SOUTH AFRICA IN THE INTERNATIONAL ARMS TRADE NETWORK (ATN) DURING NATIONAL PARTY RULE (1948-1994): A NETWORK ANALYSIS

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Abstract

South Africa is renowned for its arms industry, which was established under apartheid to counter external threats during the Cold War, increasing internal threats from the black majority, and internationally imposed arms embargoes. The country's arms industry developed numerous novel and technologically advanced weapons systems, and the war in Angola meant that these weapons systems were proven in combat. While trade with the rest of the world became increasingly difficult as subsequent embargoes were imposed, the country's perpetual conflicts demanded the import of weapons in any way possible, while the combat-proven nature of South African weapons systems allowed the country to export tried-and-tested weapons systems as well (at least until the late 1980s). This article uses network theory to investigate South Africa's role in the global Arms Trade Network (ATN) from 1948 to 1994, and discusses South Africa's overall role and trading partners. It is shown that, in terms of the trade relations in the ATN, South Africa was a central role player throughout the apartheid years, and that its role changed from importer to exporter in the later years.

Keywords: Arms trade; complex networks; apartheid; arms embargoes; sanctions; trade networks.

Sleutelwoorde: Wapenhandel; komplekse netwerke; apartheid; wapenboikotte; sanksies; handelsnetwerke.

1.   INTRODUCTION

Since Francois Quesnay's (1758) study of financial networks, trade networks have been studied *as networks* in numerous studies, e.g. Snyder and Kick (1979), Steiber (1979), Serrano and Boguna (2003), Garlaschelli and Loffredo (2005), Schiavo, Reyes and Fagiolo (2010), De Benedictis and Tajoli (2011), Squartini, Fagiolo and Garlaschelli (2011), and Vicarelli *et al*. (2013). Specifically in terms of the arms trade, Åkerman and Larsson-Seim (2014) used network theory to study the network of global arms trade transactions over the period 1950-2007, while Senekal, Stemmet and Stemmet (2015) investigated South Africa's position in the global Arms Trade Network (ATN) since 1994. The current study follows these studies in

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investigating South Africa's position in the global ATN under National Party (NP) rule, i.e. 1948-1994.

In a network approach, the focus falls on more than just the immediate trade relations of a country, and an entity's position in the entire network of trade relations can be studied. Because the emphasis is here on South Africa's position in the global ATN, we do not provide a detailed discussion of South Africa's arms industry, which has been investigated by, amongst others, Wessels and Marx (2008), Van Wyk and Grobler (2001; 2006), and Liebenberg and Barnard (2005; 2006). Rather, network analysis is used in this article to analyse the global ATN from 1948 to 1994 from a South African perspective. Like Åkerman and Larsson-Seim (2014), data was used as supplied by the Stockholm International Peace Research Institute (SIPRI), which provides a comprehensive and virtually complete database on transactions regarding major conventional arms (i.e. not nuclear, chemical, biological, less-lethal or small arms), including aircraft, air defence systems, anti-submarine weapons, armoured vehicles, artillery, engines for military aircraft, combat ships and most armoured vehicles, missiles, sensors, and satellites (Åkerman and Larsson-Seim 2014:537).[4] One of the key differences between this study and that of Åkerman and Larsson-Seim is, however, the focus on South Africa, i.e. the article conducts a node-level analysis rather than an investigation into the structure of the ATN itself.

2. BACKGROUND TO THE ARMS EMBARGOES AND THE SOUTH AFRICAN ARMS INDUSTRY

During the National Party rule (1948-1994), South Africa received a growing amount of criticism over its internal policies, culminating in sanctions during the 1980s. Part of the international strategies to ostracize South Africa during this time also included arms embargoes. In August 1963, the United Nations (UN) Security Council adopted Resolution 181, which called on all states to cease, "the sale and shipment of arms, ammunition of all types, and military vehicles to South Africa" (Stockholm International Peace Research Institute 2012). This was, however, a voluntary arms embargo, and in December 1963, UN Security Council Resolution 182 extended the voluntary arms embargo to include, "equipment and materials for the manufacture and maintenance of arms and ammunition in South Africa". In July 1970, UN Security Council Resolution 282 was passed, which called for

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4   The data provided by the Stockholm International Peace Research Institute include the date of purchase, as well as the date of delivery, but the date of the purchase was used here when dating transactions, because the date of the order was deemed a more useful indicator of when the transaction occurred, particularly in light of South Africa's barring from the international arms trade until 1994.

the unconditional implementation of the embargo, but it remained a voluntary arms embargo, and trade continued. In November 1977, following the Soweto riots of 1976 and the recognition of "liberation movements" by the UN, UN Security Council Resolution 418 imposed a mandatory arms embargo against South Africa, which stated that all states shall, "cease forthwith any provision to South Africa of arms and related material of all types, including the sale or transfer of weapons and ammunition, military vehicles and equipment, paramilitary police equipment, and spare parts for the aforementioned, and shall cease as well the provision of all types of equipment and supplies and granted of licensing arrangement for the manufacture or maintenance of the aforementioned" (Stockholm International Peace Research Institute 2012).

In 1982, the Armaments Corporation of South Africa (ARMSCOR) participated in a weapons industry exhibition in Greece, "that marked South Africa's entry into the export arena" (Botha 2003:2). In response to this event, UN Security Council Resolution 558 extended Resolution 418 in December 1984 by requesting states to also cease any imports of arms, ammunition and military vehicles from South Africa, though this was not mandatory (Stockholm International Peace Research Institute 2012). In November 1986, following the large-scale political violence and subsequent states of emergency in South Africa, UN Security Council Resolution 591 included in its scope spare parts and components, directly or through third parties, and certain dual use items, such as four-wheel drive vehicles (Stockholm International Peace Research Institute 2012). These arms embargoes were implemented in conjunction with other economic sanctions and boycotts, and as Alsheh (2013:36) writes, "by the late 1980s South Africa had become the single most ostracized, sanctioned and universally condemned regime in the history of the international community, and the paradigmatic pariah state" (also see Wessels and Marx 2008:71-72). Following the successful completion of South Africa's first multiracial election in April 1994, UN Security Council Resolution 919 terminated the arms embargo in May 1994 (Stockholm International Peace Research Institute 2012).

The arms embargoes were, however, routinely violated by numerous countries. Moore (2010:10) writes, "Most of the violations of the South African embargo come from NATO members and other Western leaning states during the Cold War." Moore argues that this violation can be explained by the fact that, "although there was widespread condemnation of South Africa's apartheid regime, these states were still willing to provide military assistance to South Africa, because South Africa remained an ally against Soviet Communist influence". Israel was South Africa's main trading partner in the arms industry. "Israel was the most systemic violator of the South African embargo. Every year the UN arms embargo was in effect, Israel continued to provide weapons to the apartheid regime and

provided more arms than any other state. These transfers represent the strength of the Israel-South African military cooperation during this era, part of which was driven by Israeli fears that the United Nations could impose a similar embargo against Israel over the treatment of Palestinians (Moore 2010:10).

From 1972, Israel gradually began taking the place previously held by France and Italy as South Africa's main arms supplier, and by 1985, 20% of Israel's total industrial exports revenue came from South Africa (Alsheh 2013:26, 35; also see Figure 2).

Lamb (2007) writes that the South African government tried to circumvent the arms embargoes in three interrelated ways:

• By developing a domestic arms industry and aiming to make it self-sufficient;

• exploiting loopholes in the embargo regulations; and

• covertly acquiring arms and defence equipment from international sources, often with the assistance of sympathetic governments.

Firstly, South Africa established its own, local arms industry. Armscor was set up in 1968 as a statutory corporation in terms of the Armaments Development and Production Act 57 of 1968, which defined the role and tasks of Armscor as, "promoting and coordinating the development, manufacture, standardization, maintenance, acquisition, or supply of armaments […] utilizing the services of any person, body or institution or any department of the state" (Botha 2003:1). Under Armscor, the South African arms sector was to become self-sufficient, partly because the NP government realized that its racial policies would continue to isolate South Africa, leading to more sanctions and embargoes. Alsheh (2013:27) writes, "From spending no more than R30 million on (mostly imported) arms in 1966, by 1980 South Africa was spending R600 million on arms, most of which was locally produced. By 1988 South Africa was exporting R1,8 billion worth of arms, becoming one of the top ten arms exporters in the world" (also see, Wessels and Marx 2008:75).

One of the flagship developments of the local arms industry was the Ratel Infantry Fighting Vehicle (IFV), which was introduced in 1977 – just as the mandatory arms embargo was also being introduced. The Ratel, which was dubbed "the Rolls-Royce of infantry vehicles" (Wessels and Marx 2008:79), became synonymous with the war in Angola and an essential part of military hardware. Scholtz (2006:118) writes, "Taking everything into account, the Ratel was probably the most flexible piece of weaponry in the Army's arsenal, one without which its operations in Angola would have been absolutely impossible."[5]

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5   Translated from the original, "Alles in ag genome was die Ratel waarskynlik die beste en mees buigsame stuk wapentuig in die Leër se arsenaal, een waarsonder sy operasies in Angola volstrek onmoontlik sou gewees het."

The Ratel was, however, only one item in a rapidly developing local industry, and local versions of foreign weapons systems were often developed. In this manner, the Soviet BM-21 Katyusha multiple rocket launcher became the South African Valkiri; the British Centurion main battle tank and its Israeli upgrade became the Olifant; and the French Mirage Mk III and Israeli Kfir became the Cheetah; which Ackerman (1987:30) called, "n dwarsklap vir die tien jaar oue wapenverbod teen die RSA [a slap in the face of the ten year old arms embargo against the RSA]". Wessels and Marx (2008:81) write that, during Operation Protea (1981) in Angola, "94% of the armaments used by the SADF were produced in South Africa, and by 1985, almost 100% of the Army's equipment was locally developed". Botha (2003:1) concurs, "By the end of the 1980s, South Africa had established a substantial defence industry, which offered products and equipment that had been developed for use in the difficult terrain in the region. The country became effectively self-sufficient in arms production. The industry manufactured most calibres of arms and ammunition; army vehicles; communications and electronic warfare equipment (such as warning and self-protection systems); and air-to-air and anti-tank missiles. It was also capable of assembling aircraft to the level of Impala trainers and Oryx helicopters, and constructing and arming strike craft and minesweepers".

Of special importance is the development of nuclear weapons, which was done with the aid of Israel. On 22 September 1979, South Africa conducted its first nuclear test, and subsequently developed a further six bombs, each capable of delivering an explosive power of between 10 and 18 kilotons (Stemmet 2002:25). The development of nuclear weapons was tied to the Cold War in particular, as Foreign Minister Pik Botha (quoted in Stemmet 2002:26) argued in 1991, "We were isolated. There was an arms embargo against us. There was a potential deterrent inherent in the capacity to produce a nuclear device in those circumstances."

Henk (2004:14) notes that the arms industry was not only important to South Africa in terms of defence, but also as an important part of South African industry and as an employer. "Arms producers accounted for fully 9% of the country's employment in manufacturing. Armscor alone was the 15th largest employer in the country. Arms comprised 6,6% of all South African manufacturing output and 1,5% of the country's gross domestic product." By 1989, Armscor employed approximately 100 000 people (Stemmet 2002:23).

However, despite Armscor's generally successful emphasis on self-sufficiency, some critical components and systems still had to be imported. These included, "a state-of-the-art combat aircraft and many ordinary electronic components" (Botha 2003:1). The lack of the former was the main reason why

South Africa lost air superiority over Angola in 1988 (Wessels and Marx 2008:82; Central Intelligence Agency 1989:51).

To supplement the local arms industry, South Africa made use of loopholes in the arms embargo. Lamb (2007:3) writes, "The vagary of the definitions 'weapons' and 'arms technology' in the embargo regulations facilitated the easy import into South Africa of a large number of items that could be used in both the civilian and military sectors. These included items like electronic equipment and various types of aircraft to be used for military purposes" (also see Wessels and Marx 2008:74). Recognizing this loophole, UN Security Council Resolution 591 included "duel use" items, but the South African arms trade remained intact, largely because of its strategic position as an ally of the West, and its ability to circumvent arms embargoes.

Thirdly, the South African government acquired arms through covert means. In 1985, General Magnus Malan, "openly admitted that any country at the mercy of an international arms embargo would have to resort to 'unconventional' buying methods from time to time" (Wessels and Marx 2008:75). At the end of the Cold War, the global arms industry came under increased pressure as the demand for arms decreased substantially. Some companies tried to convert their military technological expertise into the production of goods for the civilian market. While this strategy was mostly unsuccessful in South Africa, one success story is UEC Projects, belonging to the Altech group, which designed and manufactured the Digital Satellite Television (DSTV) decoder, which earned over R500 million per annum by 2003 (Botha 2003:9). Botha (2003:12) writes, "The weapons industry has therefore repositioned itself as a supplier of sophisticated products like components or subsystems to first-tier clients in Europe or the USA, and of complete products to second-tier clients like countries in the Middle East and South and South-East Asia."

As the graphs in Figure 1 show, the abovementioned embargos did not stop South African exports of arms, but it certainly had a direct impact on the volume and regularity of trade, and in particular on South African arms imports after 1986. The figures are SIPRI Trend Indicator Values (TIVs) expressed in US$ million at constant 1990 prices.
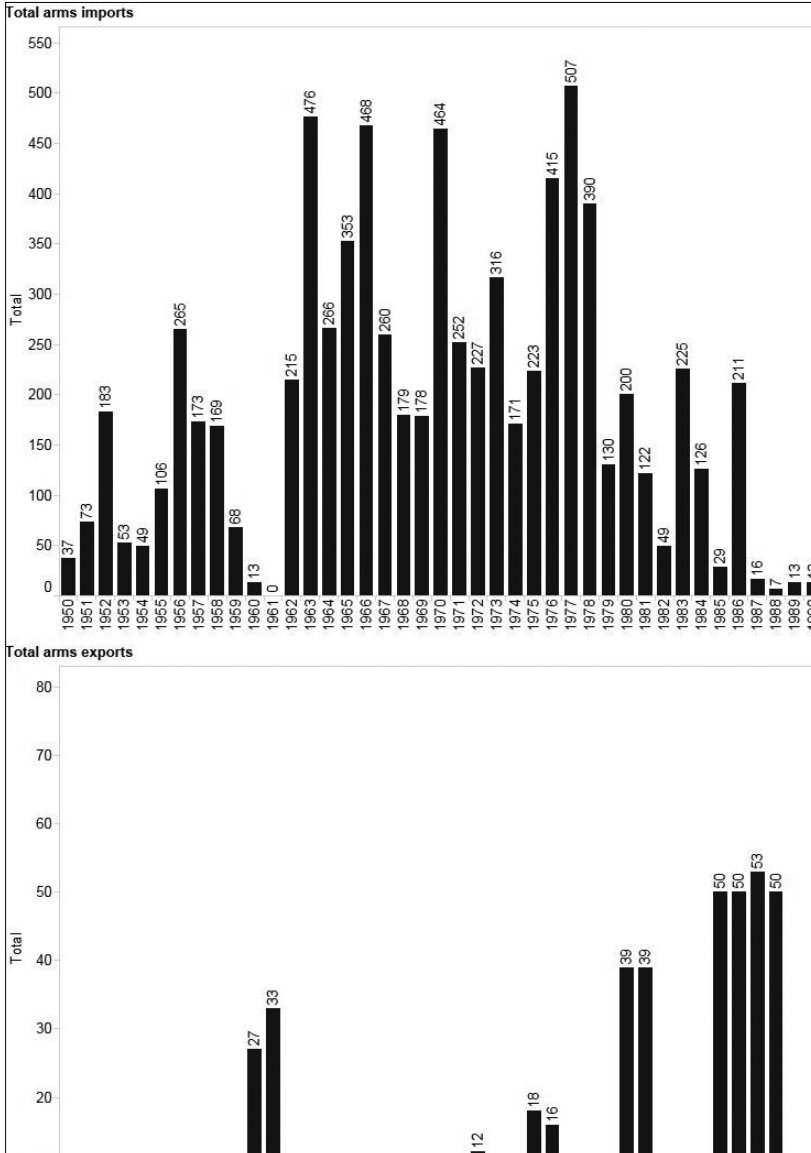
Total arms imports

Total arms exports

Figure 1. South African arms imports and exports 1950-1994 in US$ million at constant 1990 prices (data provided by SIPRI)

Note, however, South Africa's successful circumvention of the arms embargo between 1985 and 1988 in terms of exports, as well as the fact that, although arms exports were irregular, there was still a general upwards trend in exports during this period. This irregular trade is also found in weapons imports, where the impact of the embargoes is even clearer in the downward trend throughout the 1980s. From 1987 to 1991, South African arms imports were almost non-existent, while exports are more intermittent. This lull in imports was devastating for the war in Angola, as already mentioned. Very little sophisticated weaponry was entering the country at this time, which undermined the South African Air Force's ability to maintain air superiority in the face of increased Cuban involvement.

Nevertheless, a lot of trade still occurred with South Africa. Figure 2 shows South Africa's main trade partners for the period 1961-1994, as well as for the shorter embargo years – 1989 was chosen here as the end point because De Klerk's announcement of reforms in February 1990 changed the South African arms industry significantly, even though the embargo was only lifted in 1994.
Note that France was overall South Africa's main trade partner during the apartheid years, while South Africa's main trade partner during the embargo years was Israel. However, the volume of trade with the listed countries changed over time, with the majority of trade with the UK occurring during the 1950s until 1966, the majority of trade with Switzerland occurring between 1964 and 1969, with Italy between 1966 and 1984, and with France between 1963 and 1979. Israel, on the other hand, became a major contributor only after the mandatory arms embargo was imposed by the UN in 1977, and continued to supply large quantities of arms to South Africa until 1986, and then again after 1990. Between 1977 and 1989, Israel exported arms to the value of US$ 780 million (at constant 1990 prices) to South Africa. Along with Israel, West Germany was another important violator of the mandatory arms embargo, and supplied South Africa with US$ 277 million (at constant 1990 prices) worth of arms between 1977 and 1992.
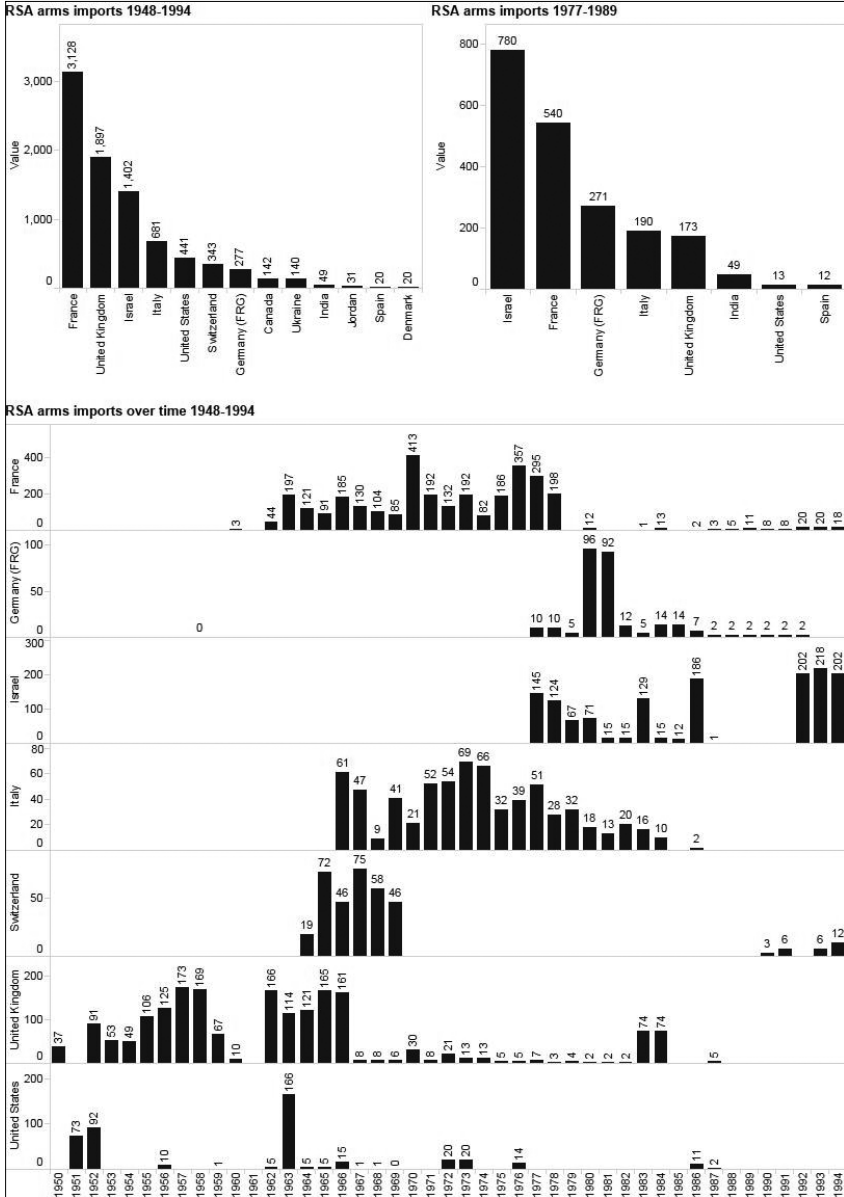
Figure 2. The main suppliers of South African arms in US$ million at constant 1990 prices (data by SIPRI)

3.   THEORETICAL FRAMEWORK

The study of complex systems has gained ground in most scientific disciplines over the past few decades. Systems that are usually seen as complex include, amongst others, conflicts (Kilcullen 2013), economies (Easley and Kleinberg 2010), the immune system (Holland 1992), living organisms (Kresh 2006), the brain (Telesford *et al*. 2011), language (Kwapień and Drożdż 2012), society and the weather (Brownlee 2007). When studying these phenomena as complex systems, the emphasis falls on how entities are related, rather than on the individual attributes of elements; for in the words of Wilden (1980:215), "entities do not create relationships so much as *relationships create entities*" (original emphasis) – it is through the network of relations in which entities are embedded that they exist and function. While no absolute definition of a complex system exists, Kwapień and Drożdż's (2012:118) definition can be taken as a working definition. "[A] complex system is a system built from a large number of nonlinearly interacting constituents, which exhibits collective behavior and, due to an exchange of energy or information with the environment, can easily modify its internal structure and patterns of activity."

Most complex systems consist of a large number of interdependent components and exhibit a hierarchical organisation where the components of a complex system are complex systems in their own right (DeLaurentis 2007:363), e.g. a human being that also consists of, amongst others, an immune system and a brain. In the case of world trade, countries for instance consist of companies, companies of people, and people of subsystems, such as the immune system – all complex systems in their own right. In the current study only one level, namely the relationships between countries in terms of the arms trade, is studied.

In addition, the interaction between component parts results in emergent behaviour, where the function of the whole system is more than the sum of the functions of individual components (Glattfelder 2013:2). The fact that complex systems are characterised by emergent behaviour in particular, highlighted the limits of reductionism, since the interdependence between component parts in a complex system prohibits taking the system apart and studying parts in isolation – the behaviour of the whole is not contained in the behaviour of the individual parts (Bar-Yam 1997:11). According to Cong and Liu (2014:599), complex network theory is particularly well-suited to the analysis of complex systems without taking entities out of the web of relationships in which they function. In the case of international trade, the overall importance of a country on a global scale cannot be gleaned without taking *all* relationships into account.

Furthermore, complex systems are adaptable (Amaral and Ottino 2004a:159) and will react to internal changes, as well as external stimuli, e.g. the immune

system adapting to a new pathogen without an external authority coordinating the system's response. World trade also displays adaptability by adjusting to local and global changes, such as thawing relations between the Soviet bloc and the West, hostility between the Soviet Union and China, and local conflicts – all without a central authority coordinating individual trade relations.

Complex network theory has emerged over the past two decades as one of the key approaches to complex systems, along with statistical physics and non-linear dynamics (Amaral and Ottino 2004b:1655). A complex network is then a network representation of a complex system, where the elements of a system are represented as vertices or nodes (n), and their connections as ties or edges (m). While network theory shares the basic concepts of complex systems theory as outlined above, network theory is more data-driven, builds on exact mathematical tools, and has "hijacked" complexity research over the past decade (Barabási 2011:15). Mathematical tools developed within network theory focus on three levels (Borge-Holthoefer and Arenas 2010:1274):

1.   A macrolevel, where the overall structure of the network is studied using e.g. average path length, degree distributions or transitivity;

2.   a mesolevel, where the focus falls on studying community structure; and

3.   a microlevel, where the focus falls on identifying individual entities that play a key role.

The current study focuses on a microlevel (node-level) analysis, while Åkerman and Larsson-Seim (2014) focussed on a macrolevel analysis of this network.

The network approach has been applied to fields as diverse as neurobiology (Telesford *et al*. 2011), economy (Glattfelder 2013), history (Padgett and Ansell 1993), biology (Aplin *et al*. 2013), and political science (Adamic and Glance 2005). As stated in the introduction, a large number of studies have analysed the World Trade Network, while the Arms Trade Network has been studied in Åkerman and Larsson-Seim (2014) and Senekal, Stemmet and Stemmet (2015). The current article follows these studies, in particular, in considering South Africa's position in the international ATN under NP rule.

4.   SOUTH AFRICA IN THE ATN DURING THE NATIONAL PARTY RULE

From 1948 to May 1994 (when UN Security Council Resolution 919 terminated the arms embargo), 228 countries (nodes n) and 1 603 transactions (edges m) are involved in the international ATN. However, it would be more significant to investigate the ATN under different leaders, especially since the mandatory arms embargo overlaps with the leadership of PW Botha. Firstly, the number of countries involved (nodes n), number of transactions (edges m) and average number of ties between countries ($<k>$) of the ATN changed in the following way for the

periods under the leadership of DF Malan, JG Strijdom, HF Verwoerd, BJ Vorster, PW Botha and FW de Klerk:[6]

Table 1. Some macrolevel characteristics of the ATN for the six periods under investigation here

Period	N	M	<k>
1948-1954	84	196	2,333
1955-1958	96	224	2,333
959-1966	132	439	3,326
1967-1978	163	825	5,061
1979-1989	182	969	5,324
1990-1994	159	591	3,717

Not only did the number of countries involved in the ATN drop significantly in the final period, but also the number of edges and the average degree of a country dropped from its highest point throughout this period to a level reminiscent of the early 1960s. This illustrates the impact of the end of the Cold War; not only the volume of trade, but also the number of countries involved in trade dropped significantly after 1990.

Centrality measures, as developed within network theory, are able to quantify South Africa's changing position in the ATN. Three of the centrality measures most often used in a node-level network analysis are Freeman's (1977) degree-, betweenness- and closeness centralities. The first simply highlights those entities with the highest number of direct ties and is a measure of activity – in this case, the country with the highest degree centrality will be the one with the largest number of trading partners and the most active role player in the ATN. In some cases, degree centrality identifies the most important role players in a network: in De Benedictis and Tajoli's study (2011) of the World Trade Network (WTN), the UK had the highest degree centrality in 1980, while the US had the highest in 2000. Degree centrality (CD) is calculated for node i with Equation 1(Prell 2012:97):

$$C_D(i) = \sum_{j=1}^{n} x_{ij} = \sum_{i=1}^{n} x_{ji}$$

1

In Equation , x_{ij} = the value of the tie from node i to node j (the value being either 0 or 1), and thus it is the sum of all ties, while n = the number of nodes in the network.

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6   The end of a leader's term was rounded off to the end of that year, while the beginning of his successor was indicated as the start of the following year. This was necessary for the calculations.

Where ties are directed, in- and out-degree can be distinguished, which brings additional meaning to the concept of degree centrality. The dataset analysed here includes who the supplier and recipient of arms was, and hence the dataset allows the construction of a directed graph (also referred to as a *digraph*) where the direction of ties is indicated. In- and out-degree then corresponds respectively to how many countries a country purchased arms from and to how many countries a country sold arms to. In-degree is calculated for node *i* with Equation 2 (Prell 2012:100):

$$c_1\left(i\right) = \sum_{j=1}^{n} x_{ji}$$

2

Out-degree is calculated for node *i* with Equation 3 (Prell 2012:100):

$$C_0\left(i\right) = \sum_{j=1}^{n} x_{ij}$$

3

While degree centrality only takes direct ties into account and is therefore a *local* measure, betweenness- and closeness centralities take the entire network into account and are therefore *global* centrality measures. Squartini, Fagiolo and Garlaschelli (2011:0461171) refer to these measures as "higher-order characteristics", "Higher-order characteristics are more complicated structural properties that also involve indirect interactions, i.e., topological paths connecting a country to the neighbors of its neighbors, or to countries farther apart." Betweenness centrality measures to what extent a node is positioned on a short path between all other nodes, and usually identifies the most important nodes in a network (Vicarelli *et al.* 2013:24; Caldarelli 2013:253; Prell 2012:107). In De Benedictis and Tajoli (2011), the UK had the highest betweenness centrality in 1980 and the third highest in 2000, while the US had the seventh highest betweenness centrality in 1980 and the highest (together with Germany) in 2000. Betweenness centrality (C_B) is calculated with Equation 4 (Prell 2012:105):

$$C_B = \sum \frac{\partial_{ikj}}{\partial_{ij}}, i \neq j \neq k$$

4

In Equation , ∂_{ikj} = the number of short paths linking actors *i* and *j* that pass through node *k*, and ∂_{ij} = the number of short paths linking nodes *i* and *j*, and thus the betweenness calculation is for node *k*.

Closeness centrality measures to what extent a node is close to other nodes in terms of network distance, and is also a *global* measure that takes the entire network into account. Because nodes at the core of a network are, on average, close to all other nodes, there is a significant amount of overlap between closeness centrality and a position acquired using a force-directed layout algorithm (e.g. Kamada and Kawai 1989 or Fruchterman and Reingold 1991). Closeness centrality (C_C) is calculated for node *i* with Equation 5 (Prell 2012:108):

$$C_C(i) = \sum_{j=1}^{n} d_{ij}$$

5

In Equation , d_{ij} = the distance connecting actor *i* to actor *j*.

South Africa's degree, in-degree, out-degree, betweenness and closeness were calculated for all six periods investigated here. Figure 3 shows the changes in South Africa's degree of these periods, and it can clearly be seen that the arms embargo did not have a direct effect on the number of South Africa's trading partners.

Note that South Africa's degree is far above the average degree from the 1960s onwards, as was shown in Table 1. This illustrates that South Africa placed great emphasis on its arms trade, and at least in terms of the country's number of trading partners, it was a major role player in this industry. In addition, South Africa's number of trade partners increased under the leadership of Verwoerd, Vorster and Botha, but then remained at 15 during the presidency of De Klerk. When degree centrality is broken down as in- and out-degree, the country's changing degree shows a more nuanced role for the country within the ATN; under all leaders, except De Klerk, South Africa's in-degree exceeds its out-degree, which characterises South Africa as predominantly an importer, rather than an exporter in the ATN. During the leadership of Botha, for instance, South Africa purchased arms from ten countries (Canada, Switzerland, France, United States, Israel, United Kingdom, Germany, Spain, Italy and India) and only exported to five countries (Australia, Iraq, Morocco, Paraguay and Sri Lanka). Under De Klerk, however, the number of countries that South Africa purchased arms from dropped significantly from ten to four (Canada, Switzerland, Ukraine and Spain), while the number of countries supplied by South Africa increased greatly from five under Botha, to 11 under De Klerk (Angola, Côte d'Ivoire, Malawi, Oman, Peru, Qatar, Singapore, Uganda, United Arab Emirates, Lebanese Forces and the United Nations). This shows how South Africa's role in the ATN changed when De Klerk announced reforms in 1990 and when South Africa withdrew from Namibia in 1989; the country shifted from being predominantly an arms importer to an arms exporter.
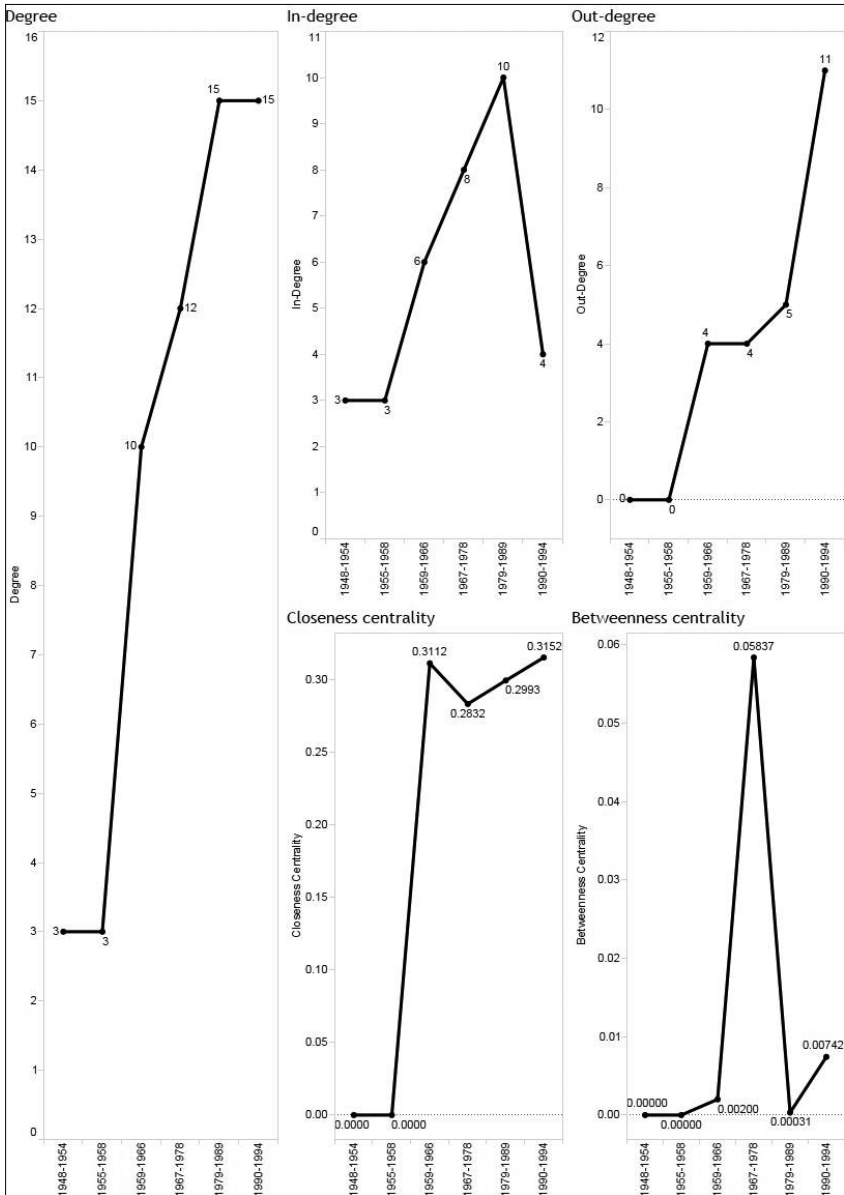
Figure 3. South Africa's degree, betweenness and closeness centrality scores between 1948 and 1994 (data by SIPRI)

In the first period, 1948-1954, there are two distinct groups of countries in the ATN, with Communist countries, such as the Soviet Union, Hungary, Poland and Czechoslovakia, forming a distinguishable subset of the ATN. South Africa was allied with the West and had direct ties to only the US, Canada and the UK (which results in a degree centrality of three (3) in Figure 3). Between 1955 and 1958, South Africa also traded with only three countries and all were key players in the Western ATN: the US, the UK and West Germany. Between 1959 and 1966 South Africa still traded with the US and the UK, but acquired a few new trading partners: Portugal, Italy, France, Denmark, Switzerland, Rhodesia (which declared unilateral independence in 1965) and Katanga. Under Prime Minister BJ Vorster, South Africa maintained its ties with the US, UK, France, Italy, West Germany, Portugal and Rhodesia, but acquired new trading partners in Jordan, India, Israel and one black-ruled state in Africa, Malawi. During the next period (1979-1989), South Africa traded with its long-time partners, the US, the UK, France, Italy, Canada, West Germany, Switzerland and Israel, and acquired a few new trading partners, Australia, Spain, Sri Lanka, Paraguay, Morocco and Iraq. In the final period, South Africa traded with Angola, Côte d'Ivoire, Malawi, Oman, Uganda, the United Nations, Singapore, Peru, Qatar, United Arab Emirates, Canada, Spain, Switzerland and the Ukraine. Note the absence of the US, UK and France in this period – an issue that will be discussed later.

When closeness centrality is considered, South Africa can be seen to have been a peripheral country in the ATN under the leadership of Malan and Strijdom. This can be expected, since the South African arms industry was limited at the time, and the country only became fully independent of the UK in 1961. However, from the time of Verwoerd onwards, South Africa functioned closer to the core of the ATN.

Betweenness centrality suggests something significant; the country achieved its highest betweenness centrality score under Vorster, which precedes the mandatory arms embargo and suggests that South Africa attained its most important position in the ATN under Vorster's leadership. The country's betweenness centrality score then drops sharply as the arms embargo takes effect under Botha, while rising again under De Klerk.

Although changing centrality scores are useful in themselves, comparing how South Africa ranked (i.e. first (1st), second (2nd), third (3rd) etc.) on these centrality scores in relation to all other countries, shows some even more meaningful trends. Figure 4 provides South Africa's changing position in terms of centrality rankings (positions are shown as negatives to show rankings more clearly):
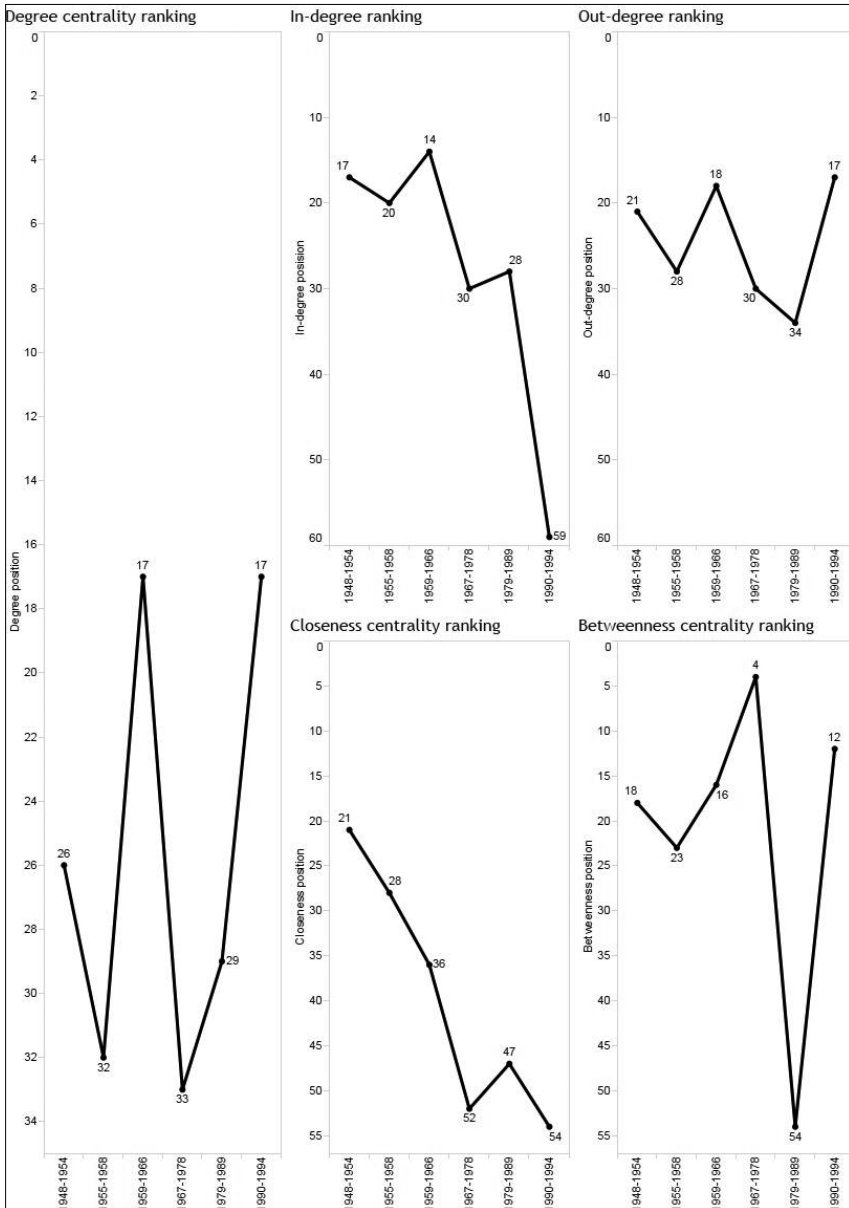
Figure 4. South Africa's centrality positions by period (data by SIPRI)

Here it can be seen that South Africa had the highest ranking in terms of degree centrality under Verwoerd and De Klerk, where South Africa was the country with the 17th highest number of trading partners in the ATN, and the lowest under Vorster, where South Africa had the 33rd highest number of trading partners in this network. However, in- and out-degree show how differently South Africa functioned under subsequent leaders. Under De Klerk, South Africa achieved its lowest position in terms of in-degree (59th in the ATN), while simultaneously climbing to its highest ranking on out-degree (17th). This underscores the numbers shown in Figure 3; South Africa's role shifted from an arms importer to exporter under De Klerk's leadership. Also note that South Africa often ranked higher on in-degree than out-degree. For instance, under the leadership of Verwoerd, South Africa was the country with the 14th highest number of suppliers in the ATN, compared with being the country with the 18th highest number of recipients. The same occurs under Malan, Strijdom and Botha, which highlights that South Africa's role in the ATN shifted dramatically under De Klerk.

South Africa's changing betweenness centrality ranking shows a very different fluctuation, with the country achieving its highest ranking under Vorster (4th), and lowest under Botha (54th). South Africa's ranking on betweenness centrality is therefore related to its high betweenness centrality score in this period, as shown in Figure 3, and shows how South Africa became a major role player under Vorster's leadership before the mandatory arms embargo marginalised South Africa in the ATN. However, after De Klerk announced reforms, the country quickly recovered much of its position in the ATN and became the country with the 12th highest betweenness centrality score, which is a relatively high position given that South Africa's industry is relatively small when compared with e.g. European countries.

South Africa's changing closeness centrality ranking shows a very different picture. Apart from the small increase from being the country with the 52nd highest closeness centrality score under Vorster to having the 47th highest closeness centrality score under Botha, South Africa steadily became less central to the ATN from 1948 to 1994. This steady decline is tied to the country's trading partners. When considering which countries traded with South Africa in this period, it is clear *why* the country moved to the periphery and obtained a much lower closeness centrality score and position. The US, UK, Germany, France, Italy and Denmark are all absent from the trade partnerships under De Klerk. While Canada and Switzerland continued to trade with South Africa (both, however, only in 1993), South Africa acquired new trade partners in the United Arab Emirates, Qatar, Oman, Peru, the Ukraine (post-Communism), Uganda and Singapore – all more peripheral role players in the ATN than the US, UK and France. The loss of South Africa's closeness centrality is, therefore, the result of the loss as a trade partner of the major role players in the ATN.

The core issue is, however, what the above centrality scores and centrality rankings mean. As already argued, South Africa was an above-average involved role player in the ATN during the rule of the NP, as shown by the fact that the country's degree is consistently higher than the average degree for the ATN, which means that South Africa always traded with a larger number of countries than the average country in the ATN. In addition, in- and out-degree scores and rankings show that South Africa's role in the ATN was mostly as an importer throughout this period, but, under De Klerk, this role dramatically changed to that of an exporter – a trend continued by the ANC government and discussed in Senekal, Stemmet and Stemmet (2015). Betweenness centrality scores and rankings show that South Africa played an important structural role in the ATN under, specifically, the leadership of Vorster, and this measure also highlights the tangible effect the mandatory arms embargo had on South Africa's position in the ATN, since the country's ranking on betweenness centrality drops dramatically under Botha. Figure 1 showed a more traditional and local measure of the effect the arms embargo had on South Africa's arms trade relations by providing total arms import figures, but betweenness centrality shows that in terms of South Africa's position in the network, the arms embargo resulted in South Africa becoming a less important role player. Lastly, South Africa's closeness centrality ranking showed that even though the country occupied an important position in the ATN, the country became a more peripheral role player in this industry as its ties with the key players – notably the US, UK and France – were severed and, although South Africa became a major exporter under De Klerk, the country did not have trade relations with the key players under his leadership. South Africa's importance in the ATN, therefore, has much to do with the country trading with peripheral countries, what Botha (2003:12) refers to as second-tier countries.

5.   CONCLUSION

This article investigated South Africa's changing position in the global arms trade network. It was shown that the country was a key player during the apartheid years, and that it traded with the most important other countries at the time – notably the US, UK, France, West Germany and Italy. However, the country's role changed during different periods, and it was shown how betweenness centrality in particular highlights the effect the arms embargo had on South Africa's position in this network. In addition, in- and out-degree highlighted the dramatic shift in South Africa's role in the ATN under De Klerk, where the country moved from being predominantly an importer to an exporter.

There are numerous further applications of network theory to study the ATN. Åkerman and Larsson-Seim (2014) show that the density of arms trade

relations between Communist countries was much less than between Western countries, which reflects the amount of control the Soviet Union exercised over its allies. Another aspect that could be studied is modularity (Q), which highlights the formation of communities in networks (see e.g. Blondel *et al*. 2008). Using modularity, one could study which countries are grouped with the West or the Soviet Bloc in the ATN, and how arms trade relations reflect diplomatic ties between countries, and especially where South Africa fits in in terms of communities in the ATN during the Cold War.

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