Value | | Est. | SE | t-Value | |
| Outdegree Density | -2.16 | 0.01 | -254.27 | ** | -2.16 | 0.01 | -260.11 | ** |
| Reciprocity | 0.54 | 0.03 | 21.45 | ** | 0.56 | 0.02 | 22.56 | ** |
| Transitive Triplets | 0.09 | 0.00 | 70.54 | ** | 0.09 | 0.00 | 76.17 | ** |
| Pre-Embargo Ego | -0.24 | 0.14 | -1.73 | ** | – | – | – | |
| Pre-Embargo of Indirect ties | 0.42 | 0.38 | 1.10 | ** | – | – | – | |
| During Embargo Ego | -0.07 | 0.02 | -3.03 | ** | -0.06 | 0.02 | -2.76 | |
| During Embargo of Indirect ties | 0.34 | 0.08 | 4.38 | ** | 0.34 | 0.08 | 3.99 | ** |
| Post Embargo Ego | 0.10 | 0.15 | 0.67 | ** | 0.10 | 0.15 | 0.69 | |
| Post Embargo of Indirect ties | 0.34 | 0.48 | 0.72 | ** | 0.14 | 0.33 | 0.43 | ** |
| Corruption | – | – | – | | – | – | – | |
| Economic Crisis | 0.08 | 0.01 | 9.52 | ** | 0.07 | 0.01 | 9.65 | ** |

The t-values are calculated by dividing parameter estimate by its standard error

*p<.05

**p<.01

## Diagnostic Investigation of Parsimonious Model

Inter-item correlations may adversely affect model estimates. Consequently, Table 9 shows the bivariate correlations for the final model. Any coefficient below .10 is too small of a relationship to be influencing these coefficients and any value above .9 is a potential threat. Several moderately strong inverse relationships exist, but none surpasses the .9 threshold. Of interest, higher trade relations exhibiting transitive triplets are associated with lower out-degree density (correlation coefficient -.426, $p < .001$), suggesting that as chain-like relations increase we find less density. Another relatively high correlation was the interaction effect during embargoes and indirect ties (correlation coefficient -.0499) and transitive triplets. One can see from the correlation matrix that there are several inverse relationships with out-degree which is evident in the model results with decreasing effect over time. This further demonstrates reliability of the results obtained in model 4.

Table 9. Bivariate Correlation Analysis

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Out-Degree | – | – | – | – | – | – | – | – |
| Reciprocity | -0.212 | – | – | – | – | – | – | – |
| Transitive Triplets | -0.426 | -0.308 | – | – | – | – | – | – |
| Econ Crisis | -0.104 | -0.092 | 0.085 | – | – | – | – | – |
| During Embargo | 0.037 | 0.012 | -0.027 | 0.102 | – | – | – | – |
| During Embargo x Indirect Ties | 0.116 | 0.111 | -0.499 | -0.171 | 0.267 | – | – | – |
| Post Embargo | -0.062 | -0.042 | 0.175 | 0.078 | -0.047 | -0.289 | – | – |
| Post Embargo x Indirect Ties | 0.074 | -0.002 | -0.063 | 0.09 | 0.126 | 0.161 | -0.086 | – |

# CHAPTER FIVE

# DISCUSSION

## Introduction

This study examines the evolution of illicit trade of small arms and light weapons using information drawn from U.N. Comtrade records of weapons transfers and reported seizures gleaned from special reports published by the Small Arms Survey or reported in the news. The resulting networks include illegal shipments and grey market trade behavior, where one partner to the trade does not confirm the trade (not fully reported) to authorities, often for political or strategic reasons. Mapping trade activity in this way, the present study investigated whether the imposition of weapons embargoes changed trade activity for the nations under sanction. To provide context for these effects, structural statistics measured how the overall illegal trade network evolved over time. The hypotheses are restated below:

$H_1$ Controlling for fiscal health, GDP, and ability to control corruption, nations under embargo will exhibit greater change in trade activity with a preference towards indirect ties.

$H_2$ Controlling for fiscal health, GDP, and ability to control corruption, nations will exhibit a preference for indirect transfers when embargos are lifted (post-embargo period).

$H_3$ Nations under fiscal duress will exhibit greater change.

## Implications

### Market Context

Out-Degree Results show lower out-degree density was seen in all four models over time. Over time, illicit and grey market trade in SALW exhibits less density. In a global market of weapon trading there are few major producers, which could also account for the lower out-degree density. With only about 6 major arms producing countries worldwide this low out-degree score is foreseeable. According to Snijders et. al. 2010 global networks in a perfect world function on a hierarchy with those on the bottom showing higher out-degree measures while those at the top have lower out-degree scores.

Reciprocity Consistent with other social network research, illicit and grey market trade activity favors reciprocity. Over time, if one country gives out weapons as an in-kind gift and some of those weapons are not used then some of the weapons will be returned to the contributing country. If you trade with one country over time from prior research, it is understood that the importer of the trade relationship will reciprocate the tie. As reciprocity increases over time, there is an increase in transitive triplets with these results as well.

Transitive Triplets The reciprocated ties reported on above could actually be part of the transitive triplet relationship as well. Reciprocation can be within transitive triplets. The results indicate an increase in transitive triplets meaning country A trades with country B, country B trades with country C, over time country A and C will have some kind of trading relationship. Transitive triplet behavior is indicative of closure in the network (Snijder, 2005). Lower density in the a decreased tendency to establish ties away from reciprocity supporting the increased closure with transitive triplets.  Which further supports lower density; which was found in the current study, with lowering out-degree effects. As well, a greater support for the idea that illegal network trade activity is built with tie formations that are not easily broken (Bresson-Cartier, 1997) with simple embargo implementations strategies.

## Embargo Effects

The results indicate; when accounting for fiscal health, during embargo implementation periods do show greater shifts of change towards indirect ties. Although the effect is lower, there is a tendency towards change in trade during post embargo periods. Prior research indicated greater change in trade during and post embargo periods (Bichler and Malm, 2013; Bichler and Franques, 2014). Bresson-Cartier (1997), argued that as countries acquired more weapons their policy decisions became more aggressive. This maybe an indication of why greater levels of change are seen during and post embargo periods.

Indirect tie formation is an indication of a chain like formation. This should open up the conversation on the global platform on how to deal with these transshipment points, and how to evaluate the routine activities of these convergence points within the network.

The highest effects were seen in the parsimonious model (model 4), during embargo implementation period and the interaction effect of indirect tie formations. Bresson-Cartier (1997), study goes to support these findings that the risk of continuing to trade during an embargoed time frame does not outweigh the benefit of the continued trade relationship: These trading relationships can be something that is well established. The interaction effect of during embargo and indirect ties was over double that of the interaction with post embargo and indirect ties. Although pre embargo was not used in the final model, in model 3 pre embargo and pre embargo interaction effect do have effect on change in the network. This change can be seen for preferential towards indirect ties. This could be the start of what is seen later during the embargo implementation period where there is a greater effect on indirect tie formation.

## Control Variables

Fiscal duress in the model did show significance towards change in the network. Countries that exhibit higher effects from economic crisis had greater tendency of change occurring. Using this as a control variable further illustrates how legal market issues permeate into illegal markets (Bichler and Malm, 2013).To see how this variable further effects change in the network additional analysis would be needed. Such as interaction effects with economic crisis and indirect ties, or reciprocity. Overall, the results gained from this variable show insight into how fiscal health effects change in the illegal arms trade. Sufficiently enough to explain its' presence in these models and continued research into its effect.

Notably, it was discovered when coding economic crisis that the effects of this fiscal problem was not restricted to United States, it did have an effect on the global economy. This variable had an effect on change in trading behavior; countries that exhibited higher effects from the economic crisis would see more change over time. This also adds to the idea that the U.N. needs to have greater oversight in the area of fiscal health on countries going through economic turmoil.

Although control of corruption although it performed poorly in the first model, the effect size, though small, did have an effect on change in the network. This variable should be considered for future research.

The covariate for GDP variable did not perform well on its own in the first trial runs. Initially GDP was considered important to have to use as a control variable. As stated previously this study was analyzing data that was not reported accurately 100% of the time, this is why it was included in the network.

## Theory

Illegal networks, based on the information gathered here, may be sparse networks made up of close-knit relationships that remain stable over time and greater trade activity is seen among trusted reciprocated ties (Kinsella, 2007). Prior research also suggested that a rational choice perspective maybe in play for these trading decisions (Kinsella, 1998). Using routine activity theory one can examine what Sampson, Eck and Dunham (2010), called the super controllers on this national level of trading that is occurring. Economic and social influencers in the current study are those that are going through economic crisis or low fiscal health. This covariate showed to positively effect change in the network. Further research should look at how this variable could be influenced to influence intimate handlers within the illicit weapons trading network. What this current study looked at is just the illicit weapons trade, but one must remember that this is part of a much bigger network of corporate financers, social groups, and political parties. What does routine activities theory say about the results found in the current study? That illicit weapons are part of a large network of smaller individuals that are not necessarily affected by the implementation of an embargo. As opportunities present themselves with adequate targets and lack of controls illegal weapons trade continuous and will continue to operate. That the individuals that make up this market are not necessarily seeking out to commit these crimes and in some case may be unaware of the crime that have committed. For example the port master decides that with his allotted time only every 10th shipping container will be inspected. He is going about his normal routines not aware that his routine has allowed 9 containers of illicit weapons to pass through his port.

## Policy

Greater investment from United Nations to create stable committees, that would act as third party liaisons to help settle disputes and reports of violence. The previous example in the literature was that of the Taliban in Afghanistan, and how the U.N. was dealing with the atrocious human rights violation that area. The embargo was put in place in 1996 and called for members to cease the import of all military assistants, called for the ruling party to ceasefire and peacefully resolve their issues. The fighting continued into the early 2000s' and the U.N. provided need based services to those affected by war. The requests for peace were not followed and no true consequences were applied. What needs to happen is greater intervening by third parties to ensure peace talks are performed and acting governmental authorities are held accountable to global criminal courts when human rights are violated. Third party mitigation needs to come be made up of long-term committee members that have a vested interest in peace and stability. In the case study previously discussed, in Sierra Leone, the third party committee sent in to establish order and peace often turned away from continued violence. The committee did not want to upset the RUF with regulations for peace. The committee members are often short-term workers that have no stake in seeing a long process through. International courts need to be more active in holding violators of arms embargoes accountable to the gross human rights violations that are likely to occur from the import of weapons to war torn regions. Another area that needs addressing from the U.N. is before the situation turns into human rights violation, fiscal health issues should be addressed.

As the current study shows, fiscal health does have an effect on illegal arms trade. This finding suggests that it is important to identify countries with fiscal health issues and addressing those issues, whether these issues are due to lack of resources or misappropriated funds, before weapons flood the region. Finding the root cause of the issue and addressing that. If the root cause of the problem is misappropriating funding stepping in and helping to balance budgets, where world leaders are concerned about fiscal responsibility. This redistribution of budgeting goes towards a stabilization on the infrastructure. From a lower level approach better pay and benefits to those that are involved with border and shipment points to help cut down on the temptation of bribes. This includes those that are in governmental positions

The previous policy changes could help, but they are only implementing policies at one level of the network. When taking routine activities into consideration and the number of intimate handlers and guardians at different levels one needs to stop implementing blanket policies and start drilling down to lower level policies that will have greater impact. A suggestion for these types of policy changes could focus on port workers and supervisors. Creating greater monitoring on them and their daily tasks. Also, civil penalties for companies that knowing and unknowing allow weapons to permeate through their access points.

## Limitations

Although an analysis of first significant digits suggests that the weapons transfer data used in this study are relatively complete, network analysis is highly sensitive to missing data. Missing from this study is the legal trade network: The legal network was not included in the study although studies confirm that legal and illegal markets have a continuous give and take relationship between them (Bichler and Malm, 2013). The complex nature of stochastic models coupled with the examination of two interdependent networks longitudinally is beyond the scope of this project. Not including the legal network in the overall project limits the results to only illegal change in the network giving a small snap shot of a much larger network. Although the current study looks at indirect tie interactions one can only interpret other covariant and structural statistics to change.

Control variables GDP and corruption may have not performed as well due to the fact that these were treated as dynamic variables. Coding issues with both variables may have caused other instability issues as well. As stated previously GDP does not have issues of shady reporting practices. When compared to an illegal network data which, exists only due to its shady reporting issues, their comparability becomes questionable. Another issue with GDP was that it was dynamically coded when it should have been a static variable. This measure could be used with a legal trade network but consideration as a variable with illegal trade might need to be dropped. Due to the previous problem stated illegal activity is activity that is no reported 100% of the time while GDP is reported.

## Future Research

Future research needs to look at the legal and illegal network simultaneously to better understand change due to the interconnect ability of the two networks. In addition, studies could use a different way to measure fiscal health, perhaps using a static measure of GDP or a different source of data. Moreover, control of corruption did not vary over time, a static variable would be more effective. . Future research should also consider using more interaction effects to account for specific change over time. Networks by nature are complex taking multiple variables, such as characteristic, spatial and temporal effects into consideration is essential to fuller understand the multifaceted nature of change why that change occurs.

Other considerations for future research is identifying the death of trade ties. While this research focused on the formation of ties, looking at the death of ties may be a better indicator of true movement. This could also be coupled with tie formation to get a larger picture of change activity.

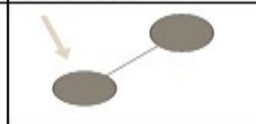
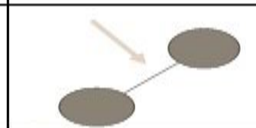
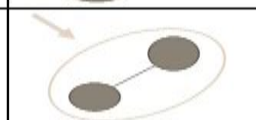
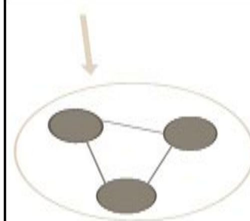
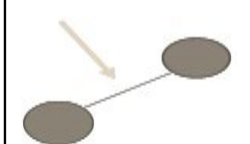
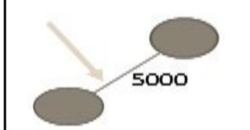
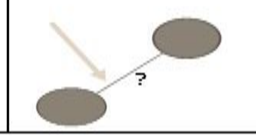
## Conclusion

Embargoes are routinely implemented by the international community to restrict the flow of small arms and light weapons into politically unstable regions. The effectiveness of sanctions fall into question when reports indicate that weapons continue to pour into embargoed territories. Using stochastic actor-based modeling, the current study investigates how shipment patterns change over time, and how trade patterns evolve in the presence of endogenous influences, such as embargoes, while controlling for corruption levels and national wealth (e.g., gross domestic product). The results here indicate that embargoes do indeed shift trade during their implementation periods. The trade shift is seen in indirect tie. The second point of interest from this study was the use of stochastic actor-oriented models as an analysis tool for the study of large complex illegal markets. Although limitations exist in this study, i.e., control covariates performed poorly, this study did illustrate this type of analysis is a credible analytic technique for future research. This work gave insight into the shifting illicit trade pre, during and post embargo and how policies should be refocused to better establish enforcement efforts to counter balance these shift trade behaviors.

# APPENDIX A

# NETWORK DEFINITIONS

Network Definitions

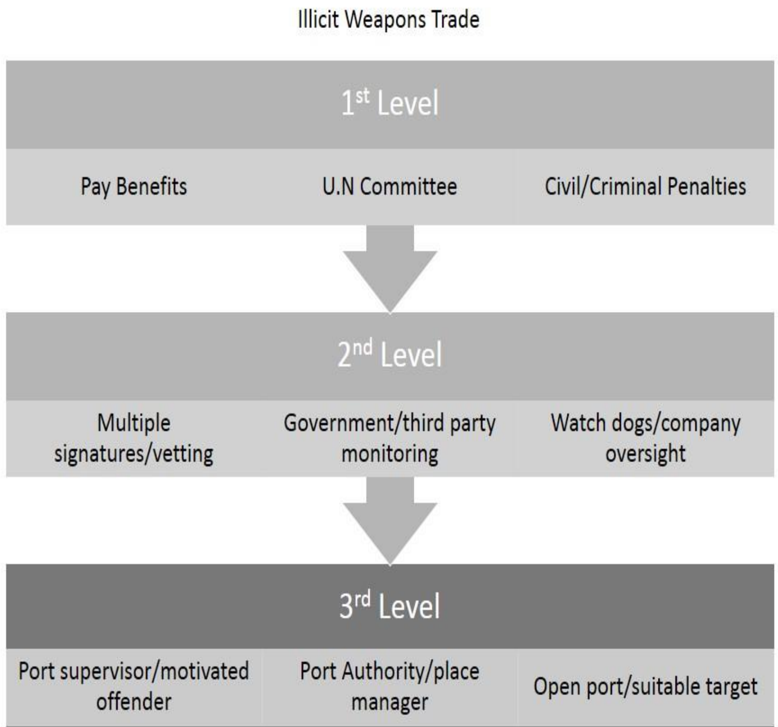
| Explanation of terms | | | |
|---|---|---|---|
| | Definitions | Example for study | Visualization |
| Node | The individual unit of analysis within an network can be a person, place, thing, or event. | Countries, Territories, or states |  |
| Ties | Are the relationship or the connection between the nodes, what relates them together. | Trade relationship between nodes the importing and exporting of nodes. |  |
| Dyad | The unit of anaylsis is looked at the two nodal level | This may be looking at how many dyadic relationships exsist with the network. |  |
| Triade | The unit of analysis is looked at the three nodal level | The trade between three countries: If Germany trades with Ireland, and Ireland trades with Spain and Spain with Germany this would make a triadic relationships. |  |
| Directed | A network that shows the direction in which a trade relationship is present | For example if Spain sends weapons to Germany then that is a directed network, this will usually have an arrow representing the direction |  |
| Undirected | A network that shows that a relationship is present but the direction of that relationship is unknown | For example if Spain and Germany have a political relationship one may not know what who started the relationship or in which direction this relationship goes in |  |
| Valued | The value that a tie between countries can have | If Spain sends 5000 dollars in weapons to Germany than that would value the tie at 5000. |  |
| Unvalued | The tie between counttries has no value | If Spain sends Germany weapons but the value is unknown |  |

(Kinsella, 2008)

APPENDIX B

SYSTEM BREAK DOWN

System Break Down




(Eck, 2002)

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