ASSESSING ARMS PRODUCTION IN THE THIRD TIER
THIRTY YEARS ON

Master of Arts in Law and Diplomacy Capstone Project

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Abstract

This paper examines data on the defense economies of 12 ‘Third-Tier’ states—countries with limited arms production capabilities—to assess how they adapted to a changing international environment over the past 30 years. Drawing on publicly available data, it proposes multiple indirect indicators of the scale of military arms production in the sample states, including an original application of econometric time series analysis to proxy incorporation of foreign-source subcomponents in military production using exchange rate exposures. The paper demonstrates that states either exited the international arms market, adapted by embracing specialization, or transcended the Third Tier through commitment to long-term investment.

“It is a condition of security that each nation manufacture its own armaments.”
- Brazilian Air Force Minister Joelmir Campos de Araripe Macedo, 1977

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Introduction

The Rise of the Rest…
Beginning in the mid-1970s, a readjustment in the global distribution of military production capabilities began to be noticed, first by peace advocates, then by defense analysts, and finally by Western policy makers. In 1975, four members of the Federation of German Scientists, writing in the *Journal of Peace Research*, decried the “strikingly accelerated proliferation” of the arms industry, no longer restricted to either “a very few countries or to the manufacturing of small arms only”.

By 1981, authors at RAND Corp., that bastion of establishment policy innovation, were studying this phenomenon as well; writing in October, one analyst noted that more and more countries—developing nations—were now capable of producing armored vehicles, guided missiles, and jet fighters, but this development had “gone largely unnoticed in the literature”.

Another team was framing the transformed arms industry in market terms, weighing the determinants of supply and demand in the Third World. By the mid-1980s, the issue had found an audience in policy and academic journals. In 1983, Michael T. Klare made a case for concern in *International Security*:

“Unfortunately, the proliferation of conventional arms-making technology has not been viewed with the same degree of concern [as the proliferation of nuclear weapons and technology], and consequently little effort has been made to curb exports of this type. Such neglect is potentially very dangerous, however, because conventional arms proliferation poses many of the same perils as nuclear proliferation: a substantial increase in the world’s collective war-making capabilities, and a corresponding decline in the world’s ability to negotiate curbs on the use of these capabilities. Indeed, while the export of conventional arms

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technology may not present as direct a threat of Armageddon as nuclear exports, it is adding to the intensity of regional conflicts, and thus helping to create an environment in which nuclear war is more likely to occur. For this reason alone, conventional arms proliferation should be viewed with the same concern as nuclear proliferation."

In 1984, Stephanie G. Neuman described in *International Organization* a constant escalation in quality and quantity of military materials produced in the Third World. In 1986, researchers at the Stockholm International Peace Research Institute (SIPRI) lamented that “the increasing number of arms producers in the world has made attempts to control the proliferation of conventional weapons and weapon technology even more difficult” than before.

The industrial phenomenon which prompted this gradual crescendo of analysis is startling when cast in figures. The number of developing countries that produced military items increased from four at the end of World War II to 50 by 1982. The value of the military items they could produce had increased as well, from USD 2 million in 1945 to USD 1.1 billion in 1981. Estimates of the total value of military production in the Third World in the mid-1980s ran between USD 6 billion and USD 23 billion, depending on estimation methodology. The following table indicates the number of states capable of producing several important categories of major conventional weapons systems in the period of rising concern:

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Table 1: Number of Third World States Producing Certain Categories of Weapons Systems

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</thead>
<tbody>
<tr>
<td>Fighters</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Helicopters</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Missiles</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Battle Tanks</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>[Not counted]</td>
</tr>
<tr>
<td>Major Naval Craft</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

As the developing world began producing more, it also began exporting more. In the 1970s, the major industrialized arms producers had held about 90% of the export market in military goods; by the period 1981-1985, this share had dropped to 75%. According to the U.S. government’s Arms Control and Disarmament Agency (ACDA), Third World exports increased from USD 600 million in 1973 to USD 4.05 billion in 1983 – a 543% increase.

Worst of all, the “dynamic expansion” of military production capabilities seemed likely to continue. Beyond the “probably durable” rise of a newly established group of producers, including Argentina, Brazil, Israel, India, the two Koreas, Taiwan, and South Africa, more countries were poised to join their ranks in the 1990s: Chile, Indonesia, Pakistan, Turkey, and Saudi Arabia. With the continued proliferation of conventional weapons production technology, it appeared in the 1980s that the world market in arms would become ever more complex and difficult to control.

Naturally, the U.S. response to this growth in Third World production capabilities was guided by Cold War concerns. An influential 1977 Department of Defense task force report on military technology export controls framed the threat of “increasing acquisition of strategic technology by

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non-allied nations” as new routes for undesirable technology transfer to the Soviet bloc. 16 But when the Soviet factor was not present or could be mitigated, both industry and government saw technology transfer as an effective means of providing economic and military assistance to friendly developing countries. 17 While noting that the transfer of production technology, might cause or influence the “outbreak or escalation of conflict, or the intensity of violence in such a conflict”, the Congressional Research Service reported in 1977 that the departments of State and Defense had conflicting policies on the overseas production of U.S. designed goods – a common conduit for the transfer of production capabilities. While the State Department claimed that it was “USG policy not to encourage production overseas of defense articles of United States origin”, the Pentagon disagreed, stating: “it is DOD policy that initiation of coproduction project agreements will be encouraged and supported”. 18 Successive administrations were similarly conflicted; while President Jimmy Carter adopted an arms restraint directive in May 1977 banning new coproduction agreements for major weapons systems with most non-allied countries, this policy was revoked in July 1981 by his successor, Ronald Reagan. 19

… Delayed?

“New defense exporters are joining the global game with advanced and well-priced offerings, creating potential threats to the U.S. and its allies, and weakening Western influence… the flood of choices in the global marketplace will make it harder to withhold advanced weapons from specific regimes, reducing Western leverage throughout the world.”


The wave of warnings about the proliferation of conventional weapons has never crested. The above quote, from an April 2015 opinion piece in the *Wall Street Journal*, betrays why: worst expectations have remained unfulfilled.\(^{20}\) Forty years after the first alarms, industry observers are still sighting a trend that has continually failed to emerge. In fact, the spike in military production observed in the developing world during the 1970s and 1980s was followed by a sharp contraction during the 1990s as the industry shrank. Signs of this coming downturn were visible as early as 1992, when Keith Krause noted that Third World countries were hitting a ceiling in the sophistication of their indigenous capabilities. The “ladder of production” up which national military industries were predicted to climb—from repair, to assembly, to co-production and licensed production, to integration of foreign components, and ultimately to independent development of modern weapons systems—was not as steady as ambitious national planners had foreseen.\(^{21}\) Even the most promising producers, such as Brazil and Israel, had plateaued and failed to build on their prior successes. Looking back on the last decades, Richard Bitzinger concluded in 2010 that “the bulk of the world’s arms-producing infrastructure remains remarkably unaltered.”\(^{22}\)

The purpose of this paper is two-fold: first, to establish the decline of the arms-producing industry in developing countries, using publicly available data on the defense economies of 12 cases, and second, to identify and assess the factors which led to the failure of military industrialization in those countries. The paper is organized into seven sections, which will:

I. Define the scope of ‘third-tier’ military industrialization and describe its nature before the end of the Cold War;

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\(^{21}\) Krause, *Arms and the State*, p. 172. Specifically, Krause points to the Brazilian AMX program and Israel’s Lavi as high-points of indigenous design past which the two countries were never able to advance.

II. Explore the consequences of the spread of military production capabilities, examining both economic and security policy implications;

III. Explain why states pursue indigenous military industries;

IV. Test the hypothesis that military industrialization in the developing world has stalled by examining data on arms production and the global arms trade;

V. Assess several factors which might explain the course of development of military industries in the developing world;

VI. In conclusion, predict whether those factors will continue to impede the spread of conventional weapons production capabilities.

This study finds that the military industries of the third tier countries have diverged in their fortunes; the development of some states’ industry has stalled and their exports have stopped, while other states’ production capabilities have matured and expanded. In Section V, I find that the lone multilateral export control regime affecting conventional weapons, the Wassenaar Arrangement, had little effect on the development of the third tier industries, while general changes in the arms market created an environment hostile to new entrants. Further, I find that states pursued different strategies in adapting to this market: exit, additional investment, or specialization.

The significance of conventional weapons production has been, as indicated previously by Klare, been relatively neglected in the arms control literature in comparison with the high-stakes topic of nuclear war and the high-likelihood subject of internal conflicts fueled by small arms. Without preemptsing the fuller discussion below on the consequences of conventional weapons proliferation, the importance of arms production is summarized well by David Kinsella: “we need look no farther than to realist theory for the immediate forces driving third world arms production”.23 Countries holding the means of producing modern weapons systems do not view arms transfers as just another sector of international trade, and correspondingly they cannot view the establishment of arms production capabilities in other states as just another economic

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development. Even more than arms transfers, which are a “direct transfer of the capability to carry out political violence and represent the ability to change the balance of power”, the proliferation of arms production techniques is always an inherently political act with the potential to modify the material structure of the international system.


I. Definitions and a Snapshot of the Third Tier Arms Industry

Locating the Third Tier

Up to this point, this analysis has used the adjectives “developing” and “Third World” interchangeably to describe its primary subjects. Neither term is satisfactory for a reason central to the outcome of the analysis: which countries are under investigation strongly determines the factors that influence their military industries. Rather than relying on these vague terms, I separate arms-producing states into three tiers following the typology established by Krause in his 1992 examination of the global arms trade.26 Other authors have proposed similar ‘tierings’.27

Krause defines the first tier of arms-producing countries as those capable of manufacturing all categories of major weapons systems using advanced, leading-edge designs based on indigenous research. Within this tier reside solely the United States and Russia. The second tier is composed of states which can indigenously manufacture and design all, or most, categories of major weapons systems, but seldom produce designs that grant a qualitative military advantage. The members of this tier have traditionally included the Western European states and the regional powers of East Asia—China and Japan. Since 1992, the capabilities of the Western European states may have degraded and it is questionable whether the production capabilities of those states still extend across all categories of weapons systems. The consolidation of the continent’s aircraft manufacturers into the transnational Airbus conglomerate and the impending merger of tank manufacturers Krauss-Maffei Wegmann and Nexter (German and French firms, respectively) are illustrative of the dominant trend.28 Nonetheless, as a loose political grouping Western Europe has maintained a productive capability that can be easily qualitatively differentiated from that of third-tier states.

26 Krause, Arms and the State, p. 154.
The third tier is composed of states which fail to meet second-tier standards; they cannot manufacture many weapons systems indigenously and rely on foreign designs and licenses. The earliest third-tier producers were Argentina, Egypt, India, China, and North Korea. The first had a pre-war military industrial base, while Egypt, India, and China obtained help from German specialists in the immediate post-war period. These states were joined by Israel, South Africa, and Brazil between the late 1950s and the early 1970s, as well as South Korea, Singapore, and Taiwan later. Australia and Sweden are sometimes included within this tier as well, the first having a strong shipbuilding tradition and the second maintaining an international presence in the market for combat aircraft—in addition to being home to the arms manufacturer that shared its name with the Nobel Peace Prize. The key differentiator between Australia and Sweden, on the one hand, and the second tier, on the other, is the former pair’s lack of historical great power pretentions; in other words, there is a clear mismatch between specific aspirations for their military industries and more general national aspirations.

China is a singular case. It moved from licensed production of Soviet systems to illicit reverse engineering after the Sino-Soviet split in the 1960s, attaining high degrees of self-sufficiency. While it continues, to this day, to rely on Russia for aircraft engines, its military industry developed in relative isolation and enjoys significant autarky. Most analyses of the developing world’s arms industries do not include China in the third tier, although Krause does. As a Russian industry analyst has pointed out, the arms industry of contemporary China enjoys the

soft-power benefits of an enormous financial backer when approaching export clients.\textsuperscript{32} Compared to other third tier states, it is also differentiated by an acknowledged role in international security through its seat on the UN Security Council, as well as the benefits of scale in its internal defense market. For these reasons, this analysis will not include China within its definition of the third tier.

Japan is another important borderline case in the international hierarchy, but compared with China the reasons for excluding it from the third tier are much clearer. Its high level of industrialization prior to World War II separates it from the developing countries of East Asia, and its uniquely pacifist constitution and lingering post-war aversion to the use of force have produced an inward-looking defense industry that, until very recently, could not access the export market.\textsuperscript{33} However, many of the challenges that confronted the Japanese defense industry are shared by third tier countries, and many of the solutions adopted have been similar. Indeed, Japan’s aerospace industry has had enormous success in supplanting first-tier subcontractors; three Japanese manufacturing conglomerates—Mitsubishi, Kawasaki, and Fuji—account for 35\% of the parts used in the Boeing 787 airliner.\textsuperscript{34}

A third borderline case is presented by the Eastern European countries formerly of the Warsaw Treaty Organization (WTO). During the first wave of alarm over the rise of the third tier in the 1980s, the policy implications for the West of military production trends in the WTO were quite different from the implications of militarization in the Third World and it therefore made little sense to group the two together. By the early 2000s only Poland and Romania had large arms-producing firms left, and increasingly these have been oriented toward integration with NATO. Across Eastern Europe production has fallen sharply since the heydays of the mid-1980s: by


90% in Czechoslovakia and Hungary, 79-90% in Bulgaria and Romania, and by 50% in Poland. This radical push toward demilitarization was fueled by a general rejection of Soviet-era militaries on account of their close association with the Communist regimes of the region.\textsuperscript{35} Because of the specificity of the circumstances which led to the decline of the Eastern European industries it would not be useful to include them within the scope of this analysis.

**Dominant Modes of Production in the Third Tier at the End of the Cold War**

A successful arms industry requires two material ingredients: finance and technology. To be financially sustainable, the state or private firms must be willing to bear the costs of importing or financing indigenous manufacturing of production tools and machinery, while accepting the monetary risks associated with uncertain development programs. To be technologically sustainable, an arms industry requires access to production technologies, a base of continuing basic research, and experience with integrating sub-systems and innovative design—all of which call for scientists, engineers, and patents. When a country lacks the ability to sustain the financial burden but has a strong technological base, as typified within the second tier, it can turn to co-development projects. The third tier has the opposite problem: a strong will to allocate state and private funds toward the development of an arms industry, but little access to technology. Under these conditions, it can turn to co-production and licensing.\textsuperscript{36}

Among the third tier, the category of arms that is most widely produced indigenously is small arms and ammunition.\textsuperscript{37} The technology on which these are based is mature and relatively unchanging; most developing states can produce explosives, castings, and bullets, and have only been constrained by the industrial challenges posed by the manufacture of firearms barrels.\textsuperscript{38}

\textsuperscript{38} Brzoska and Ohlson, ‘Arms Production in the Third World: an Overview’, p. 18.
Beyond these systems, co-production and licensing have been critical to the establishment of third tier production capabilities. The two modes of production are distinct—co-production refers to cooperative manufacturing based on an agreed distribution of work, while licensing involves the purchase of design-use rights followed by independent manufacturing. In practice, licensed production—particularly of complex weapons systems—can be as heavily reliant on foreign assistance as co-production, as third tier countries imported many of the subcomponents that were integrated into licensed designs. In 1979, U.S. defense companies had signed 58 co-production agreements with foreign partners, including 20 with firms in developing countries, with a total value of USD 8.5 billion. Licensing was more prevalent; by 1988, U.S. firms had signed 140 licensing agreements with foreign partners, of which 40 were developing countries. Agreements with the third tier tended to compose a higher proportion of European licensing agreements: by 1988 France had signed 51 agreements of which 38 were with developing countries, while the corresponding figures for West Germany and the United Kingdom were 36 and 23, and 30 and 18, respectively. In 1985, of aircraft and naval warships produced in developing countries, half were manufactured under license, while production of helicopters and submarines was entirely based on licensed designs. Leading licensees included India (20 systems produced under license), South Korea (15), Taiwan (13), Indonesia (12), Brazil (11), North Korea (10), Turkey (9), Argentina (8), and Egypt (8). South Africa was an early adopter of licensed production, signing 127 licensed production agreements in 1961 alone in anticipation of the voluntary embargoes requested by the UN Security Council in 1963 and 1964.

39 Past licensed production is a statistically significant predictor of the size of a third-tier country’s current arms production, according to Kinsella, ‘Arms Production in the Third Tier’, p. 275.
One downside of licensed production was the age of the designs first- and second-tier states were willing to offer the developing world; in 1980, licensed designs were on average 22 years old.\textsuperscript{44} Along with other reasons discussed in the next section, this spurred third-tier countries to move toward production of indigenous designs. This often required more intimate and long-lasting relationships with foreign sponsors to facilitate assistance with designs and the licensing and importation of subcomponents. While co-production and co-development agreements among first and second tier states can be fraught with competitive tensions, cooperation is more likely to be stable when the technological gap between partners is wide. When firms are afraid that cooperation with a foreign peer may result in transfer of proprietary capabilities, doing long-term damage to competitiveness, they have an incentive to torpedo cooperation or demand harsh side-payments.\textsuperscript{45} The vast technological inferiority of third-tier firms mitigates this concern, but also promotes a high-level of dependency. As a result, almost all major weapons systems integrated in a third-tier country rely on foreign components, and most third-tier designs are beneficiaries of outside assistance.

For example, three prominent third-tier main battle tanks developed indigenously before 1985 were the Argentine TAM, the Israeli Merkava, and the Indian Vijayanta. All three incorporated engines imported from or designed by companies abroad: Germany’s Motoren- und Turbinen-Union (MTU), the United States’ Teledyne-Continental, and Britain’s Leyland. Similarly, each tank sat on a transmission and steering system imported from abroad, and fired a main gun designed abroad and produced under license.\textsuperscript{46} The Osorio, a Brazilian tank design developed later in the decade, also used a British suspension system and a German engine and transmission, while the South Korean K-1 incorporated similar key subcomponents from the United States.\textsuperscript{47}

\textsuperscript{44} Neuman, ‘International Stratification and Third World Military Industries’, p. 179.
\textsuperscript{46} Wulf, ‘Arms Production in the Third World’, pp. 338.
A similar pattern prevailed for aircraft. Brazil’s AMX light ground attack plane was developed with the help of Italian firms Aeritalia and Aermacchi, and 70% of its components were imported. A canceled Israeli combat aircraft program, the Lavi, was developed with U.S. assistance and would have incorporated a license-produced Pratt & Whitney engine, and may have subsequently been the basis for a Chinese design, the J-10. The French Mirage III fighter jet was a popular base for third-tier knock-offs: South Africa produced an improved version as the ‘Cheetah’, and Israel did the same as the ‘Kfir’. Saab, the long-time Swedish designer and manufacturer of advanced combat aircraft, doubled the amount of foreign-produced components in its newest design, the Gripen (first flown in 1988), compared with its last offering, the Viggen (first flown in 1967).

The same applied for armoured vehicles, such as Brazil’s Cascavel and South Africa’s Ratel, and helicopters such as the South African Rooivalk. In fact, during the 1980s, third-tier weapons systems with an import content lower than 30% were an “exception rather than the rule”. 80% of aircraft, missile, and naval weapons systems incorporated two or more foreign subsystems, and of more than 300 indigenous systems identified by Krause in 1992, fewer than 10% were produced truly independent of foreign assistance. Several states, notably North Korea and Singapore, became particularly successful at upgrading foreign designs (a process known as

54 Half of that 10% was multiple-rocket launcher systems or towed artillery firing unguided rockets. Krause, Arms and the State, p. 176.
‘add-up’) with domestically produced but more advanced or modern subcomponents. Alternatively, imported designs can be optimized for local conditions; for example, Israeli Aircraft Industries modified its early license-produced jets by removing long-range radar, fuel tanks, and heaters—all superfluous when defending a small, hot territory—and replacing them with additional electronics and weapons.

Co-production and licensing are often accompanied by offset agreements, which are also commonly signed in tandem with direct arms sales or military services deals. An offset is a commitment by the seller of a product to invest money in industries selected by the purchaser. A simple defense offset attached to an off-the-shelf purchase of a weapons system would commit the selling firm to invest in the buying country’s economy—either in the buyer’s military industry or in another sector. Originally, offsets were intended to be an alternative to co-production or licensing, when the establishment of a second production line in the buying company would be too expensive but the buyer still wished to reduce the costs of an off-the-shelf purchase while creating jobs at home. However, more complex modern offset arrangements might obligate the selling firm to not only invest locally, but invest specifically to create an assembly line for the production of subcomponents to be incorporated in the underlying arms sale. As an offset obligation becomes more integrated into the original arms sale, a simple transfer of goods might become sophisticated enough to be almost indistinguishable from a co-production or licensing agreement. The scale of the offset investment can be large; obligations

56 Steinberg, ‘Israel’, p. 281.
greater than 100% of the dollar value of the underlying arms sale are common, and higher percentages are the norm among states in Western Europe.\textsuperscript{60} For instance, the Norwegian government demanded a 180% offset obligation from Saab when the firm offered 48 of its Gripen combat aircraft.\textsuperscript{61}

Offset policy originated in the 1960s in industrialized countries, but offsets themselves are “as old as industrial collaboration in arms production.”\textsuperscript{62} By the 1980s, more than 60 countries had countertrade or offset policies in place, and by 1992 that total had increased to 132.\textsuperscript{63} Their growing popularity stemmed from the belief that offsets were effective as a means of obligating technology transfer from a partner-supplier to the indigenous industry. In fact, third-tier countries often chose suppliers based on their willingness to transfer production capabilities; in 1990, Malaysia chose to buy the Bae Hawk trainer plane rather than the Panavia Tornado, a much more capable combat aircraft, because of BAe’s willingness to set up local manufacturing.\textsuperscript{64} India’s offset policy is representative: it requires vendors to satisfy an offset obligation by producing subcomponents locally, directly investing in the Indian defense industry, or through co-production arrangements with Indian suppliers. In response to offset requirements, first-tier suppliers have been forced to outsource component assembly across the globe. Two of the United States’ most modern combat aircraft designs are reliant on foreign industry for major subsystems: South Korean firms produce the forward fuselage and wings of F-15s, while Turkey manufactures the air intake ducts for the F-35.\textsuperscript{65}


\textsuperscript{62} Willett and Anthony, ‘Countertrade and Offsets Policies and Practices in the Arms Trade’.

\textsuperscript{63} Martin, ‘Countertrade and Offsets’, p. 16.


\textsuperscript{65} John Birkler, Gordon T. Lee, Soumen Saha, Paul Bracken, Mark A. Lorell, and Shane Tierney, \textit{Keeping a competitive U.S. military aircraft industry aloft: findings from an analysis of the
Close ties between third-tier states and partners in the developed world were conduits for the spread of military production capabilities, but these ties also sustained a dependency that has been difficult to outgrow. How the primary modes of production in the third tier—co-production, licensing, integration of foreign components in indigenous designs, and offset-led technology transfer—slowed down the maturation of indigenous military industries will become apparent in light of the economic difficulties detailed later in this analysis.

II. Negative Consequences of Arms Production Proliferation: Economics and Security

Economic Choices and the Defense Burden

Historically, developing states have included the defense sector within programs of general industrialization, and the importance of state involvement in seeding the arms industry may be increasing over time.\(^{66}\) The prominence of the state in third tier military industrialization underlines the importance of weighing the costs and benefits of the initial policy decision to invest in the defense industry. Given the limited capital, financial and human, available to developing states, this decision can be a much more stark “guns versus butter” choice than in the developed world.

The most simplistic hypothesis of the effect of industrial militarization on the economy of a third tier country is that it may displace investment in the civilian sector by draining national savings.\(^{67}\) National economic statistics indicate that this happened in two Latin American countries, Chile and Argentina, during the 1970s.\(^{68}\) Military expenditure more broadly can also lead to high government indebtedness, as was the case throughout Sub-Saharan Africa and the Middle East during the 1980s.\(^{69}\) The opportunity costs in terms of manpower and debt are often poorly appreciated before an initial investment is made.\(^{70}\) As a result of these purported effects, aid donors began applying caps on military expenditure as a condition on loans in the 1980s as a

\(^{66}\) Ross, ‘Developing Countries’, p. 104-105.


Nonetheless, under the correct circumstances—some examples of which will be discussed below—investment in the defense sector can generate employment, stimulate important industries, and provide capital for technological innovation. Indeed, a series of studies conducted by the economist Emile Benoit in the 1970s suggested that military spending might boost future GDP growth in less developed countries.\footnote{Emile Benoit, \textit{Defense and Economic Growth in Developing Countries} (Boston: D.C. Heath, 1973), pp. 1-24; Emile Benoit, ‘Growth and Defense in Developing Countries’, \textit{Economic Development and Cultural Change}, Vol. 26, No. 2 (Jan. 1978), pp. 271-287.} These studies were influential among developing nations and taken as proof of the importance of military industrialization as a critical engine in the drive toward economic modernity.\footnote{Carol Evans, ‘Reappraising Third-World Arms Production’, \textit{Survival}, Vol. 28, No. 2, (Mar. 1986), pp. 100-101.} Benoit argued that military expenditure increased growth because it mobilized previously unused resources within a developing economy, but his statistical model failed to control for a number of important macroeconomic variables that also influenced GDP growth.\footnote{Deger and Smith, ‘Military Expenditure and Growth in Less Developed Countries’, p. 336; also see Oyinlola Olaniyi, ‘Military Spending and Economic Development in Sub-Saharan Africa: A Supply-Side Analysis’, in Jurgen Brauer and J. Paul Dunne, Eds., \textit{Arming the South: The Economics of Military Expenditure, Arms Production and Arms Trade in Developing Countries} (Houndmills: Palgrave, 2002), pp. 277-278.} A 2005 survey of the empirical economic literature on the relationship between military expenditure and growth rates suggests that there is no clear statistical evidence
that the former has any effect on the latter. Unfortunately, new evidence can do little to unwind the policy damage inflicted by Benoit’s conclusions of four decades earlier.

Government investment in defense industries may not even be the most effective means of creating employment—a secondary, informal goal of defense spending that is often played down. Third tier military firms sometimes employ enormous numbers of people. Israel is the most outstanding case: Israeli Aircraft Industries once wrote the most paychecks in the country, and in the 1980s about 20% of the workforce was employed by a major defense firm. During the same decade, 9% of the South African workforce was employed by defense firms, as were 10% of Swedish engineers, machinists, and metalworkers. In 1991, India’s Ordnance Factories, a state-owned supplier of less complex weapons systems and small arms, employed around 170,000 workers. Contrary to the view taken by the Cold War-era Swedish government that employment in the defense industry is an efficient tool for achieving total employment, more recent evidence from the United States suggests that government investment in civilian sectors can be a more productive catalyst for employment than equivalent amounts of expenditure on supporting defense jobs. In developing countries specifically, the capital-intensive nature of the defense industry can hurt broader development goals by siphoning scarce capital into a sector of comparative disadvantage.

76 Steinberg, ‘Israel’, pp. 284, 290.
81 Krause, *Arms and the State*, p. 166.
The defense industry is also a particularly poor choice for government investment because of strong evidence that it is disproportionately susceptible to corruption. Features that render the defense sector vulnerable include: the necessity of strong cooperation between state and firm, creating many opportunities for collusion; ubiquity of customized products, for which costs are difficult to evaluate and control; state promotion of economic activity at inefficiently high levels; and the sheer scale of defense procurement programs.82 Most importantly, military industries are steeped in secrecy, which makes external accountability difficult to maintain. As a result, one estimate of the scale of corruption within global defense industries attributes 40% of all global corruption to the sector.83 The creation of rents—opportunities for actors to leverage privileged access to state resources for private gain—within the defense sector can drag down economic efficiency.84 Only in exceptional cases of development-focused authoritarianism have states been able to turn rent-seeking to productive ends; one example of such a case is the government of South Korean dictator Park Chun Hee, who enforced “performance criteria” for the management of state-distributed rents to private firms and individuals.85

Effects on Regional Security
The security effects of conventional weapons proliferation are no longer a pressing concern in the security studies literature (except with relation to small arms proliferation and the incidence of sub-national instability), but this section endeavors to restate the case that the spread of

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83 Joe Roeber, ‘Hard-wired for corruption: the arms trade and corruption’, *Prospect*, No. 113, Aug. 28, 2005. Roeber attributes this estimate to an official at the CIA, who told Roeber in 1997 that the 40-45% range was the intelligence agency’s best estimate of the scale of graft in the industry.
military production capabilities can be a serious threat to regional peace.\textsuperscript{86} The effects of weapons proliferation cannot be discussed without reference to that well-worn term of art, the ‘arms race’. During the Cold War, the effects of arms racing on the nuclear weapons stockpiles was the most observable example of this trend, each quantitative and qualitative improvement in the U.S. and Soviet arsenals stimulating a response.\textsuperscript{87} Earlier, the naval arms race between Imperial Germany and the United Kingdom preceding 1914 was identified as a cause of the bipolarization that transformed a local conflict into World War I; later, historians also pointed to the importance of the arms race on land between Russia—re-equipping after the 1905 defeat to Japan—and its neighbours.\textsuperscript{88} The interwar period spawned the earliest studies of this phenomenon precisely against the background of the public demonization of the arms trade and arms industry as promoters of war—indeed, a civilizational threat—leading to limited renationalization and experiments with export controls.\textsuperscript{89}

In 1919, Lewis Fry Richardson proposed a pair of equations to model an arms race between two countries, wherein the change in each state’s arms purchases is determined by its reaction to the other state’s purchases, fatigue from past expenditure, and constant historical grievances between the two states.\textsuperscript{90} After a revival of interest in formal modelling in the 1950s after a re-statement of Richardson’s work by Anatol Rapoport in 1957, the two joint equations spawned a large


\textsuperscript{89} Cooper, ‘Humanitarian Arms Control and Processes of Securitization’, p. 147.

family of theoretical and empirical studies that sought to find evidence of arms races in bilateral or more complex systems of states. The results of that search were disappointing: in 1980, a review article concluded that “[t]he existence and extent of arms races are now widely treated as empirical questions rather than items of faith.”91 The authors noted that past work had concluded domestic political and bureaucratic impulses were as important in determining future military spending as action-reaction dynamics between states.92 A 1984 attempt at modelling the U.S.-Soviet arms race in conventional forces summed up the frustration of the econometricians: “With the conventional wisdom [of the existence of an arms race] so firmly entrenched, why are the results often so contradictory and so frequently at odds with the arms-race argument?”93 Two serious challenges are: separating out the effect on a state’s arms acquisitions of general hostility between opponents from the specific effect of arming oneself—in other words, establishing that arms races have a causal force independent of simple rivalry; and specifying which measure of arms acquisitions—for example, changes in total military expenditure, or weapons counts, or force structure, or some other variable—should be taken into account in the model.94 More recent studies have had more success showing that arms race models accurately describe Indo-Pakistani and Greece-Turkey relations, but the relevant literature has thinned to a point where no convincing argument has yet to be made that these successful models are sufficiently grounded in political theory and defensible against alternative specifications.95

Stepping back from the statistical evidence and examining several cases of arms supply before and during conflict, it is possible to identify several ways the proliferation of arms producing states could damage regional security. First, the acquisition of new armaments can have a strong

effect on a state’s decision to pursue antagonistic policies that risk conflict. Prior to the series of
clashes that culminated in the 1965 war between Pakistan and India, both sides had been armed
by the United States and the United Kingdom. India was bolstered to defend itself against China,
at whose hands it had suffered a sharp defeat in 1962. Pakistan was armed to prop up the
government and maintain a balance of forces with India. As one observer noted, the United
States enabled the spectacle, during the 1965 war, of “Pakistanis in American Patton tanks
fighting Indians in Sherman tanks.”96 The net effect of arms sales to both sides was not a stable
equilibrium of forces; rather, it was an increasingly fraught relationship between the neighbors as
supporters of a harsh line were emboldened by the modernization of their militaries.97 In the next
two decades, further cases of policymakers emboldened by a recent arms build-up included:
Yahya Khan, the Pakistani dictator, avoiding compromise in the East Pakistan crisis of 1971 as
he awaited further deliveries of Chinese weapons systems; the Argentine invasion of the
Falklands in 1982; the Israeli occupation of southern Lebanon in 1982; and the Libyan
intervention in Chad in 1983.98

Second, the availability of alternative arms suppliers can prolong a war. While the embargo
organized by the United States and the United Kingdom convinced Pakistan to agree to a
ceasefire in 1965, the supply disruption only became decisive when Pakistan was unable to
acquire more war materiel from the states it approached: Turkey, Iran, China, and Indonesia.99
Two decades later, the rise in third tier arms producers was a key factor in the length of the Iran-
Iraq war, which drew in weapons from Argentina, Brazil, China, Egypt, Israel, and both North
and South Korea. The scale was unprecedented: Brazil and Egypt sold armored vehicles and
artillery to the belligerents in the hundreds. The “outstanding lesson” of that conflict was fighting
can be sustained even in the face of a major supplier embargo.100 Arms embargoes create an
economic incentive to break them, and the more effective the embargo the greater the financial

96 Quoted in Michael Brzoska and Frederic S. Pearson, Arms and Warfare: Escalation, De-
97 See Brzoska and Pearson, Arms and Warfare, pp. 26-36.
98 Brzoska and Pearson, Arms and Warfare, p. 51; Klare, ‘The Arms Trade: Changing Patterns in
the 1980s’, p. 1279.
99 Brzoska and Pearson, Arms and Warfare, pp. 35-36.
100 Klare, ‘The Arms Trade: Changing Patterns in the 1980s’, pp. 1264, 1279; for a table of items
and political incentive to break ranks.\textsuperscript{101} As a result, they are difficult to maintain; to operate effectively they must be enforced by a great power and with the proliferation of potential exporters the role of enforcer would likely become more difficult to perform.\textsuperscript{102} Beyond the United States, only China has evinced the political and economic clout to enforce an embargo—on Taiwan—and even that has proven leaky.\textsuperscript{103}

Third, the accumulation of conventional weapons systems can be an important enabler for the militarization of domestic political struggles. The increase in the number of countries capable of providing counterinsurgency equipment to compromise-leery governments threatens to promote violent solutions; significant arms build-ups were precursors to military crack-downs in Chechnya, Colombia, Sudan, and Sri Lanka.\textsuperscript{104} The last case is instructive: when Pakistan delivered a shipment of 150,000 of mortar shells and an equal number of hand grenades to the Sri Lankan army in early 2008, the Indian government felt obliged to somehow match that contribution in order to maintain political influence over Colombo.\textsuperscript{105} By allowing importing states to play military patrons off of one another, the proliferation of conventional weapons prevents suppliers from urging restraint and negotiation.

\textsuperscript{103} See Chih-cheng Lo, ‘Taiwan’, in Ravinder Pal Singh, Ed., \textit{Arms Procurement Decision Making, Volume II: Chile, Greece, Malaysia, Poland, South Africa and Taiwan} (Oxford: Oxford University Press, 2000), p. 188.
Implications for Great Power Relations under the New Multilateralism

The spread of conventional weapons production technologies might also have implications for great power relations. As the transfer of arms is implicitly a transfer of power, the dispersal of the ability to effect changes in the balance of power will make international relations more complex. First, great powers may be able to use the productive capabilities of the third tier powers to obtain technologies that they cannot obtain from their rivals. From the perspective of the United States, this fear was best represented in the attempts by Israel to sell military technology to China. In congressional testimony unclassified in October 1993, CIA director James Woolsey accused Israel of supplying China throughout the last decade with advanced military technology that the U.S. and its Western European allies had refused to transfer.\(^{106}\) Washington accused Israel of transferring designs for a wide range of tactical missile systems, the cancelled Lavi fighter project, and the Patriot anti-ballistic missile system.\(^{107}\) While not all of these accusations could be proven given their sourcing from U.S. intelligence, the United States continued to act on similar claims, later threatening to exclude Israel from the Joint Strike Fighter program if it transferred unmanned aerial vehicle technology to China.\(^{108}\) U.S. difficulties in managing the Israeli-Chinese proliferation channel are mirrored by the difficulties China may face in maintaining an implicit embargo of Taiwan.\(^{109}\)

Second, great powers may be less able to use access to military technology in competitions to influence smaller countries of strategic significance. During both the Nixon and Carter administrations, the United States approached export controls and transfers of technology as a bargaining chip in bilateral relationships. Henry Kissinger, national security advisor and later secretary of state, warned that “expanding trade without a political quid pro quo was a gift”. Samuel Huntington, who served on Carter’s National Security Council, argued for a U.S. policy that could “open and close the economic door” at short notice.\(^{110}\) With greater availability of

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\(^{107}\) Shichor, ‘Israel’s Military Transfers to China and Taiwan’, p. 82.


\(^{109}\) Lo, ‘Taiwan’, p. 188.

basic war-fighting materiel, particularly small arms, artillery, aircraft trainers, and counter-insurgency aircraft, this channel of influence will narrow. It is not only the United States which would suffer from the erosion of its ability to influence clients; Russia has also found that its influence over potential customers has weakened as its unique position in the arms market as a supplier of low-cost equipment has disappeared. For example, Russia’s relations with India were set back when it revealed that it had no contractual terms it could employ to prevent China from selling the JF-17, an indigenous combat jet design incorporating a Russian jet engine, to Pakistan in the face of Indian protests.

Third, the spread of conventional weapons production capabilities may make it harder for great powers to manage coalitions. Indigenous arms production capabilities may increase the agency of junior partners in alliance webs; an example of such a trend is currently unfolding in the East Asian region where U.S. treaty partners have discussed collaborative arms production plans that may weaken the United States’ ability to set the tone and pace of balancing behavior against China. The possibility of a sale of Japanese submarines to Australia, for example, might increase threat perceptions in Beijing even without U.S. interference in the tender decision. As expanded upon below, the extensive network of licensed production contracts between South Korean ship-building firms and countries in Southeast Asia may also have a similar effect in suggesting balancing coalitions. A great power patron tied to an increasingly active network of weaker allies cannot welcome the prospect of losing control over the character and purpose of that network while the risk of being inadvertently pulled into a great power conflict remains constant.

III. Factors Contributing to the Proliferation of Arms Production Capabilities

Taking into consideration the potential economic and security drawbacks to military industrialization, why should we have expected the number of third tier states to have increased over the last thirty years? To put it differently, why did third tier states pursue an independent arms production capability? This section considers several explanations.

Overview of the Debate
Several attempts have been made to weight the relative importance of macroeconomic and political factors in the decision to establish a military industrial complex. Statistical studies based on regression of comparable country-level variables have considered factors such as size of the economy (GDP or GNP), wealth (per capita GDP or GNP), debt, military expenditure, and various measures of industrial or technological capacity. From the first, however, analysts have realized that political factors play a large role in determining whether states choose to develop an indigenous defense industry.

A 1980 study by Ilan Peleg found that a developing country’s level of military industrialization—calculated by tallying scores for indigenous self-production, co-development, and licensed production—was largely determined by per capita military expenditure, the number of scientific journals it published (a rough proxy for technological capacity), and whether it had been recently subjected to an embargo. Stephanie G. Neuman criticized Peleg’s study and others for not taking into consideration the null cases and therefore selecting on the dependent variable, excluding countries from their sample which had been embargoed but did not respond by developing an arms industry. However, the examples she identifies of such responses are countries which endured a partial embargoes by one or other superpower, not a multilateral

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Robert Rosh, taking into consideration the null cases, affirmed that past experience of an embargo was a key determinant in the decision to pursue an arms industry. David Kinsella discovered an additional political result: that the less diversified a state’s source of arms imports, the more successful its defense industry. Kinsella speculates that this result may indicate a greater incentive to seek autonomy or that a dedicated relationship with a small number of patrons can yield more technology transfer.

Another key conclusion frequently reached in empirical studies of third-tier arms industries has been that the size of a country’s economy is a strong predictor of its likelihood to develop an indigenous arms industry, which suggests that there are certain benefits of scale in a large internal market. Based on this finding, Neuman predicts that the international arms industry will remain highly hierarchical, with larger countries hosting more developed production capabilities. In developing a formal model of the determinants of arms production, Levine, Mouzakis, and Smith argue that there is a “switch point” over which a country is large enough to make domestic production economically feasible. Robert E. Looney and P.C. Frederiksen agree with Neuman, determining that size, population, and national income are all supportive of arms production, but also suggest that access to foreign currency can be a key limitation on the importation of production equipment. There is disagreement, however, between Neuman’s position that the absolute size of a country is of the most importance, and more nuanced arguments about qualitative or quantitative strengths of its economy. For example, Rosh accepts that the size of a country’s economy is an important determinant, but also finds that its export position in the international division of labor is equally critical. Brzoska and Ohlson find that

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118 Neuman, ‘International Stratification and Third World Military Industries’, p. 188.
the scale of civilian manufacturing is a better predictor of the scale of arms production when examined alongside military expenditure. Kinsella refines Neuman’s argument, finding that the scale of a country’s industrial output and export capacity are better determinants of arms production.

Supply Security, Dependency, and Prestige
The strong, almost perfect correlation between past embargo and future arms production suggests that insecurity of supply is a common reason for the establishment of an indigenous military industry. In part, this correlation can be explained in terms of a straightforward security concern that arms imports might dry up when they are the most needed. Following the 1965 war between India and Pakistan and concomitant arms embargo, described in a preceding section, both countries pushed toward indigenization of their arms supply in response to their wartime experience. Chile, embargoed by the United States from 1976, made an attempt to establish a domestic production capability after finding itself at a disadvantage in crises with neighbours Bolivia and Peru in 1974-1979 and with Argentina in 1978. States have also sought indigenous solutions when the most advanced technology is denied to them; following the 1982 U.S. decision to deny Taiwan either the F-16 or the F-20—a Northrop plane designed explicitly for the export market—the island’s government launched an Indigenous Defence Fighter program that was originally expected to produce 250 combat aircraft. Similarly, Australia developed an indigenous radar warning receiver for installation in its fighter aircraft after being denied re-programming information needed to modify a U.S. equivalent.

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125 Brzoska and Pearson, Arms and Warfare, p. 7
127 Tuomi and Väyrynen, Transnational Corporations, Armaments and Development, p. 127.
country has the heft to put political pressure on its suppliers when they stop deliveries, as the United States deployed via the Swiss government when Swatch, the watchmaker, canceled shipments of oscillators destined for one of Boeing’s guided munitions production lines in March 2003 in protest against the U.S. invasion of Iraq.\(^{130}\)

However, indigenization is not the only available response to uncertainty in supply; a state might also decide to diversify its imports as Greece did in response to a transatlantic embargo from 1974.\(^{131}\) Brazil also adopted a visible policy of buying from at least two countries for each category of major conventional weapons.\(^{132}\) The choice between diversification and indigenization, while strongly influenced by the industrial capabilities of a state as established in the empirical literature, has also been colored by the dependency discourse that emerged and flourished in the same decades as the third tier.\(^{133}\) This was the era of the Non-Aligned Movement and the New International Economic Order, as well as the development of dependency theory in political economy.\(^{134}\) The last push for autarky before WWI, when smaller countries demanded turnkey factories to produce the most modern arms, had been submerged in the anti-militarism of the interwar period which framed the arms industry as a threat to civilization.\(^{135}\) As a result, few developing countries began the post-war period with substantial military industry—Argentina being an exception\(^{136}\)—and those that were newly independent had been subjected to military dependency as a method of colonial control.\(^{137}\) Thus, in states with no

\(^{130}\) Hasik, *Arms and Innovation*, pp. 67-68.


\(^{133}\) Ross, *Arms Production in Developing Countries*, p. 2.


\(^{136}\) This country having a “long history of unsuccessful attempts to establish an autonomous arms industry” according to Wulf, ‘Arms Production in the Third World’, p. 331; also see Krause, *Arms and the State*, p. 154.

\(^{137}\) Ross, ‘Developing Countries’, p. 90.
immediate need for weapons the push for an independent arms production capability acquired an ideological tinge. For example, the Brazilian program was expanded in 1968 and 1977 after U.S. cessation of military aid and criticism of the government’s human rights record.¹³⁸ The anti-dependency argument was vindicated by the arms transfer policies of the Nixon and Carter administrations which, despite their ideological disparities, both treated the selective liberalization of export controls as a bargaining chip in bilateral relations.¹³⁹

The pursuit of true autarky has always been Sisyphean. As Jacques Gansler, a former U.S. undersecretary of defense for acquisition, technology, and logistics, pointed out, even in its youngest days the United States was highly reliant on foreign-manufactured gunpowder.¹⁴⁰ From the Renaissance to the eighteenth century, all the European great powers imported critical strategic goods; Spain sold iron to the English navy, while England sold lead to the French army.¹⁴¹ The move toward indigenization by the third tier countries created new dependencies: on customers, on subcomponent suppliers, and on imported designs and innovation. As long as foreign assistance cannot be substituted out in a crisis, dependency persists. Whether dependency has decreased is debatable; Krause argues that two trends are contributing to falling dependence: the substitution of licenses from the first tier with licenses from second-tier states, which are less inclined to set restrictions on how weapons are used; and the shift from dependency on entire weapons systems to dependency on subcomponents is less visible and therefore less politically salient.¹⁴²

There is also evidence that developing states pursue arms production to burnish national prestige and because they believe possession of a military industry is an appropriate marker of status. In Brazil’s case, there may be no better explanation for a recent 45% increase in its military expenditure than a desire to stake out a claim to great power status, given the exhaustion of the dependency discourse and the country’s continuing position of security on the South American

¹⁴⁰ Gansler, *Democracy’s Arsenal*, p. 17.
¹⁴² Krause, *Arms and the State*, pp. 177-178.
continent. A similar political culture that asserts great power status as a central tenet of national identity may be a driver behind the arms production investments of India and Nigeria. Similar regional claims motivated South Korea and Indonesia, Bitzinger argues. In Southeast Asia, Mahathir Mohamad in Malaysia and B.J. Habibie in Indonesia both relentlessly promoted defense industries as a marker of modernity, and as a potential locus of south-south cooperation. These aims were visible in the 1997 agreement between South Africa and Malaysia for licensed production of the Rooivalk by Malaysian firm Airod and the Chilean bid to supply Malaysia with offshore patrol vessels (OPVs).

Economic Benefits – Even if Elusive
Until the 1990s, developing countries envisioned military industrialization as a ladder of increasingly sophisticated production modes that could contribute to a national “drive toward modernity”. As previously explained, contemporary empirical studies failed to find a positive relationship between military expenditure and economic growth. Nonetheless, the misleading results of Benoit’s early statistical studies have been ‘confirmed’ enough times by individual, highly specific success stories to convince developing states that military industrialization can catalyze growth in the wider economy.

Israel, for example, was inspired by what it understood to be the French model of industrialization: reliance on an outsized and export-oriented arms industry to transform what was a largely agricultural state in the nineteenth century into an advanced industrial power. The allure of this economic success story was increased by France’s independent policies during the Cold War. France was indeed a highly export-oriented second-tier producer; in 1977, the aircraft manufacturer Dassault-Breguet reported a foreign origin for 77% of its sales, and the

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146 Neither agreement came to fruition. See Willett, ‘East Asia’s Changing Defence Industry’, pp. 112, 127.
country’s major subcomponent manufacturers, such as Matra, Thomson-CSF, and SNECMA, were also export-reliant.\textsuperscript{149} Within the second-tier, France was not alone: shortly after the formation of British Aerospace, in 1978 the company reported 55\% of its sales originating abroad; Germany’s Messerschmitt-Bölkow-Blohm, another leading aircraft manufacturer, attributed 60\% of its turnover to foreign projects in the same period while its compatriot and rival, Dornier, earned 85\% of its revenue abroad; Italian firms were also similarly positioned.\textsuperscript{150} Among third-tier producers, Israel was unique in achieving a comparable level of exports, high enough to sustain an indigenous industry that would otherwise have suffered severe overcapacity. As early as the late 1970s, three major Israeli firms—Tadiran, Israeli Military Industries, and Israeli Aircraft Industries—each exported more than 50\% of their total output.\textsuperscript{151} Brazilian investments briefly attained similar results, with 90\% of its military production—mainly armoured vehicles and missile systems—exported during the 1980s, but this proved unsustainable.\textsuperscript{152} In addition to the difficulties most third-tier countries encountered breaking into the export market, they also confronted the fact that domestic production did little to improve their trade balances—another expected economic benefit cited in support of military industrialization—given the heavy foreign exchange burden of importing subcomponents.\textsuperscript{153}

Other states were inspired by tales of successful military-to-civilian ‘spin-off’, the application of technologies and techniques mastered through defense investment to civilian industries. According to one economic historian, many of the technologies—notably wrought iron puddling and lathe manufacturing—which enabled the industrial revolution were spin-offs from innovations in gun-casting during the second-half of the eighteenth century.\textsuperscript{154} Again, Israel

\textsuperscript{149} Tuomi and Väyrynen, \textit{Transnational Corporations, Armaments and Development}, pp. 36-37.
\textsuperscript{151} Steinberg, ‘Israel’, p. 301.
provided exemplary cases: Israeli Aircraft Industries was able to adapt short-takeoff and landing (STOL) technology originally destined for military jets to a 24-seat regional civilian airliner, and the Israeli military electronics industry gradually grew into the civilian sector. Despite Israel’s successes, spin-off benefits have proved difficult to realize, even in developed countries. A recent empirical study of the effects of military research on economic growth found that the effect was positive in the United States, negative in the United Kingdom, and statistically insignificant in France. The authors of that study posited that the difficulties inherent in providing civilian entrepreneurs access to technologies developed at secretive defense laboratories make successful commercialization rare. Additionally, as exemplified in the failure of the United Kingdom’s Defence Technologies Enterprise, an intermediary set up by the state in 1984 to facilitate commercialization of military technology, direct transfer of blueprints and items can often be of limited use without corresponding tacit knowledge.

A different strategy for leveraging military production to obtain indirect ‘spin-off’ benefits involves obliging first- or second-tier exporters to accept an offset obligation to provide unrelated civilian technology; Taiwan Aerospace was able to enter the civilian sector when the government negotiated for the French firm Aerospatiale to transfer wing technology for regional passenger jets as part of a deal to sell Taiwan the Mirage 2000-5 combat jet. Within the third tier, limited spin-off successes have been recorded in the aircraft industries of Brazil, Sweden, and South Korea. East Asia has proven a fertile region for spin-off, potentially because of the high “absorptive capacity” of its technologically sophisticated civilian economies. More recently, however, Indonesia, Singapore, South Korea, and Taiwan have moved away from actively seeking ‘spin-off’ benefits and toward ‘spin-on’—the application of advanced civilian

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159 Willett, ‘East Asia’s Changing Defence Industry’, p. 129.
technology to military products.\textsuperscript{162} In Indonesia’s case, spin-off benefits were never achieved because of the technological gap between a purpose-built military industry—with high dependency on foreign inputs—and a laggard civilian sector. Further, skill shortages in the local workforce meant few jobs were created by the military sector.\textsuperscript{163}

**Simple Size of the Economy**

Indeed, the increase in flourishing, newly industrialized economies might suggest that the number of states capable of entering the arms industry should increase over time. Neuman’s argument that the size of a nation’s economy is the most important determinant in its likelihood of becoming an arms producer would lead us to expect that as states’ economies become larger relative to their peers, they will become capable of joining the third tier. After all, the post-war U.S. dominance in arms production had little to do with technology and rather more to do with its economies of scale and the gigantic size of its domestic market.\textsuperscript{164} During the 1970s, several Middle Eastern economies that benefitted from the upsurge in oil prices transferred their petrodollars toward indigenous production, Iran being the most prominent example.\textsuperscript{165} In 1970, the Shah’s government set up Iran Aircraft Industries with the help of its minority-stake partner, Northrop, to service and support military aircraft newly acquired from the United States. In 1976, a joint venture between Iran Electronics Industry and British Aerospace was established to produce Rapier surface-to-air missiles, and the same Iranian firm also had an agreement to collaborate with Hughes Aircraft to manufacture anti-tank TOW missiles. Bell Helicopters prepared plans for a USD 575 million turnkey manufacturing plant in Isfahan that would have produced its new Model 214 transport helicopter.\textsuperscript{166} All of this was made possible by the country’s new-found wealth. Only a decade earlier, U.S. Senator J. William Fullbright could


\textsuperscript{164} Moravcsik, ‘Arms and Autarky in Modern European History’, pp. 32-33.

\textsuperscript{165} Albrecht, Ernst, Lock, and Wulf, ‘Militarisation, Arms Transfer and Arms Production in Peripheral Countries’, pp. 200-202.

\textsuperscript{166} Tuomi and Väyrynen, Transnational Corporations, Armaments and Development, pp. 188-190.
argue against the sale of F-4 Phantom II fighter aircraft to Iran by referencing the development priorities competing for the country’s scarce funds.¹⁶⁷

Iran’s nascent military industry was disrupted by first the 1979 revolution and later the war with Iraq. The lack of financial resources held back other regional powers, such as Egypt, which relied on Saudi financing until 1979 and the collapse of the Arab Organization for Industrialization.¹⁶⁸ The spike in oil prices since the end of the Cold War has supplied the Gulf states with new funds for military industrialization, but so far they have focused on arms imports. For example, the United Arab Emirates, which signed contracts to purchase USD 20.3 billion of major conventional weapons systems since 1991, directs offsets toward diversification of the civilian economy as well as into professionally managed investment funds.¹⁶⁹ But if Neuman and the other analysts surveyed above are correct, all other factors being equal, we should expect to see the number of arms producing countries increase as countries become wealthier and their economies grow.

The Growth in Offsets
The continuing growth in offsets should have contributed to an increase in the number of countries with the technological base necessary to either become a third-tier producer of military items, or to increase the complexity of their products. The most persuasive finding that supports this expectation—beyond the many anecdotes of successful spin-off—is Kinsella’s conclusion that past licensed production has a statistically significant positive effect on the volume of subsequent arms produced in third-tier countries.¹⁷⁰

¹⁶⁷ Tuomi and Väyrynen, Transnational Corporations, Armaments and Development, pp. 185.
Even in the early 1980s, arms buyers were becoming increasingly demanding. According to Northrop president Thomas V. Jones, once, “you could walk into [customers’ offices] with a package under your arm, unwrap it and wave it in the air...[now] they want to share technology, not just buy a piece of equipment.” As previously mentioned, the number of countries with formal offset policies increased through the decade, driven by the belief that offsets are an effective method of providing investment and technology to start-up military industries. In 1996, more than 130 countries had policies in place. Since then the increase in dollar value has continued; a 2012 study by the consulting firm Avascent estimated that yearly global offset requirements in the aerospace and defense sector would increase from around USD 25 billion in 2005 to more than USD 50 billion in 2016, while cumulative obligations would reach about USD 450 billion by 2016. Much of that growth, according to Avascent, will be attributable to an increase in obligations from buyers in two regions: the Middle East and North Africa, and Asia. Within the latter region, India and South Korea—both key third-tier countries—will account for 60% of the obligations.

The growth in offsets defies attempts by the United States since 1988 to curb the spread of production technology. From the mid-1970s through the 1980s, a largely laissez-faire attitude toward offsets predominated among the major defense integrators of the first- and second-tier countries. Major arms acquirers made extraordinary demands of patrons and partners; even states receiving credits from the United States for arms purchases could successfully mandate obligations. Taiwan was able to negotiate a retroactive offset for a 1992 deal with

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172 Martin, ‘Introduction and Overview’, p. 3.
175 Willett and Anthony, ‘Countertrade and Offsets Policies and Practices in the Arms Trade’.
Lockheed. The major policy decision that heralded new reservations in Washington about the long-term wisdom of offsets was the imposition in 1988 of a cap at 30% on the offset level acceptable in a partnership between General Dynamics and McDonnell-Douglas, on one side, and local partners in the Korean Fighter Program, on the other. The new policy course has been difficult to maintain because second-tier firms also competing for contracts with third-tier partners are also increasingly eager to provide technology transfer concessions to win deals. As the United Kingdom’s Defence Export Services Organisation concluded, “yesteryear's formula of best product, best price, and best delivery will no longer stand up to competition that offers attractive offset incentives. It is a buyers [sic] market.” Of course, that realization likely informed the UK’s recent decision to require an offset obligation 1.3 times the cost of airborne warning aircraft purchased from the U.S. firm Boeing.

177 Lo, ‘Taiwan’, p. 203.
180 Gansler, Democracy’s Arsenal, p. 43.
IV. Trends over the Last Thirty Years – An Examination of Available Evidence

The following sections explore five metrics that provide a data-driven illustration of how the military industries of 13 third tier countries have evolved. The 13 countries are: Argentina, Australia, Brazil, Egypt, India, Israel, North Korea, Singapore, South Africa, South Korea, Sweden, Taiwan, and Turkey.\textsuperscript{181} Five indirect metrics are needed because reliable estimates of production figures do not exist; SIPRI ceased publication of comprehensive production estimates in the late 1980s and moved toward tracking the value of production of the world’s largest defense firms; no other publisher has taken on the challenge of tracking total production. Estimates published during the 1980s—for example, in Brzoska and Thomas Ohlson’s 1986 study—were based on SIPRI’s figures.\textsuperscript{182}

Figures for Total Production
Since 1988, when SIPRI moved toward only tracking the 100 largest arms-producing companies, the comparability of data has been questionable. Lack of reliable data excluded South Korean and Russian companies from the tables for several years in the 1990s; this limitation still prevents inclusion of Chinese firms. Comparability is also difficult throughout the 1990s because of the large number of mergers within the defense industry, which consolidated production totals among companies and led to more production being included in the Top 100 table over time. This led to progressively larger total production values for the largest firms and countries despite falling overall industry-wide activity. The peace dividend is therefore underrepresented in this particular data set. Additionally, the activities of smaller firms is not published if they are not in the Top 100 companies, which could bias the data against or for greater production by the third tier countries—it is not possible to know the effect of this arbitrary cut-off on our conclusions.

From 1988, the data show an upward trend in the proportion of global arms production attributable to the third tier firms in the SIPRI Top 100, peaking in 1999. This proportion dipped

\textsuperscript{181} Not all countries are included in all metrics because data coverage may not permit full coverage.
\textsuperscript{182} Brzoska and Ohlson, ‘Arms Production in the Third World: an Overview’, p. 8 and Appendix I.
through 2007, then rose again to a new high between 2011 and 2013. The drop in production share after 1999 can be attributable to the aforementioned industry consolidation, or the increase in production within the United States after the launch of two wars in 2001 and 2003. Given the large share of total production tallied in the SIPRI top 100 attributable to the United States, this would severely suppress the third tier’s share.

*Figure 1: Total Third Tier Production and Share of Global Production in the SIPRI Top 100. Constant dollars calculated with U.S. dollar GDP deflator*

Because of the many comparability problems that affect interpretation of the Top 100 list, a more useful approach to examining the data is to focus on the composition of the third tier companies represented in the list, rather than totals. The graph below (Figure 2) shows that the companies of several third tier states dominate the yearly totals, while other countries are entirely unrepresented—this latter category includes Argentina, Egypt, and Taiwan. The most consistently represented states are Israel, Sweden, and India; their overwhelming dominance within the data is the most important and defensible conclusion to be taken from the SIPRI Top 100 numbers. The entirety of South Africa’s arms production, which declines over time, is attributable to the state arms maker Armscor, which was later restructured into Denel. Singapore’s arms production is represented entirely by the state-controlled firm ST Engineering, formerly a subsidiary of Singapore Technologies. Arms production in South Korea increases from 2000, but the validity of the conclusion that there was minimal production in the 1990s is undermined by the non-inclusion of market data for that country during that period.
Figure 2: Decomposition of Third Tier Countries’ Shares of Global Arms Production in the SIPRI Top 100

Exports as a Proxy for Total Production

If figures for total production are incomplete and inconclusive—ultimately, unreliable—another approach for evaluating the fortunes of the third tier might be examining their military exports. At a theoretical level, exports could be a good proxy for total production because small states do not have a domestic market large enough to sustain the revenue streams an independent arms industry needs to survive. What Andrew Moravcsik calls the autarky-efficiency dilemma—that pursuing autarky is expensive, requiring an inflated military budget or government subsidies, but opting for economic efficiency by allowing exports allows the dissipation of technological leads and military superiority—is less troublesome for smaller states. In confronting this dilemma, third-tier producers can decide to export secure in the knowledge that their products contain few technological innovations and that their customers are unlikely to pose a threat if far enough away, which may be not the case among great powers. Relying on exports can be a sustainable policy; Moravcsik notes that in the mid-18th century, the tiny Bishopric of Liege produced ten times the quantity of muskets as all of France. In more recent times, smaller third-tier producers, such as Chile and Argentina, have survived by relying on exports. Chile sold considerable quantities of cluster munitions and land mines to Iraq in the 1980s, while Argentina

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supplied Croatia with arms from 1991-1995.\textsuperscript{185} During the 1980s, the third-tier was dependent on exports for about 20-30% of total sales, although several states, notably Brazil at between 70-90% of sales, were highly dependent.\textsuperscript{186}

All other factors being equal, trends in exports should be a good indicator of how trends in production have changed over the last thirty years. Unfortunately, all other factors are not always equal. The biggest problem is one of size – larger countries may have a domestic market large enough to sustain an industry without exports, the key example being India. Another problem is that certain third-tier states may have their exports blocked for political reasons, as has been the case with Taiwan and South Africa.\textsuperscript{187} Additionally, export totals can be highly sensitive to fluctuations in demand, as in the mid-1980s when they were “artificially stimulated” by the Iran-Iraq War.\textsuperscript{188} Finally, the extremely small fraction of the total worldwide trade in arms staked out by the third-tier means that any deal can have a large impact on export trends despite corresponding with little change in underlying production patterns. For example, if, in 1993, six countries—the United States, United Kingdom, Germany, Russia, and China—accounted for 99.3% of all exported tanks in service,\textsuperscript{189} any one third-tier export could cause a large shift in percentage numbers in one year without corresponding with any real change in tank production capability.

On top of these considerable theoretical problems, data on arms exports suffer many of the weaknesses as data on arms production. Two leading researchers at SIPRI, a leading collator and publisher of aggregate arms trade data, summarized their frustrations in 1987 thus:

“We are constantly being exasperated by armchair theorists who conduct statistical exercises on some of our figures, without paying any attention to the

\textsuperscript{186} Krause, \textit{Arms and the State}, p. 169.
\textsuperscript{187} Krause, \textit{Arms and the State}, p. 160.
\textsuperscript{188} Krause, \textit{Arms and the State}, p. 160.
\textsuperscript{189} Gansler, \textit{Democracy’s Arsenal}, p. 43.
obvious margins of errors. They then complain bitterly when next year’s revisions make their correlation coefficients insignificant.”

Information on the arms trade is compiled by SIPRI using a limited number of incomplete but complementary sources: arms sales disclosures from exporters, materials from firms producing weapons, declarations from importing countries, and intelligence sources. The Bureau of Arms Control and Verification of the U.S. Department of State (and, prior to 1999, the U.S. Arms Control and Disarmament Agency) publishes on an annual basis a different compilation of arms trade statistics known as the ‘World Military Expenditure and Arms Transfers’ (WMEAT) series drawing on U.S. sources. SIPRI and WMEAT have slightly different foci: the former estimates the value of arms transferred based on production costs, while the latter estimates cost to purchaser; the former tracks only transfers of major conventional weapons systems, while the latter includes small arms and light weapons. Nonetheless, compilers of the two data sources face similar challenges. They cannot make use of trade accounts as these typically lack the necessary granularity and naturally disguise military end-use items when they have dual uses. Translating transfers into comparable monetary values raises problems of valuation; for example, in 1986, WMEAT abruptly increased its valuation of past Soviet transfers based on a new assessment of the value of support material included with transfers. Most importantly, states

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192 Researchers often track annual reports published by arms exporting countries, submissions to the UN Register of Conventional Arms, news reports, press releases, company filings, budgetary documents, and private sources including leaked intelligence reports.
195 Brzoska and Pearson, Arms and Warfare, p. 21.
deceive, obscuring and manipulating information on their exports and production. However, despite the problems with both sources data—SIPRI and WMEAT—the data can be used with caution to interpret trends.

Analyses of trends through the last decade of the Cold War showed that third-tier exports were steady at between 2% and 4% of the world total. In 1978, they accounted for 3.2% of total arms sales; that figure only increased to 3.3% in 1983. Several states accounted for a large proportion of total third-tier sales; typically, in the period between 1980 and 1984, Brazil, Egypt, and Israel together accounted for 60% of all third-tier exports. Eventually, exports reached a peak of between 7% and 10% of the worldwide total before declining in the first half of the 1990s. Between 1986 and 1990, three of the main exporters, Brazil, Israel, and Egypt, were all facing dropping orders and severe economic problems.

Figure 3: Percentage Share of World Arms Market Attributable to the Third Tier. Sources: SIPRI and WMEAT.

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197 Brzoska and Pearson, Arms and Warfare, p. 21.
200 Ross, ‘Developing Countries’, p. 100.
The two sources, SIPRI and WMEAT, disagree on whether total sales increased or decreased between 1984 and the early 2010s. SIPRI data indicates that third tier exports—including two states not always included in prior estimates, Sweden and Australia—rose sharply in the early 2000s, and then settled at between 5% and 8% of world total exports. WMEAT data, which only runs to 2011, indicates that third tier exports declined in the 1990s to under 3% of the world total before rising to 4%. The difference between the two tallies may reflect variation in scope for inclusion, sources, or methods for valuing exports. While the two sources disagree about whether exports have fallen or risen, they do agree on two points: first, that combined third tier exports have claimed a larger part of the export market than China, the ex-Soviet and WTO countries, and all other exporters; and second, that several large exporters dominate among the third tier.

Figure 4: Percentage Shares of World Arms Market. Sources: SIPRI (left) and WMEAT (right). “Others Consolidated” Include All Other Suppliers, Excluding the First and Second Tiers and the NATO Countries.

Israel and Sweden are the dominant third tier exporters; the former accounted for 32.7% (SIPRI) or 36.8% (WMEAT) of the total, and the latter 30.8% (SIPRI) or 28.0% (WMEAT). SIPRI data indicates that South Korea is the next largest exporter, with about 9.1% of the total, but WMEAT data puts Seoul’s exports at half that amount, about 4.6%. The two data sources agree that Australia, Brazil, North Korea, and South Africa each accounted for between 4% and 6% of the third tier total, while Turkey accounted for around 3%. Singapore accounted for between 1.9% and 1.4% of third tier exports, while Argentina, Egypt, India, and Taiwan all contributed 1% or lower of the total.
There are several trends visible in the data. The first is the large persistent exports of Israel and Sweden. The second is the emergence of South Korea as an increasing exporter; the SIPRI chart shows a more visible increase but WMEAT data also speaks to the country’s continuing presence in the export market. Third, to a lesser and more recent extent, Turkey has also emerged as a minor exporter. Fourth, Brazil, Australia, and South Africa exports have continued as well, but at lower volumes. Finally, both sets of data show that the share of exports from other third tier states—Argentina, Egypt, India, North Korea, Singapore, and Taiwan—has shrunk to an almost negligible amount.
Defense R&D Comparisons

A second indicator that could help evaluate the health of the third tier military industries is the level of R&D investment in the military sector. Because the technological advantages that underwrite military superiority can be perishable, R&D can be as important for the viability of a country’s military industry as total industrial output. During the Cold War, this was reflected in the superpowers’ dominance of global R&D expenditure; in the early 1980s the United States and the Soviet Union together accounted for 85% of all global military R&D funding. From the mid-1960s, the second-tier countries recurrently feared that the U.S. defense industry’s vast research budgets were promoting brain drain in Europe. In 1981, while the United States devoted nearly half of all government R&D expenditure to military-related research, while Germany devoted 9% and Japan only 2%. At the heights of Reagan’s defense build-up in 1986, the percentage surged to 70% of all U.S. R&D expenditure. Firms located in European second-tier countries have had to rely on export profits to make up for lower government support. Within the third tier, several countries also have outsized commitments to military R&D. India, in particular, which historically directed toward study of special materials such as steels and alloys for military application, tends to assign a relatively high proportion of government R&D toward the military.

The data collected for this section are primarily from the OECD’s Database of Government Budget Appropriations or Outlays for R&D, which are organized by socioeconomic objective, and are supplemented by national data for Brazil, Argentina, and India. The time series are very incomplete and data on defense R&D is entirely missing for several countries, notably Israel and

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207 Tuomi and Väyrynen, Transnational Corporations, Armaments and Development, p. 198.
Singapore. One contemporary estimate of the proportion of government-funded R&D devoted to military research for Israel puts it at around 30%.\textsuperscript{208}

\textit{Figure 7: Share of Government R&D Assigned to Defense R&D}

![Graph showing share of government R&D assigned to defense research over time.](image)

\textit{Figure 8: Share of National R&D Assigned to Military R&D}

![Graph showing share of national R&D assigned to military research over time.](image)

There are several conclusions that be inferred from this data. First, India continues to commit considerably more of government R&D funding to defense research than its other third tier

peers. While data is very incomplete, it appears that Turkey and South Korea are also devoting a large amount of government R&D to defense. Second, several countries, notably Sweden and Australia but also perhaps Taiwan, have reduced government R&D funding. Sweden sustained high levels of state support through the 1980s, but has reduced its commitments noticeably over the last decade and a half. Third, the Latin American countries included in the sample, Brazil and Argentina, have consistently assigned very small proportions of their state-supported R&D funding to defense.

Of course, state-funded R&D accounts for only one part of a country’s R&D budget. Unfortunately, data on private sector and non-profit research devoted to military R&D is even scarcer than data on government appropriations. What data is available, via the same sources, suggests that the observations hold true (see Figure 8).

**Defense Sector Patents**

A third alternative approach to directly assessing the productive capabilities of the third tier is an examination of defense-sector patents. As the military industry of a country expands, it is intuitive that the number of patents related to defense technologies would also increase. This potentially provides us with a useful window through which the growth of production capabilities—or more accurately, production technology—can be compared across the third tier states.

There are several important caveats that affect the usefulness of analyzing the data assembled below, deriving from the methodological weaknesses of patent analysis, the unique characteristics of the military sector, and the cross-national scope of this study. First, patents are not a direct measure of innovation output as stimulated by research investment; patents are evidence of innovation but their quantity can also be affected by the cost of patenting, the economic value of the innovation, and the strategic interests of the firm or business that controls the innovation.209 This means that patents only uncover a fraction of a study sample’s inventions, and their representativeness may vary. Second, the military sector is more accustomed to

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protecting property rights through secrecy rather than patents as the latter typically require the disclosure of the key characteristics of an innovation that make it valuable. Given the competitive strategic motivations for military innovation, this disclosure is seldom welcome.\textsuperscript{210} Further, all patents are difficult to classify into industrial and sectoral categories because of differences between origin and potential use, and the military is no different.\textsuperscript{211} In fact, because of the dual-use nature of many military technologies, this problem may be more pervasive than for other industries. Third, cross-national comparisons of patent activity can lead to unwarranted conclusions because national characteristics can affect the rate at which innovations are patented. For instance, it is conceivable that variation in institutional characteristics of a country’s patent protection architecture, such as confidence in judicial independence or administrative transaction costs, could influence the willingness of inventors to apply for patents.\textsuperscript{212}

Bearing these challenges in mind, this analysis will only make judgments about trends, and only within countries. The data used were collected from national patent offices’ online databases for Brazil, India, Singapore, South Africa, South Korea, Sweden, and Turkey, and from the European Patent Office’s ESpaceNet international patent search service for Argentina, Australia, Egypt, Israel, and Taiwan. Two second-level and three third-level categories from the International Patent Classification system were selected to represent defense innovations. F41 covers “Weapons”, including small arms, missile launchers, and armoured vehicles and their parts; F42 covers various types of ammunition; B63G includes naval weapons and some categories of military ships; and B64C and B64D includes aircraft and their components.\textsuperscript{213}

\textsuperscript{213} F41 and F42 were used in a 2011 study of the spin-off effects traceable in patent citations, but are too restrictive for an analysis of the entire defense industry. See Manuel Acosta, Daniel Coronado, and Rosario Marin, ‘Potential Dual-Use of Military Technology: Does Citing Patents Shed Light on This Process?’, Defence and Peace Economics, Vol. 22, No. 3, (Jun. 2011), pp. 338-343.
Within the patent data, the growth of the South Korean industry is more visible than in any other metric. Two other trends stand out: the number of patents filed in Turkey has risen substantially, and Australia’s share of patents filed has dropped, despite previously being a popular filing location.\textsuperscript{214} Within Brazil, the most significant observation might be that the number of aerospace-related patents rose very quickly before declining, while patents for the other military industries remained flat. This reflects the success of Embraer as a civilian aviation company in contrast with the stagnation of the country’s other military industries.

\textsuperscript{214} While the graph indicates that filings in Australia have declined, this may not be true as the number of filings in ESpaceNet also declines for other countries with a national registry against which totals can be compared. The Australian registry does not allow searches by broad industry classifications.
Licensing within the Third Tier

The development of third tier military industries began with licensed production. As production capabilities evolved and matured, these states continued to license more advanced first- and second-tier designs. Trends in licensing provide an important insight into potential proliferation risks, as the spread of independent manufacturing capabilities often follows licensed production. Thus, it is not only the inward flow of licenses that proxies the growth of third tier industries, but also the outward flow of indigenous designs to other developing countries.

The SIPRI Arms Transfer Database includes entries for licensed production contracts, and below are graphs indicating how licensed production into and out of the third tier has evolved over the last thirty years. Production under license typically lags the signing of contracts by a few years, and some contracts result in longer production runs than others.

*Figure 11: Inward Licensed Production Contracts Signed (left) and Licensed Production Programs in Production (right)*

Licensed production continued to be a popular option among the third tier states. As Figure 11 indicates, India signed by far the most licensed production deals, 78 over the thirty year period, while other states signed very few; Argentina, Israel, North Korea, Singapore, and Taiwan each entered into between 2 and 5 deals over the three decades. While the small number of contracts signed by North Korea and Taiwan can be explained by their international isolation, the low use
of licenses in the other three countries is open to interpretation. Australia (31), South Korea (40), and Turkey (40) also signed a large number of license deals over the thirty year period, while Brazil and Egypt trailed with 17 each.

*Figure 12: Outward Licensed Production Contracts Signed (left) and Licensed Production Programs in Production (right)*

The number of third tier licenses granted to other countries has increased significantly over the last thirty years, although the number of deals dropped off in the last five years. The dominant licensors of military production rights are Israel and Sweden, a reflection of their mature defense industries and ability to design and develop complete weapons systems or significant subcomponents. An example of the latter, which accounts for ten of Israel’s outward licensing contracts, is the Litening precision targeting pod, an electronics subsystem that has been installed on U.S. military aircraft including F-16, F-15, and F/A-18s fighter jets, the A/V-8B and A-10 ground-attack aircraft, and B-52 bombers. Another popular Israeli outward license is the Spike-MR/LR anti-tank missile, which has been licensed for production in numerous second-tier countries such as Germany, Italy, and Spain. Other categories of Israeli designs licensed for production abroad include air-, ground-, and maritime-search radars, small naval vessels, anti-ship missiles, mortars, self-propelled guns, surface-to-air and air-to-air missiles, and unmanned aerial vehicles.
While the most famous Swedish design licensed for production abroad is the Saab Gripen combat aircraft, which Brazil recently committed to spending USD 5.8 billion for 36 aircraft, the country also licenses the production of its armoured vehicles. During the 1980s, Sweden granted licenses to Norway and Pakistan for the production of portable surface-to-air missile systems, and also sold the latter country the rights to produce almost 400 trainer aircraft. It licensed submarine technology to both Australia and Japan, and has sold a number of radar types to South Korea, including fire-control and artillery-locating systems. Finally, the Swedish firm Bofors developed the 57-mm naval guns mounted on the U.S. Navy’s Littoral Combat Ships, as well as the guided missile destroyer, the *USS Zumwalt*.

Of the other third tier countries, the most growth has been in outward licenses of South Korean designs. These designs fall into three main categories. The first is naval ships; Korean designs for landing platform docks, frigates, offshore patrol vessels, submarines, and minesweepers have been licensed out for production across Southeast Asia and South America. The second category is trainer aircraft; the KT -1 trainer has been produced in both Turkey and Peru. The third and last major category is artillery, more than 400 units of which have been licensed for production in Poland and Turkey.

Both Turkey and South Africa have developed armoured vehicles for licensed production. Turkey sought out a manufacturing partner in Malaysia, where 136 Pars armoured personnel carriers and infantry fighting vehicles are currently being manufactured. South Africa and Rhodesia were early innovators in what were later coined mine-resistant armoured protection (MRAP) vehicles by U.S. forces in Iraq. Operating in the deserts and velt of Angola, Rhodesia, and Southwest Africa during the 1970s and 1980s, the apartheid-era militaries had to cross vast territories while maintain protection against landmines. After 2008, South African designs were exported to Jordan, Kazakhstan, and Yemen, as well as the United States.²¹⁵

²¹⁵ Hasik, *Arms and Innovation*, pp. 112-115.
Contribution of Third-Tier Firms to First- and Second-Tier Products – Integration through Subcontracting

A further indicator of the vitality of third-tier military industries is the degree to which they supply subcomponents to integrators in first- and second-tier countries. This form of integration is difficult to detect, but “[l]ike an iceberg… globalisation is much more significant below the surface,” argues one industry analyst. With increasingly globalized supply chains, multinational firms are able to reduce costs and risks by reaching across borders. The same competitive pressures that promote this behavior also affect the defense sector, despite states’ misgivings about dependency. Among the first- and second-tiers, this pattern has led to both consolidation—most visibly in the creation of the European aeronautics giant Airbus SE—and specialization on core competencies. It is therefore logical to question whether the third-tier has participated in this pattern of integration.

Indeed, there exist illustrative examples of important contributions third-tier subcontractors have made to complex systems. Austal, an Australian ship-builder specializing in fast aluminium catamarans, was contracted by General Dynamics to build frames for the U.S. Navy’s Littoral Combat Ships. James Hasik hypothesizes that Austal’s success as an independent contractor hinges on the importance of hands-on knowledge in ship-construction and the geographical remoteness of Australia from the first-tier, which means a buyout would produce few cost reductions. Hasik also notes examples of third-tier firms partnering with first- and second-tier companies to bid for contracts in first- and second-tier states: Embraer, the Brazilian aerospace firm, teamed up with Lockheed Martin in an attempt to win a contract for a new airborne reconnaissance plane (the bid failed), while Elbit Systems, an Israeli defense firm, partnered with French firm Thales to produce the ‘Watchkeeper’ unmanned aerial vehicle (UAV) for the United Kingdom. A 2002 RAND study also examined the similar marketing agreements between

218 Hasik, *Arms and Innovation*, pp. 87-89, 95.
Israeli firm Rafael and two U.S. partners, Lockheed Martin and Northrop Grumman, to sell missiles and targeting pods to the U.S. military.\textsuperscript{220}

The case of the United States is illustrative; as a first-tier state, it has the most independence of supply in defense goods and should therefore have the least trouble in monitoring subcontracts. Under the Federal Acquisition Regulations, government managers of contracts can demand prime contractors disclose the identity of subcontractors in advance.\textsuperscript{221} Despite having the legal authority to maintain ongoing visibility of its reliance on foreign goods and services, in practice the Department of Defense has struggled with keeping track of the final destination of its funds. For example, during the Afghanistan and second Iraq war, three major agencies involved in the occupation and reconstruction effort—the Departments of Defense and State, and USAID—were assessed by the House of Representatives to have almost no oversight of their supply chains.\textsuperscript{222} A bipartisan Commission on Wartime Contracting found in 2011 that the agencies had problems controlling corruption risks in subcontracts to foreign firms and could not ensure that payments reached their intended recipient.\textsuperscript{223}

In 2001 and 2004, the Department of Defense conducted studies of its reliance on foreign subcontractors for major acquisition projects, ranging from combat jet engines to chemical warfare suits. The 2004 study surveyed prime contractors and two tiers of subcontractors who provided parts for twelve major acquisition projects to assess the national origin of their goods,

\textsuperscript{221} FARS Subpart 44.2, 44.201-1 Consent requirements. Can be accessed at General Services Administration, ‘Federal Acquisition Regulation (FAR)’, Acquisition.Gov website, last updated Jul. 2, 2015, available at \url{https://www.acquisition.gov/?q=browsefar}.
relying on respondents to gather the information. It found that foreign subcontracts represented four percent of the contract value of the study sample, and concluded that “[u]tilizing the identified foreign sources does not impact the long-term readiness of the Armed Forces”. The study assessed that the use of components from Singapore and Sweden, and titanium metal from Russia in General Electric’s F414 Engine did not pose a dependency risk as all suppliers were dependable and substitutable. A similar finding was upheld for the use of an Israeli thermal battery—which itself incorporated Malaysian parts—in the CBU-97 Sensor-Fuzed Weapon, and Turkish electronics and metal sheets in a short-range ground-to-ground missile system. Follow-on studies reached the same conclusion, but relied on prime-contract-level data from the Federal Procurement Data System and did not analyze subcontracts in detail.

Unfortunately, these data points are not comprehensive enough to allow conclusions on the overall performance of the third tier. Neither, unfortunately, are aggregate arms transfer databases. However, both sets of estimates used in the prior analysis of the exports of the third tier are unsatisfactory for assessing whether subcomponent exports have trended upward while total exports stayed flat. The SIPRI arms transfers database lacks scope—it does cover some major subcomponents such as engines and military sensors, but does not cover others. WMEAT includes both “weapons of war, [and] parts thereof”, but provides country-to-country totals without publishing granular information on categories or types.

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228 See similar reports for fiscal years 2005-2008. See Gansler, Democracy’s Arsenal, p. 65 for conclusions of the 2001 report, which are similar.
229 See Stockholm International Peace Research Institute, ‘SIPRI Arms Transfers Database – Methodology’.
The remainder of this section proposes, describes, and applies an alternative approach to assessing whether the imports of subcomponents intended for use in defense products has increased. This approach creates a proxy indicator for the level of subcomponent imports: the foreign exchange exposure risk of publicly listed prime contractors and major suppliers. It cannot indicate the precise level of imports, but it assists in assessing whether there is a trend. Critically, this approach assumes that the stock price of firms is in part determined by the actions of actors who have privileged information, not available to the external researcher, about the firm’s operations. This assumption has previously been used in forensic economic analyses such as that of Stefano DellaVigna and Eliana La Ferrara, which examines how critical events during conflicts affect the stock price of firms suspected of violating embargoes to sell weapons to belligerents,231 and François-Xavier Delaloye, Michel A. Habib, and Alexandre Ziegler, which estimates the importance of banking secrecy for four Swiss banks by comparing how their stock prices reacted to negotiations between the United States and Switzerland on the sharing of private account data.232 The shared assumption is that hidden business practices which are otherwise difficult to detect—embargo breaking, protecting law-breaking clients, or relying on imported subcomponents—can be communicated through the stock market when outside events threaten the profitability derived from the hidden practices.

In this study, I rely on changes in the exchange rate as the outside events which should trigger a stock market reaction if a firm relies on foreign subcontractors. If a prime contractor or first-level subcontractor employs foreign subcontractors, its profits may be susceptible to shifts in exchange rates as supply contracts may be priced in foreign currencies. Even if supply contracts are priced in the integrator’s own currency, shifting exchange rates will improve or hurt profitability over the long term as the currency strengthens or weakens. While exchange exposure risk might also derive from relationships with customers thereby preventing us from using exchange exposure as a direct proxy for reliance on imports, this problem is attenuated by the fact that defense firms’ main customers are either higher-level integrators or their government. Even when defense

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articles are exported from the United States, for example, 40% of the time the government of the United States mediates these sales and purchases the products from firms before transferring them to clients.\textsuperscript{233}

The calculation of exchange exposure is a standard tool in the toolbox of financial analysts, even though the methodology for doing so continues to evolve as new estimation techniques are developed by statisticians and econometricians.\textsuperscript{234} Identification of exchange exposure risk through regression analysis of the impact of exchange rates on stock prices was conducted in the early 1980s by, among others, Michael Adler and Bernard Dumas, who established that exposure risk can be represented by the coefficient in a regression of one time series on the other, but through the 2000s researchers struggled with the problem of inconclusive estimates which contradicted expectations of high exposure risk.\textsuperscript{235} Models began controlling for movements in the broader stock market, and using new estimation techniques beyond basic ordinary-least squares to achieve greater precision.\textsuperscript{236} Another important innovation was adapting models to allow for asymmetric effects on stock prices—that is, accounting for the possibility that currency appreciations and depreciations may have different magnitudes of effect on stock price.\textsuperscript{237}

Newer studies have centered on the GARCH (General Autoregressive Conditional Heteroskedastic) estimation model for time series analysis. The GARCH model allows for more precise coefficient estimates than ordinary-least squares regression because, in addition to modeling the statistical process which generates the dependent time series, it also takes into consideration changes in the variance of the time series—hence, conditional heteroscedasticity.238 As applied to the impact of exchange rate returns on stock price, application of the GARCH model was pioneered by Dilip K. Patro, John K. Wald, and Yangru Wu in a study of currency effects on an the entire stock markets of 16 countries.239 Gregory Koutmos and Anna D. Martin expanded the model by including a term to represent the effect of exchange rate volatility on stock prices; examining nine U.S. sectors, they find that 17.8% of the sample exhibited stock price exposure to changes in the exchange rate, while 25.0% exhibited exposure to changes in the volatility of the exchange rate.240 As explained by Koutmos and Martin, exchange rate volatility can impact the profitability of a firm by increasing the cost of hedging transactions the firm must take to mitigate risk.241 A later study by Prabhath Jayasinghe and Albert K. Tsui found exposure to changes in the value of the Japanese Yen in six of fourteen Japanese industrial sectors, using a derivative of the GARCH model.242

Adapting the methodology used by Koutmos and Martin, I estimated the effects of exchange rate changes and changes in exchange rate volatility on the returns to stock prices of 19 listed U.S. defense-sector firms, plus one Canadian firm.243 Daily returns are used, increasing the number of

243 The exchange rate returns used in this study are calculated using the major currencies trade-weighted U.S.-dollar index maintained by the Federal Reserve Bank of St. Louis, while broader movements in the stock market are controlled for using the Fama-French factors described in Eugene F. Fama and Kenneth R. French, ‘Common Risk Factors in the Returns on Stocks and Bonds’, *Journal of Financial Economics*, Vol. 33, No. 1, (Feb. 1993), pp. 3-56. The estimates were re-calculated using the USD-Israeli Shekel exchange rate to test for a correlation over time
observations used in the regressions. The firms were chosen because their shares have been continuously listed from 1985 to 2015—roughly the historical scope of this study. Admittedly, this does introduce the possibility of bias on the basis of survival, which would delegitimize the results if there is correlation between the exchange exposure risk of firms and their longevity. There is no immediately apparent reason to believe such a correlation exists, as many firms within the sector were absorbed during the period due to state-sanctioned industry consolidation, not financial difficulties related to exposure to foreign business or suppliers. Unfortunately, few firms in second-tier states met the inclusion criteria described above as most were, until recently, privately owned or owned by the state.

The coefficients for the effects of exchange rate returns and exchange rate volatility were calculated every 30 trading days over the 30-year span, using the last 504 days of trading activity in each calculation as a sample window. The choice of 504 trading days was a compromise between a larger number of observations to improve the precision of the estimates, and limited number of observations to allow for changes in the business model of the firm. The results of the regressions were plotted, along with their 95% confidence interval, over the term of the study and are located in Appendix I. Figure 13 contains an example of the coefficient estimates over the thirty-year study period for Northrop Grumman Corporation.

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that reflects the close integration of Israeli subcontractors with U.S. defense firms, as discussed below. The results of the shekel-dollar estimates mirror the results of the primary specification. Di Iorio and Faff also find that daily data produces better estimates compared to monthly data in their study of exchange exposure in the Australian stock market. Nonetheless, this possibility does warrant further study using the stock prices of delisted firms.
The results strongly suggest that the exchange rate exposure of the U.S. defense sector has not changed over the last thirty years. For the overwhelming majority of the observation periods for all the firms in the sample, estimates of exchange exposure risk are not distinguishable from zero at the 95% confidence interval. The same applies for estimates of stock price exposure to exchange rate volatility. One firm, CAE Inc., does exhibit more frequent periods of exchange exposure risk, which is consistent with it being the only Canadian firm in the sample. The results of the GARCH analysis therefore do not support the hypothesis that the defense industry of a first-tier state, the United States, has increased the use of imported goods over the last thirty years.

Conclusions
Between the end of the Cold War and the present day, the fortunes of the Third Tier have diverged. Based on the data discussed in the previous sections, growth of military industry in several countries slowed down significantly—in Argentina, Egypt, and Taiwan for example. In others, such as Australia, Brazil, and South Africa, the defense industry continues to innovate and export, although at lower levels than before. There are also clear successes within the group, notably Israel, which has almost established parity with the second tier as a major producer of military items, and Sweden, which has consolidated and specialized while maintaining a steady position in the export market. Finally, there are several national military industries that are on a growth path, such as South Korea and Turkey.
V. Explaining the Last Thirty Years

Post-Cold War Conventional Weapons Non-Proliferation Regimes

The political and institutional structure of the Cold War took time to unwind, and one such legacy structure, the Coordinating Committee for Multilateral Export Controls (CoCom), survived for more than a year. In March 1994, CoCom was dissolved as member states negotiated a new non-proliferation regime that was eventually adopted the following year: the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies.246 Neither informal regime impeded the development of the military capabilities of the third tier states, but for different reasons; this section will explain the irrelevance of these two multilateral export control regimes (MECRs).

CoCom could not control the proliferation of military production technology to the Third World because it lacked the correct focus. Originating in the broad strategic embargo that the United States and its Western European allies adopted in the early Cold War to weaken the Soviet economy, CoCom was designed by the United States and implemented, sometimes reluctantly in Europe, with the goal of hamstringing the military economy of the Soviet sphere.247 The logic was one of increasing costs through denial: coordinated export controls could make it more difficult for the WTO to upgrade its military systems, forcing it to commit more resources to military R&D to develop responses to Western military innovations. As such, it only requested its participant parties—the NATO countries plus Japan and Australia—to bar controlled items intended for export to the communist world.248

Further, CoCom states besides the United States were consistently unenthusiastic about its effect on their exports, and correspondingly implemented CoCom policy leniently. The United States

248 China was also included in the scope of CoCom restrictions.
initially accepted weak enforcement as an alternative to a complete lack of inhibitions on European trade with the Soviet bloc, but under Carter it attempted to persuade allies to tighten controls in exchange for expanded access to U.S. technologies. Following a scare in April 1982 after the publication of a CIA report entitled *Soviet Acquisition of Western Technology*, which warned of a concerted campaign to acquire militarily significant innovations in part through efforts to “legally purchase uncontrolled Western technologies” and the “diversion of controlled technology from legitimate trade channels”, the United States pushed CoCom to tighten controls while launching a “Third Country Initiative” to entice non-CoCom states to adopt equivalent controls on a bilateral basis in exchange for favourable technology transfer terms. Despite this effort, CoCom states generally only agreed to control items if they could be shown to have a “strategic” significance proven using U.S. intelligence. In particular, European states objected to U.S. efforts to control knowledge, skills, and information and limit technology-transfer mechanisms such as joint ventures, sale of turnkey plants, and provision of technical training. Eventually, and over the loud and continuing objections of allies, the Reagan administration began asserting extraterritorial jurisdiction over U.S.-origin technologies located abroad, requiring foreign entities to apply for export licenses from Washington to re-

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export controlled goods originally sourced from the United States.\textsuperscript{253} This effort was seen abroad “as conflicting with widely accepted principles of international law and national sovereignty”\textsuperscript{254}.

There are two reasons we might expect the Wassenaar Arrangement to have had an impeding effect on the proliferation of military production technology. First, the geographical scope it is intended to target was broadened—indeed, according to its founding document, the ‘Initial Elements’, the new regime “will not be directed against any state or group of states”\textsuperscript{255} The United States had advocated in negotiations a system that would allow targeting of international pariah states—at the time, Iran, Iraq, Libya, and North Korea—but in the face of allied objections accepted a broader goal of promoting international security.\textsuperscript{256} As a result, the global scope of the Wassenaar Arrangement suggests the creation of a club of militarily industrialized states and a coordinated effort to keep other states from accessing that club—refocusing nonproliferation efforts from the East to the South. The inclusion of the post-Soviet and former WTO states, which were persuaded to legislate and enforce export controls in exchange for technology transfer, reinforced the club-like quality of the Arrangement by bringing in nearly all the states with significant military production capabilities.\textsuperscript{257} In fact, inclusion and nonproliferation were explicitly connected; the United States opposed Russian participation until the latter agreed not to export military weapons or nuclear reprocessing technology to Iran.\textsuperscript{258}

\textsuperscript{258} Grimmett, ‘Military Technology and Conventional Weapons Export Controls’, p. 3.
Second, there are precedents for MECRs with a global scope and joint East-West membership, some of which have notched important nonproliferation victories. The Nuclear Suppliers Group (NSG), created in 1974 in reaction to India’s first test of a nuclear device, brought together the superpowers and important nuclear suppliers such as France. Its goal was to coordinate export control policies to prevent the spread of technology useful in the production of nuclear weapons, and has had successes in raising the costs of nuclear pariahs’ weapons programs. There also exists the Missile Technology Control Regime (MTCR), founded in 1987 in response to Iraq’s launch of medium-range ballistic missiles against Iran during their eight-year war. Export controls erected by the regime’s members prevented Argentina, Egypt, and Iraq from cooperating to develop the Condor II ballistic missile, and was effective in dissuading China from selling longer-range missiles to Pakistan and in pressuring Germany to prevent exports of missile-related technology to Libya and Iraq. The regime also noticeably slowed missile proliferation to Brazil, South Africa, South Korea, and Taiwan, while Poland and the Czech Republic destroyed Soviet-era holdings in order to qualify for admission.

Both the NSG and the MTCR have endured failures as well. States and their enablers, such as the network of Pakistani scientist A.Q. Khan, successfully circumvented export controls imposed on nuclear-related technologies, although the importance of these contributions is difficult to judge. Less well-known are defections from the MTCR, which included a West German contribution to the Indian Agni missile and a gradual softening of U.S. opposition to South Korea’s development of 300-kilometer-range and then, more recently, 800-kilometer-range ballistic missiles. The

MTCR ultimately could not prevent the improvement of Indian, Iranian, Israeli, North Korean, and Pakistani missiles to ranges of between 1,000 and 2,500 kilometers.\textsuperscript{264}

If the Wassenaar Arrangement has a broader scope and a more inclusive membership, its failings must be attributable to different factors. A critical one is the set of obligations agreed to by the Wassenaar founders in 1995. To be clear, these obligations are only political commitments; neither CoCom nor the Wassenaar Arrangement were regimes created by a treaty with binding, legal obligations.\textsuperscript{265} Nonetheless, these obligations differed between the two regimes. CoCom stipulated common guidelines and allowed any member to veto an export authorization. It was institutionalized; it had both a small functional secretariat and an ongoing conference of political representatives and national experts meeting on a weekly basis to conduct continuous reviews of export proposals. It conducted rolling reviews of three common control lists and discussed their implementation at the national level.\textsuperscript{266} CoCom’s lack of legal basis did not render it ineffective, and as such we cannot blame the informality of Wassenaar for its failings.

Rather, it is the specifics of the informal obligations adopted at Wassenaar that render it relatively weak. First, the United States could not convince the other parties to agree to continue the CoCom veto system, and indeed had doubts itself about granting new members a veto of arms sales to Israel or Taiwan.\textsuperscript{267} Instead, states agreed to notify each other of license denials, in order to coordinate efforts to thwart buyers seeking a different source for the technologies denied to them. Without a pre-transfer veto right, there was no reason for consensus review, and without consensus review, there also disappeared any justification for the physical footprint—frequent

\textsuperscript{264} Mistry and Smith, ‘The Missile Technology Control Regime, the Hague Code of Conduct, and Missile Proliferation’, p. 236.
\textsuperscript{266} Bertsch, Cupitt, and Elliott-Gower, ‘Multilateral Export Control Organizations’, pp. 35-39.
meetings and a secretariat—that had characterized CoCom. Second, the broadening of the geographical scope of coverage reflected the collapse of a shared perception of threat emanating from the Soviet bloc. While the ‘Initial Elements’ of the Wassenaar Arrangement state that the regime’s purpose is to prevent “destabilizing accumulations” of conventional weapons—a phrase used frequently in the early 1990s following the Gulf War—in practice this meant the regime only focused on states considered to be of immediate concern: Iran, Iraq, Libya, and North Korea. Indeed, the Wassenaar Arrangement has been most successful when a common threat emerges; this is evident in the adoption in 2003 of common export controls on man-portable air defense systems. Otherwise, the regime’s original primary sponsor, the United States, has been content to move toward ‘end-use’ controls, under which even non-listed items and technologies are to be controlled if they are to be used by specific militaries.

Third, while the negotiators of the Wassenaar Arrangement defended the weakening of obligations by pointing to stronger transparency commitments, the effectiveness of these measures is debatable. Because the transparency measures are inter-state and not oriented toward informing the public, it is not possible for outside observers to assess the degree to which they have influenced export control actions. Exceptionally, Michael Lipson noted that in the first round of data exchanges, 30 of 33 member states provided information on arms transfers, while only half the members did so for dual-use technologies. Without information about participation in subsequent data exchanges and the granularity of information exchanged, the usefulness of the transparency measures is difficult to infer.

Fundamentally, the Wassenaar Arrangement is ineffective because the political and economic circumstances at its inception were unfavourable toward a strong regime. The political background—the end of the Cold War—have been discussed. The economic background is equally important. CoCom was founded during a period of U.S. economic preeminence when Washington was able to entice European partners to enforce strict export controls with promises of access to advanced U.S. technology. By the latter half of the Cold War, when the Carter and Reagan administrations began an enforcement crackdown, European economies had recovered and the leverage offered by U.S. technology had declined. Equally importantly, militaries became increasingly reliant on civilian technologies. This had three effects: first, the application of the ‘militarily significant’ standard became harder as the line between military and civilian technologies blurred; second, the rate of innovation accelerated, making control lists harder to maintain; and third, listing technologies originating in the civilian sector was more politically contentious as it cut off access to profitable civilian markets. In sum, the weakness of the Wassenaar regime reflected the culmination of a long trend of growing criticism about the economic effects of CoCom.

The result has been discordant export policies. For example, while the United States and its European allies agreed in principle to bar arms sales to Beijing following the Tiananmen Massacre of 1989, between 1993 and 2002 France sold China USD 120 million in defense items through an exception for dual-use goods. Similarly, the United Kingdom transferred engines for the JH-7 combat airplane as well as an early warning radar system, while France and Germany provided marine diesel engines for Chinese submarines and frigates. The lack of a common policy meant U.S. nonproliferation goals were undermined while U.S. companies, such as the aviation firm Grumman Corp. which until 1989 was helping upgrade the J-7M fighter aircraft, were denied access to the market. Alternatively, the goal of preventing the destabilizing accumulation of weapons systems also seems to have not been successful in some regions. One result of Chinese re-armament has been a slow-moving naval arms race in Southeast Asia; around the world, submarine fleets have shrunk since 1990 except in two regions, the Middle

274 Gansler, Democracy’s Arsenal, p. 312.
East—where total numbers have increased from 26 to 36 deployed boats—and Southeast Asia, where 176 boats in 1990 have increased to 229 in 2015, a 30% increase.\textsuperscript{276} France, Germany, Russia, and South Korea—all founding members of the Wassenaar Arrangement—have exported submarines to the region.\textsuperscript{277}

The political and economic context of the Wassenaar Arrangement’s founding should render the result unsurprising. European negotiators were consistently motivated by a desire to loosen controls on dual-use items that could be economically profitable, ignoring the difficulty exporters face in determining the end-use of these items. A recent study of manufacturers in Flanders\textsuperscript{278} determined that within the region’s defense industry, which is dominated by producers of components for integration abroad, among exporters the level of “effectively unknown end-use” was between 60% and 78%.\textsuperscript{279} At the same time, the United States settled for a regime that could serve its short-term interest in isolating pariah states, passing on the possibility of a regime that could manage long-term proliferation risks.

The Peace Dividend - Market Oversupply and Falling Demand
By 1985, the international market in military hardware had become a buyer’s market. The “market shift” was detectable in an increase in offset demands—previously, simple cash or credit terms had been the norm—and in increasingly competitive finance terms. Reports of bribery by exporting firms to secure contracts were becoming increasingly common; early reports of fraud charges in India implicated eight contenders for a howitzer contract. Importers could demand and receive the most advanced weapons systems despite first-tier reluctance to supply them, and some Third World countries, such as Jordan, Kuwait, and Nigeria, had the temerity to play one superpower off against another.\textsuperscript{280}

\textsuperscript{277} According to the SIPRI Arms Transfers database, available at http://www.sipri.org/databases/armstransfers.
\textsuperscript{278} Belgium’s federal structure delegates export controls to the country’s two regions, Flanders and Walloon.
\textsuperscript{279} Tomas Baum and Nils Duquet, \textit{Flemish Foreign Arms Trade 2013} (Brussels: Flemish Peace Institute, 2015), p. 17.
That was before the Cold War ended and the new governments of the post-WTO and post-Soviet countries began selling off excess military equipment. While the extensive pilfering of the Ukrainian arsenal—totaling materiel worth USD 32 billion before 1998—is now infamous, state-sanctioned arms transfers across the region were also considerable.281

_Figure 14: Exports from Ex-Soviet/Ex-WTO countries. Units are SIPRI Trade Indicator Values. Source: SIPRI Arms Transfers Database._

The flood of illegally exported weapons has been blamed for the easy availability of small arms in the 1990s’ numerous low-intensity conflicts and civil wars, and their accessibility to illicit arms brokers goes some ways towards explaining the ineffectiveness of arms embargoes on Liberia, Somalia, Rwanda, and Sierra Leone.282 Eventually, some of the Eastern European nations tightened their export controls and enforcement efforts as part of NATO or EU accession processes.283 However, legal exports also had an effect on the market in major conventional weapons systems is less clear. Ironically, in seeking to escape dependency on foreign suppliers, the third tier may have become too reliant on foreign customers to endure the new competition in cheaper, last-generation military hardware.284


284 An irony pointed out in Ross, ‘Developing Countries’, p. 117.
To evaluate whether the sell-off of post-Soviet and post-WTO military systems hurt the Third Tier states, I compiled a list of the top 30 importers of third tier military goods between 1970 and 1990, which together accounted for 85% of the exports of the third tier states. As a percentage of their total arms imports, six of these 30 nations imported more from the WTO (including the Soviet Union) during that 20-year period than from the third tier, while 24 imported more from the third tier. In the decade from 1990 to 2001, five states continued importing more from the post-WTO states (including Russia), while one swapped to importing more from the third tier. Meanwhile, of the 24 states that previously imported more from the third tier, 15 states continued importing more from the third tier while nine swapped to importing more from the post-WTO states. If we exclude the NATO states from the analysis on the assumption that these would have been unlikely to swap to WTO-imports because of interoperability challenges, those figures become 11 and nine – a 45% swap rate.

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285 After removing Yugoslavia and South Vietnam from the data set for reasons of comparability.
Table 2: Analysis of Third Tier customers. Data from SIPRI Arms Transfers Database.

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<td>30.8</td>
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The buyer’s market influenced indigenization efforts in one other way: it made the costs of local projects more difficult to justify when foreign suppliers were willing to offer better weapons systems for less money. This dynamic was most apparent in Taiwan, which suffered a major setback to its Indigenous Defensive Fighter (IDF) program due to a reversal in Western arms sales policies. Prior to the 1990s, the United States and France had been unwilling to anger Beijing by providing advanced combat jets to Taipei; Washington’s refusal to sell the F-20 Tigershark, specifically designed by Northrop with second-rate characteristics for the export market, provided the initial impetus for the IDF. When Taiwan signed a contract in 1992 for 150
F-16s and 60 Mirage 2000-5s, the number of IDF jets to be acquired was slashed from 250 to 130.²⁸⁶

Oversupply in the international arms market was only one effect of the end of the Cold War. The sea change in international relations also resulted in lower military expenditure in parts of the world—most noticeably in Europe. To cope with smaller budgets, militaries turned to life extension plans and away from acquisitions of new, expensive platforms, particularly military aircraft. As of 1994, there were 300 second-hand military airframes contracted for delivery between 1993 and 1997; of more than 7,600 combat aircraft in Southeast and East Asia in service that year, 85% were obsolete and designed before 1966.²⁸⁷ Life extension programs kept early Cold War designs flying, such as the U.S. F-5 and the Soviet MiG-21. For third tier countries, the consequences diverged. States seeking to develop and market indigenous platforms were left with few customers to spread costs with, but states that had focused on upgrading and improving (“retrofitting”) mature weapons systems stood to benefit. Brazil’s Engenheiros Especializados (commonly known as Engesa), a designer and producer of armoured vehicles, poured USD 100 million of its own money into developing a main battle tank in the mid-1980s that found no buyers; the firm subsequently declared bankruptcy in 1993.²⁸⁸ Similar, if less ignominious, fates befell the AMX jet fighter project, a collaborative effort with Italian firms Aermacchi and Aeritalia, and the Inhauma-class corvette, both of which were substantial investments with recognized risks.²⁸⁹ In contrast, Israel, North Korea, and Singapore, all countries with a long history of relying on ‘add-up’ to improve foreign designs through incorporation of local components, followed the opposite strategy. While the development of North Korea’s military has been hampered by sanctions, the Israeli and Singaporean national industries were able to adjust to the post-Cold War era in part by taking advantage of the market for upgrades, particularly electronics.²⁹⁰

A second reason the peace dividend had divergent effects on the third tier is simply that the improvement in international security was uneven across regions. In Latin America, defense spending remained low through 1994, as relations improved among the regional powers, particularly Argentina, Brazil, and Chile in the Southern Cone. Whether because of growing economic integration, transitions to democracy, or solutions to sources of mistrust—such as the nuclear ambitions of Argentina and Brazil—the security threats perceived by the three states fell away in parallel with, but independently of, the end of the Cold War.\(^{291}\) As seen below, the third tier states of Latin America made little effort to increase their military effort over the decade: Brazil’s military expenditure rose along with its economy, while Argentina’s expenditure declined as a proportion of gross national product. Later, when military expenditure rose by 50% in Brazil between 2003 and 2009, this was driven more by appeasement of the military staff than external perceptions of threat.\(^{292}\)

Figure 15: Military Expenditure of Three Latin American Countries. Source: WMEAT 1999.

Contrast that trend with the regional pattern in East Asia, where there was no peace dividend in terms of reductions in military spending.\(^{293}\) Declining global sums of defense expenditure

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\(^{293}\) Geoff Harris, ‘Military Expenditure and Economic Development in Asia during the 1990s’, in Jurgen Brauer and J. Paul Dunne, Eds., *Arming the South: The Economics of Military*
through 1997 are the product of an outsized U.S. contribution; while U.S. spending declined and then held steady until after the September 2001 terrorist attacks, they never fell in Asia.\textsuperscript{294} Looking back on the decade in 2002, Geoff Harris could list several competing theories to explain the lack of a regional peace dividend: rising expenditure in line with fast-growing economies, balancing against China, hardware acquisitions as symbolic assertions, small arms races among local rivals, refocusing on external security after periods of domestic upheaval, or spending as part of natural cycles in military modernization.\textsuperscript{295} By 2010, however, it had become clear to Bitzinger that “[m]any of these countries – particularly in the Asia-Pacific – appear willing to pay the premium for achieving high levels of autarky in arms acquisition.”\textsuperscript{296} China and Japan are still willing to accept inefficiencies and reluctant to allow foreign investment in their defense industries, as is India—not an East Asian country but clearly a state whose military capabilities affect East Asian investments. South Korea only reformed its defense industries following the failure of its \textit{chaebols}, family conglomerates that had previously internally subsidized military research, precipitated by the 1997 financial crisis.\textsuperscript{297} During the subsequent reorganization of the \textit{chaebols}, which encompassed all of their corporate sectors, one stated goal was to attract foreign direct investment following rationalization and consolidation, but when the newly formed Korean Aerospace Industries was approached by a Boeing-BAE consortium to take a 35% stake in the new national champion, the Korean government opted for a USD 440 million bailout rather than compromise with the potential investors’ demands for a degree of managerial control.\textsuperscript{298} Similarly, while the strategic rationale for upgrading tanks faded with the end of the Cold War as North Korea could no longer rely on the Soviet Union for modern tanks, the government decided to continue replacing old tank turrets with new ones to keep Hyundai Precision Industries’ production lines open.\textsuperscript{299}

Enduring Economics and Technological Trends – Part 1: Confronting the Costs

Finally, the divergence in fortunes among the third tier states can be explained by two factors: the enduring economic challenges to creating a full-spectrum indigenous military industry, and the increasing ‘civilianization’ of defense innovation. States that attempted to pursue the heavy industry and associated engineering capabilities to establish a traditional defense industry ran headfirst into economic reality, while those that specialized to leverage advanced civilian technologies were able to maintain one foot in the export market.

The freedom from dependency sought by the third tier is difficult to achieve. Being small individual consumers of defense goods in a global buyer’s market, the third tier states cannot achieve the economies of scale needed to make costs manageable. First- and second-tier states can accept and subsidize the defense sector’s permanent overcapacity, while poorer countries cannot—indeed, the smaller second-tier states are increasingly struggling to sustain the burden. The industry provides few late-comer advantages; there are high barriers to entry and tight controls on technology, as well as barriers to export to large first- and second-tier markets. Those third tier states that are developing countries with weak industrial bases must invest across a wide range of subcomponents in order to create one final weapons system. For

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301 Krause, Arms and the State, p. 58; second-tier producers are tackling overcapacity through mergers and giving up on autarky, see Mabee, The Globalization of Security, p. 99.
example, one of the key barriers to development of an indigenous main battle tank is the lack of large foundry pieces in developing countries, as these are difficult to produce and have few applications.304 But states that surmount the initial costs of setting up specialized heavy industry capabilities enjoy only a few years of economic sustainability before a second, even steeper investment demand emerges: the mass inputs of scientists, engineers, technicians, equipment, and production technology needed to produce the innovation that underwrites a competitive arms industry.305 This explains why certain third tier countries failed to advance to sustainable indigenous production of complete weapons systems; the Lavi strike fighter program, besides being a commercial failure, almost bankrupted Israel Aircraft Industries, and Egypt could not build on its modest success in producing Dassault’s Alpha Jet under license.306 Bitzinger blames “technology overreach” and “technonationalism” for overly complex projects that could not be justified in terms of cost, local sourcing, or economies of scale.307

Collaboration is no panacea; the United Kingdom’s National Audit Office found that development costs in collaborative projects were 140% to 200% higher than costs in comparable national programs.308 In explaining why this happens, Marc DeVore argues that delegation of collaborative activities to profit-minded firms creates a principle-agent problem that is attenuated by the monopolistic structure of defense industries, resulting in wasteful spending. Further, collaborative production requires successful management of antipathies created by the collective action problem, such as states seeking relative advantage in industrial roles or demanding a single weapons platform play multiple roles. This produces duplicative production lines and compromise designs with inferior capabilities, respectively, each of which increases costs.309 Further, as explained by Jonathan Tucker, as a third tier state’s capabilities improve, first- and second-tier firms will likely become less willing to collaborate out of concern that doing so

306 Krause, Arms and the State, p. 173.
308 Gansler, Democracy’s Arsenal, pp. 314-315
would create a potential future rival.\textsuperscript{310} And without a single large customer to anchor demand for a collaborative project, third tier states have a harder time than first-tier producers convincing prospective development and production partners to join a project.\textsuperscript{311}

In the face of these economic realities, a small number of third tier states have decided to bear the cost. The most drastic example is Israel, which continued to devote a third of all government expenditure to defense through the early 1980s, as well as a third of expenditures on investment. In that decade, another third of government expenditure went to servicing debts—much of which was the result of past defense expenditures.\textsuperscript{312} In 1982, the country’s defense budget was equal to 32\% of gross national product, and debts attributable to defense costs totaled USD 7.9 billion.\textsuperscript{313} The economic sacrifice was massive; deficit spending produced an inflation rate of 135\% in 1980.\textsuperscript{314} The result, however, was a stark decline in imported content from 98\% in 1967 to 17\% in 1989.\textsuperscript{315} The extent to which Israeli-designed weapons systems, such as the Merkava main battle tank, were attaining capabilities comparable with NATO and WTO equipment first became visible after the 1982 war in Lebanon.\textsuperscript{316} During that conflict, Israel’s early innovations with what were then referred to as “remotely piloted vehicles” for battlefield intelligence were also first tested.\textsuperscript{317} In the mid-1980s, the arms industry was by far the most sophisticated sector in the Israeli economy, with the electronics, aeronautics, and specialty metals industries

\begin{footnotesize}
\begin{enumerate}
\item Tucker, ‘Partners and Rivals’, pp. 89-91.
\item Caverley explains this problem in light of the challenges faced by the Eurofighter compared to the JSF. Caverley, ‘United States Hegemony and the New Economics of Defense’, p. 607.
\item Steinberg, ‘Israel’, pp. 286, 289.
\item Steinberg, ‘Israel’, p. 289.
\item Shichor, ‘Israel’s Military Transfers to China and Taiwan’, p. 75.
\item Harkavy and Neuman, ‘Israel’, p. 200. Hasik argues that the development of remotely piloted vehicles in Israel was a result of “selective factor disadvantage”; because manpower was scarce and precious, a premium on avoiding pilot casualties prompted military industry to prioritize research in unmanned systems. See Hasik, \textit{Arms and Innovation}, pp. 46-47.
\end{enumerate}
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dominating the country’s high-technology sector.\textsuperscript{318} Arms exports accounted for a third of all industrial exports by 1981.\textsuperscript{319}

Of course, Israel is unique both in its security environment and the resources available to its industrial planners. From its fraught beginnings as a regional pariah, the debate on how government spending should be allocated was never a choice between guns and butter; “it has been a guns versus guns debate; whether the materiel should be purchased in Israel or from another country”\textsuperscript{320}. Aside from the extensive practical lessons derived from frequent existential wars with hostile neighbours, the high state of military preparedness—specifically, mandatory military service—also benefitted the arms industry by producing a workforce with widespread technical training.\textsuperscript{321} Additionally, the young nation had access to unique stocks of imported human capital: Jewish scientists and engineers immigrating to Israel. For instance, the core of Israel Aircraft Industries’ early engineers were Americans who fought in the Israeli war of independence.\textsuperscript{322} Finally, Israel was able to fund much of its military research and development through exports of subcomponents to a uniquely open U.S. market, as well as direct U.S. financial aid.\textsuperscript{323}

Notwithstanding these distinct advantages, by the 1990s the Israeli armaments industry was in decline and searching for new export clients as traditional customers, such as Latin America’s conservative dictators, disappeared.\textsuperscript{324} The Middle East Peace process, while interminably frustrating and slow to produce results, permitted the government to reduce defense budgets from 13.2% of GNP in 1982 to 8.2% by 1992.\textsuperscript{325} Ambitious programs such as the Lavi strike aircraft were scrapped, and industrial policy refocused on preserving core competencies, such as

\textsuperscript{319} Harkavy and Neuman, ‘Israel’, p. 211.
\textsuperscript{321} Carus, ‘Israel: Some Economic and Social Considerations’, p. 144.
\textsuperscript{322} Steinberg, ‘Israel’, pp. 278-279.
\textsuperscript{323} Jackson, ‘Arms Production’, pp. 236-240.
\textsuperscript{324} Harkavy and Neuman, ‘Israel’, p. 204.
\textsuperscript{325} Shichor, ‘Israel’s Military Transfers to China and Taiwan’, p. 75.
command and control systems, communications equipment, and electronic warfare systems, as well as various categories of tactical missiles.\textsuperscript{326}

Without Israel’s existential imperative and unique financial and human capital resources, few other states have been able to succeed in squarely confronting the economic challenges to establishing a broad, comprehensive military industrial base from scratch. One other potential success is China, which is outside the scope of this analysis. A more slow-moving and less clear-cut success is India. Like China, India is a large country with great power ambitions, and yet like other third tier countries, it is still a developing nation with uneven industrialization. Like Israel, it has frequently clashed with its neighbours and faces an insecure security environment, yet does not face any existential threat due to its far greater strategic depth. Potentially, India has both the size and the security imperative to pursue broad-based military industrialization.

Despite being one of the earliest Third World states to locally produce complete weapons systems, mostly under license, the country has struggled to progress toward indigenous design and development. In the period 1950-1954, together with Argentina and Brazil, India jointly produced 80\% of all Third World defense goods.\textsuperscript{327} In 1980, it was manufacturing ships, missiles, aircraft, and armoured vehicles—one of only six Third World countries able to do so, alongside Argentina, Brazil, China, India, Israel, and South Africa.\textsuperscript{328} As discussed above, the Indian government has continued to devote a very large portion of government research and development funding, about 30\% to 35\%, to the military sector. Consistently, it has pursued a policy of indigenization, demanding “licenses, a high degree of indigenous work, transfers of technology and know-how, and participation in the development and design processes” as well as the right to export parts produced under license or with the assistance of foreign manufacturers.\textsuperscript{329} Typically, weapons systems produced in India would begin with a high-proportion of imported subcomponents, with foreign content gradually substituted for with

\textsuperscript{327} Neuman, ‘International Stratification and Third World Military Industries’, p. 173.
\textsuperscript{328} Neuman, ‘International Stratification and Third World Military Industries’, p. 178.
\textsuperscript{329} Tuomi and Väyrynen, \textit{Transnational Corporations, Armaments and Development}, pp. 198-199.
domestically produced parts over the life of the production run. Thus, Vijayanta main battle tank, based off of the British Chieftain, used 43% local content in 1968 and 68% local content by 1972 after 400 tanks had been manufactured.330

Indian military industry has continued this strategy of gradual indigenization. From 1986, India moved away from a heavy reliance on Soviet systems and began a military rapprochement with the United States. The deal that launched this move included the sale of General Electric F-404 aircraft engines for incorporation in an indigenous Light Combat Aircraft (LCA), indicative of the continuity in approach.331 Thirty years later, it is not clear that the country’s industry has been able to bridge the gap between integration of foreign subcomponents and indigenous design. In January 2011, India launched its first official defense production policy, with a goal of achieving 70% self-reliance in equipment; in 2011 only 30% of defense procurement was from domestic sources. Consulting firm Deloitte estimated that in order to meet that goal, domestic industry would have to double its output every year for five consecutive years—an unlikely event.332 To encourage further investment in the private defense sector, a major point of controversy has been the government’s cap on majority foreign ownership of private defense firms.333 This cap is not necessarily a deterrent by itself, but its intersection with India’s offset policy, last updated in 2006, which requires foreign vendors to invest in Indian defense firms or buy from Indian suppliers, has made foreign investment a “non-starter” as defense firms are unlikely to put funds, much less technology, into joint ventures over which they cannot exert a degree of control.334 The recent, high-profile failure to negotiate technology transfer and coproduction terms for the sale of 126 Dassault Rafale combat aircraft, of which India sought to produce a majority domestically, highlight the continuing difficulty the government has had in

333 This bar, which was set in 2001 at 26% of equity ownership, was raised in August 2014 to 49%. See Rajat Pandit, ‘Hike in defence FDI cap fails to lure investors’, The Times of India (online), Mar. 11, 2015, available from http://timesofindia.indiatimes.com/india/Hike-in-defence-FDI-cap-fails-to-lure-investors/articleshow/46522466.cms.
convincing foreign partners that assisting the Indian military industry will not result in long-term competition. Additionally, indigenization remains slow-paced. The LCA project, first initiated in the 1980s, eventually produced the Tejas LCA, achieving initial operational clearance in December 2013. The program’s cost was projected in 2004 to total USD 4.3 billion, but by 2014 that figure had grown to USD 7.9 billion. Since then, the plane has been criticized by the country’s Comptroller and Auditor General for shortfalls in operational capabilities and being only 35% indigenous in content—half the proportion touted by Hindustan Aeronautics Limited, the state-owned manufacturer.

Nonetheless, the Indian military sector continues to expand. There are a growing number of small- and medium-sized enterprises providing outsourcing services to the major government-owned munitions factories. According to an estimate made by KPMG and the Confederation of Indian Industry, India’s Ordnance Factories and other Defence Public Sector Undertakings new outsource 20% to 25% of their work to these smaller firms. New service-oriented partnerships have also been established, such as a helicopter-maintenance joint venture between Vectra Group India and Russia’s Vertolety. Most significantly, India has maintained strong industrial links not only with traditional supplier Russia, but also Israel. The latter provided a USD 1.1 billion airborne early warning and control system to New Delhi, and is co-developing the Barak-2 surface-to-air missile with India.

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340 Gansler, Democracy’s Arsenal, p. 336.
The achievements of Israeli industry and partial success of Indian industrialization should not be underestimated. Other national military industries with less pressing security imperatives and generous government support have regressed. Egypt’s defense industry suffered three periods of decay: once in the 1960s when U.S. and European pressure, as well as Israeli terrorist attacks, persuaded foreign scientists and technicians—mostly Germans—to abandon Cairo; for the second time after 1979 when Gulf countries pulled their financial backing for joint military projects in response to the Egyptian détente with Israel; and again in the 1990s as the country’s main specialization, cheap versions of Soviet designs, lost their market niche to the ex-WTO arsenal and increasing competition from other third tier producers.\(^\text{341}\) Some firms have half-survived by diversifying away from defense markets to relieve overcapacity. For example, Singapore Technologies Group, which in the 1980s was heavily defense-oriented, moved to accruing 62% of its revenues from civil businesses in the 1990s, sustaining an otherwise overcapacity enterprise.\(^\text{342}\)

**Enduring Economics and Technological Trends – Part 2: Embracing Specialization**

The ‘civilianization’ of the defense industry has provided an alternative to traditional heavy-industry- and government-R&D-intensive strategies for third tier states. Focusing on retrofitting, as Singapore and Israel have done, is part of a more general strategy of adapting specialized competencies, particularly in civil electronics, to remain part of the defense market. “Spin-on” from the civil sector, wherein research is funded by profitable products rather than meagre state budgets, has also been pursued in the first- and second-tiers; it was an explicit focus of the merger between first-tier aerospace firms Boeing and McDonnell Douglas in 1997. The post-merger firm is largely separated into civil and military divisions, a legacy of each the two firms’ core competencies, but features a joint spin-on unit dedicated to applying each division’s innovations to the other.\(^\text{343}\)

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\(^{342}\) Willett, ‘East Asia’s Changing Defence Industry’, p. 129.

The third tier states that can benefit from “spin-on” are few. One is South Korea, which has experienced incredible growth in its high-tech industries over the last twenty years and has therefore been well-placed to integrate civil and military research and development. In 1998 and 1999, the government passed laws to promote dual-use technologies and the participation of technologically advanced civilian firms in the defense industry, respectively.344 By combining an existing capacity to produce major weapons systems under license or in collaboration with U.S. firms with the country’s indigenous electronics industry, the government sought to develop complete weapons systems without U.S.-origin content, through which the United States can and has exerted an extraterritorial re-export veto.345 The intended effect of these laws was unintentionally undermined by the government-led restructuring of the chaebols’ defense subsidiaries, which delinked civil and military research, as well as a policy of Specialization and Systemization, which barred duplicative research but erected barriers to entry.346 This latter policy was terminated in 2008, but the long period of government protection had already created an oligopoly in some sub-industries; an anti-trust investigation found in 2012 that two shipbuilding contractors, Samsung Thales Co., Ltd. and LIG Nex1 Co. had conspired to split contracts related to the construction of the country’s third-generation of attack submarines.347 The net result has been expanding exports, but production still largely focused on satisfying domestic demand.348 At present, the country has been pinning its hopes on the KT-1 and TA-50 trainer aircraft, which were developed with help from Lockheed Martin for the export market.349

In moving away from “bending metal” and “prestige” platforms, countries like South Korea and, to a lesser extent, Taiwan have been able to adjust to a global defense industry that has seen creeping globalization despite the best efforts of states to preserve autarky. Unlike the globalized defense industry of the nineteenth century, the globalized defense industry of the twenty-first century features transnational integration of supply chains. Manufacturers of critical subcomponents have concluded that leveraging their exports can ensure the continued supply of complete weapons systems. Defense contracts are no longer just procurement deals, but also a critical way to obtain dual-use technologies through offset terms that commercial contracts cannot provide. The global industry is now characterized by a “hub and spoke” structure, or alternatively, “rapidly changing constellations” of companies, with a greater focus on systems integration and less focus on vertical integration. The third tier states may find it increasingly attractive to find a niche within this network structure and establish their comparative advantage as a manufacturer of critical components for other members of the network. Those which can find a niche—such as the technologically advanced East Asian states—will benefit more than those which cannot.

Within this globalized industry, the question of who benefits the most is difficult to answer. Stephen Brooks argues that with the increasing importance of being a part of multinational networks, the opportunity costs of choosing isolation—the price of autarky—increase. The experience of India suggests this may be true; that raising barriers to foreign direct investment can handicap the development of indigenous capabilities. However, as Jonathan Caverley argues against Brooks, the globalization of military supply chains benefits the international system’s military hegemon, the United States, because interdependence inevitably spreads to all states that wish to remain at the leading edge of military technology creating common vulnerabilities. At

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the same time, the United States can retain an advantage in the difficult practice of systems integration, with which its prime contractors have unrivalled experience. However, with easier cross-border access to technologies, the opportunities to leap-frog the first-tier states may increase. For example, in 2009, China’s Xian Aircraft International was able to buy Fischer Advanced Composites of Austria, quickly obtaining an advantage in special materials, while a Chengdu Aircraft Company designer was able to convince a California-based laboratory to test advanced composites for the aerospace firm. Conceivably, the third tier states may find that these opportunities allow them to once again narrow the gap with the established producers of the global military industry.

358 Bitzinger, Raska, Lean, and Weng, ‘Locating China’s Place in the Global Defense Economy’, p. 188.
VI. In Conclusion: a Roadmap for Further Research and a Glance at the Future

In Section IV, this study finds clear evidence in publicly available data that the last thirty years have imposed a decisive test of will on the third-tier states. Those states have responded by specializing, intensifying investment, or exiting the arms market, as described by the scholars and experts cited in this paper. In Section V, it also presents evidence that suggests the end of the Cold War disrupted the market to the detriment of the third tier states, while regional the peace dividends may also have played a role in sapping support for military industrialization. It further establishes that the Wassenaar Arrangement, a post-Cold War multilateral export control regime, was not designed to and therefore could not control the proliferation in military production technology.

Given the lasting importance of confronting the proliferation of conventional weapons, as established in Section II of this paper, the trend toward survival and adaptation by certain members of the third tier raises research and policy questions that cannot be covered in this study. The research questions frame a program of study that would focus on identifying in detail the factors at the level of industrial engineering and institutional design that enable or inhibit the success of de novo military industry. This program of study could begin with comparative industrial studies from the arms-length distance of a library, but in all likelihood, due to the paucity of more detailed literature on military industrialization in the third world, would have to incorporate original qualitative data-gathering. The model for such a program of study would be Yudit Kiss’ investigation of the decline of the ex-Soviet and ex-WTO military production factories, which relied heavily on interviews with persons intimately involved in the management of those enterprises.359 Access to such persons may be easier to obtain in Latin America, where a regional peace has decreased the sensitivity of defense issues, than in Asia, where security concerns are returning to the fore.

The many potential policy questions raised by this research would center on the uncertainty of whether military industrialization is likely to continue spreading. While states like Argentina and Egypt dropped from the third tier and others, such as Israel, graduated out of it, there is always

359 Kiss, Arms Industry Transformation and Integration.
the possibility that new states will rise to join the group. This has the potential to trigger again a new cycle of insecurity and public waste, no less damaging to the development of young nations as in the earlier wave of military industrialization that began in the 1970s. Alternatively, it is possible that the market contraction of the post-Cold War period has not finished destroying incentives to establish military industry and the number of arms producers will continue to decline. After all, as Krause pointed out in 1992, there is no reason to assume continuous expansion in the global market. Several factors that will affect the likelihood of further proliferation of military industry will be discussed below.

The Arms Trade Treaty
First, the conventional arms control regime complex has been bolstered by a new convention, the Arms Trade Treaty (ATT) of 2013 which entered into force on December 24, 2014. This treaty employs two strategies to slow proliferation: first, ensuring minimum standards for national systems of export control, and second, promoting common criteria for denying exports (or re-transfers) of conventional weapons. It contains several complete prohibitions on the transfer of weapons: when they violate UN sanctions; when they violate international agreements on the transfer or illicit trafficking of conventional weapons; and when they are likely to be used in “the commission of genocide, crimes against humanity, grave breaches of the Geneva Conventions of 1949, attacks directed against civilian objects or civilians protected as such, or other war crimes”. While these obligations—particularly the last one—are weighty, additional obligations that might prevent conventional weapons proliferation are much weaker. Notably, states are only obliged to stop an arms transfer that could “undermine peace and security” if it determines there is an “overriding risk” of this outcome—and it is free to make that determination on its own behalf. Further, the scope of the treaty includes only weapons systems and their parts and components, but does not cover production technologies, dual-use items, or technology transfer. The spread of military production was simply not the focus of the

362 ‘Arms Trade Treaty’, Article 7, Par. 1(a) and Par. 3.
drafters of the ATT, and thus it is unsurprising that its obligations against enabling that spread are non-existent.

**Growing Economies in Three Candidate Countries**

Second, given Neuman’s finding discussed in Section III that larger states, at least in terms of economic output, are more likely to engage in military production, we must assess whether there are fast-growing economies likely to take up military industrialization. Of the twenty-largest countries by gross domestic product in 2014, a small number have not been discussed in this text: Mexico, Saudi Arabia, and Indonesia. Mexico has persistently been a troubling case of the dog that failed to bark for theorists seeking generalizations about the impetus for military industrialization. Its size and level of industrialization suggest it as a prime proliferation candidate, yet military industry in Mexico has never flourished. Neuman notes that Mexico’s military has also historically been relatively small, while Brzoska suggests that secure borders produce little rationale for a domestic arms industry.363 Both explanations remain applicable today: Mexico’s security forces remain focused on a low-tech struggle with criminal elements, while it remains unthreatened by either the giant to the north or its southern neighbours. Recently, it has experimented with assembling Dutch-designed offshore patrol craft and mine-resistant vehicles designed in Israel on a Ford chassis, but these ventures into licensed production are still relatively low-complexity exceptions to a general trend of purchasing weapons systems from foreign countries, primarily the United States.364

Saudi Arabia, while importing USD 75.7 billion in foreign-origin weapons systems between 2004 and 2011, has also not been persistent in seeking to establish a domestic arms production capability despite clear demand.365 Instead of taking advantage of the leverage offered by the volume of its arms purchases to mandate technology transfer and co-development, the Saudis have preferred offsets into civilian industries. For example, the offsets required as part of the Al-Yamamah arms package, negotiated with the United Kingdom in 1985, included British

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364 Data from the SIPRI Arms Transfers Database’s Trade Registers, for 1992-2014 deliveries to Mexico.
investments in pharmaceuticals, livestock feed, linseed oil, and refined sugar, while in 2006, Raytheon fulfilled an offset obligation by funding a shrimp farm. While the monarchy has at times attempted to negotiate co-production arrangements for major acquisitions such as the F-15 combat jet, it is susceptible to the petitions of defense planners who typically argue for straightforward acquisitions. Indeed, in the period 1992-2014, despite importing tens of billions of dollars in weapons systems, primarily from the United States, the United Kingdom, and France, Saudi Arabia requested co-production arrangements for only two deals: it produced components for 315 U.S. Abrams tanks imported from 1993 to 1994, and assembled 50 MSTAR ground surveillance radar units purchased as completed kits from the United Kingdom between 1998 and 2000. The result of this wavering, if not token, commitment to indigenization has been a small arms industry employing around 6,700 people (many of whom are foreign experts), focused on maintenance and repair.

Indonesia, on the other hand, had developed the second-most-advanced defense industry in Southeast Asia after Singapore’s in the late 1980s, producing licensed designs of warships and aircraft, as well as small arms and ammunition. Jakarta appears to have been motivated by past experience with unwilling suppliers—the Soviets during the 1960s, and the United States in both the 1950s and 1960s—but also driven by a belief that strategic industries are a critical component of national economic development. The prospects for further Indonesian military industrialization are unclear. On the one hand, Indonesia’s location in a region roiled by the growing power of China might incline it to seek greater autonomy. However, as previously

368 Data from the SIPRI Arms Transfers Database’s Trade Registers, for 1992-2014 deliveries to Saudi Arabia.
372 Blank and Kim, ‘Arms Sales and Russia’s Future as an Asian Power’, p. 280; Indonesia also disputes certain maritime boundaries with China but has not indicated that these disputes are a key security concern, see Prashanth Parameswaran, ‘A New Indonesia Military Base Near the South China Sea?’, The Diplomat (online), Jul. 17, 2015, available from
mentioned, the country’s past experience with arms production produced few of the promised technological benefits for the wider economy, and the arms industry was largely designed and promoted by a single personality, Dr. B. J. Habibie, long-time minister for research and technology, who ended his career briefly serving as transitional president in 1998-1999.\(^{373}\) While news broke in 2010 that Indonesia will co-develop a modern jet fighter with South Korea, the scale of Indonesian involvement in the project seems limited to providing about 30 engineers and 20% of the budget.\(^{374}\) The scope for Indonesian aerospace engineers to contribute seems to have been narrowed even further with the announcement that the prime contractor, Korea Aerospace Industries, will be simultaneously partnering with Lockheed Martin to design the new plane.\(^{375}\)

**Evolution of the Arms Industry – Globalization and Civilianization**

The arms industry remains a simple business in internal conflicts, with small arms and light weapons enough to launch a rebellion, and basic artillery sometimes enough to win one.\(^{376}\) At the level of international conflict, however, at which actors have the capital resources to produce sophisticated weapons systems, the arms industry is evolving from its roots as a nationally based business with clear separation from the civilian sectors. As previously discussed in Section VI, this evolution is the result of two trends that originated in the civilian sphere: globalization and the information revolution. With prime contractors sourcing from a global network and small manufacturers able to specialize based on existing civilian competencies in high-tech sectors, the arms industry will no longer be composed of single-purpose national institutions.

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\(^{375}\) Joyce Lee, ‘South Korea picks KAI, with Lockheed, for $7.9 billion fighter jet development’, Reuters (online), Mar. 30, 2015, available from http://www.reuters.com/article/2015/03/30/us-korea-aerospace-lockheed-martin-idUSKBN0MQ0BB20150330.

Globalization and civilianization could affect the likelihood of new third tier states emerging in several ways. First, because defense manufacturers in small defense markets will be able to sell to a wider number of clients, globalization may make it easier for military industry to be stood up. Second, because civilianization suggests lower barriers to transitioning from civilian application of technologies defense applications, states with little prior experience in arms manufacturing but mature information-based technologies may be increasingly better positioned to enter the defense market. These two hypotheses suggest greater proliferation, but some rebuttals can be advanced. Because globalization goes hand in hand with specialization, developing countries’ military industries may find it easier to focus on core competencies rather than taking on more ambitious projects aimed at producing complete indigenous weapons systems. In addition, the number of civilian technologies that can be converted to defense use is limited and not all developing states will be able to take advantage of “spin-on”. These hypotheses could all be tested through further research in order to identify policy implications.

Changes in the Structure of the International System
An important factor external to the economic structure of the defense trade is the structure of the international system and the highest-level politics that shape it. The most important change in that structure is the gradual move toward multipolarity as the United States’ dominant position is challenged by rising powers, notably China. Great power dynamics can have an important impact on third tier arms industries; for example, during the first decades of the Cold War, both the United States and the Soviet Union indirectly suppressed incentives to establish arms industries throughout the developing world by transferring vast supplies of WWII-vintage surplus to client states as part of their bipolar stand-off.

The growth of Chinese power has raised threat perceptions in Asia Pacific, creating conditions for a region-wide push toward greater defense spending and military industrialization. Additionally, Chinese support could embolden clients, such as Pakistan and North Korea, leading to more investment by India and South Korea.\(^{377}\) The causal chain from threat to military industry is incomplete, however; there are many other balancing options available to states living in the shadow of Chinese power. The most obvious alternative is to purchase more advanced

weapons systems from the United States. Indeed, arms sales interdependency can be critical leverage for smaller states seeking to commit a larger protector to its defense.\textsuperscript{378} As advanced weapons systems are imported, domestic firms may be displaced.

More generally, multipolarity may weaken the relative benefits of establishing domestic defense industries because a larger number of great powers will mean more suppliers of advanced weapons systems and therefore lower prices and better contract terms. Further, with more great powers in the system, it will be more difficult to attain consensus to establish effective multilateral arms embargoes, meaning security of supply will be less fraught for developing countries. This would again remove an important incentive to establish indigenous military industry.

**Good News, Bad News, and Not News**

Taking into consideration the factors briefly discussed in this conclusion, it would appear that the economic and political incentives to establish indigenous military industry in developing countries are waning. Nonetheless, such an assessment is very preliminary and must be further evaluated through study of both the historical record and current conditions in developing countries.

The primary lesson that can be extracted from this study is one that supports much of the existing literature on military industrialization: that establishing an indigenous arms industry is difficult and expensive, and any progress is vulnerable to a lapse in dedication or a market downturn. This is good news for proliferation policy if we assume that economic planners in developing countries are rational and public-minded, and can keep defense planners at bay. It is bad news, however, if we take the more pessimistic view that non-rational or conditionally rational decision-making can overwhelm economic incentives. On top of committing public monies toward wasteful arms races and the corruption inherent in the defense industry, developing countries will end the day with new arms ventures with little chance of long-term viability. This would be a double burden for security and development policy, but sadly, the experience of the

third tier suggests it would not be news if more developing countries proceed down this well-worn path.
Appendix I

The 20 firms included in the study sample are:

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Level</th>
<th>Products as of latest annual filing</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAR Corporation</td>
<td>Prime and sub-contractor</td>
<td>aviation services, maintenance and repair, sale and lease of engine and airframe parts</td>
</tr>
<tr>
<td>Astronics Corporation</td>
<td>Sub-contractor</td>
<td>avionics products, aircraft structures, engineering design, certification and test systems</td>
</tr>
<tr>
<td>The Boeing Company</td>
<td>Prime</td>
<td>military aircraft, military electronics, missile systems</td>
</tr>
<tr>
<td>CAE Incorporated</td>
<td>Prime</td>
<td>civil and military aviation training simulators, training services</td>
</tr>
<tr>
<td>Ducommun Incorporated</td>
<td>Sub-contractor</td>
<td>aviation structures, military electronics, and engineering services</td>
</tr>
<tr>
<td>Esterline Technologies Corporation</td>
<td>Sub-contractor</td>
<td>avionics and controls, sensors, advanced materials for aerospace structures</td>
</tr>
<tr>
<td>GenCorp Incorporated (renamed Aerojet Rocketdyne Holdings Incorporated in April 2015)</td>
<td>Prime and sub-contractor</td>
<td>propulsion systems and precision-guided munitions</td>
</tr>
<tr>
<td>General Dynamics Corporation</td>
<td>Sub-contractor</td>
<td>military vehicles including tanks, civilian aircraft, naval vessels</td>
</tr>
<tr>
<td>Harris Corporation</td>
<td>Prime and sub-contractor</td>
<td>tactical communications systems, secured information networks</td>
</tr>
<tr>
<td>Heico Corporation</td>
<td>Sub-contractor</td>
<td>jet engine and aircraft replacement parts</td>
</tr>
<tr>
<td>Honeywell International Incorporated</td>
<td>Sub-contractor</td>
<td>aircraft engines and avionics, sensor systems, automation control</td>
</tr>
<tr>
<td>Moog Incorporated</td>
<td>Sub-contractor</td>
<td>precision motion and fluid controls for aerospace and defense systems</td>
</tr>
<tr>
<td>Northrop Grumman Corporation</td>
<td>Prime</td>
<td>military aircraft, unmanned aircraft, military electronics and radar systems, command and control systems</td>
</tr>
<tr>
<td>Oshkosh Corporation</td>
<td>Prime</td>
<td>military wheeled vehicles</td>
</tr>
<tr>
<td>Precision Castparts Corporation</td>
<td>Sub-contractor</td>
<td>aerostructures and cast metal components</td>
</tr>
<tr>
<td>Raytheon Company</td>
<td>Prime</td>
<td>air and missile defense systems, command and control systems, tactical missiles</td>
</tr>
<tr>
<td>RELM Wireless Corporation</td>
<td>Prime and sub-contractor</td>
<td>radio communications systems</td>
</tr>
<tr>
<td>Sturm, Ruger &amp; Company Incorporated</td>
<td>Prime</td>
<td>small arms</td>
</tr>
<tr>
<td>Textron Incorporated</td>
<td>Prime</td>
<td>military helicopters, trainer aircraft, sensors and surveillance systems, armored vehicles</td>
</tr>
<tr>
<td>United Technologies Corporation</td>
<td>Prime</td>
<td>military helicopters, jet engines, avionics and aerospace subcomponents</td>
</tr>
</tbody>
</table>

The following figures are graphs of the estimates of the coefficient representing the magnitude of the effect of changes in exchange rate returns on stock price returns over time (“Exchange_b”), as well as graphs of the estimates of the coefficient representing the magnitude of the effect of changes in the volatility of exchange rate returns on stock price returns over time (“exchvar_b”). The time sample is the thirty year period of the study, from 1985 to 2015. The 95% confidence interval is provided. Gaps in the data occur where the GARCH specification fails to accurately model the underlying relationship between the variables; this causes the estimation technique—Maximum Likelihood Estimation—to return an error value.
The Boeing Company
Sturm, Ruger & Company Incorporated
import excel "Stockprices.xlsx", sheet("Import") firstrow
tset NewDate
cd "C:\Users\Xiaodon Liang\Desktop\tempcapstone"

quietly arch Exchange, arch(1) garch(1) distribution(t)
predict exchvar, var

gen Dmod=0
replace Dmod=1 if Exchange>0

gen ModEx=Dmod*Exchange

****FORVALUES approach for KM***
set more off
**create output variables**
gen Exchange_b=.
gen Exchange_se=.
gen LExchange_b=.
gen LExchange_se=.
gen ModEx_b=.
gen ModEx_se=.
gen LModEx_b=.
gen LModEx_se=.
gen exchvar_b=.
gen exchvar_se=. 
gen capturelog=

**MAIN LOOP**
forvalues i = 504(30)7666 {
capture arch PrecisionCastparts Exchange L.Exchange ModEx L.ModEx Market Riskfree SMB HML L.Market L.Riskfree L.SMB L.HML exchvar if NewDate='i' & NewDate=('i'-503), arch(1) garch(1)
distribution(t) gtolerance(999)
if _rc==0 {
replace capturelog = 0 if NewDate='i'
replace Exchange_b = _b[Exchange] if NewDate='i'
replace Exchange_se = _se[Exchange] if NewDate='i'
replace LExchange_b = _b[L.Exchange] if NewDate='i'
replace LExchange_se = _se[L.Exchange] if NewDate='i'
replace ModEx_b = _b[ModEx] if NewDate='i'
replace ModEx_se = _se[ModEx] if NewDate='i'
replace LModEx_b = _b[L.ModEx] if NewDate='i'
replace LModEx_se = _se[L.ModEx] if NewDate='i'
replace exchvar_b = _b[exchvar] if NewDate='i'
replace exchvar_se = _se[exchvar] if NewDate='i'

} else {
replace capturelog = _rc if NewDate='i'
}
display `i'
}

**Export to Excel**
export excel Date Exchange_b Exchange_se LExchange_b LExchange_se ModEx_b ModEx_se LModEx_b LModEx_se exchvar_b exchvar_se capturelog using "PrecisionCastparts-GARCH", sheet("KM-Exchange") firstrow(varlabels)

**cleanup**
drop Exchange_b
drop Exchange_se
drop LExchange_b
drop LExchange_se
drop ModEx_b
drop ModEx_se
drop LModEx_b
drop LModEx_se
drop exchvar_b
drop exchvar_se
drop capturelog
set more on
Bibliography

Primary Sources


Secondary Sources


Baum, Tomas, and Duquet, Nils, Flemish Foreign Arms Trade 2013 (Brussels: Flemish Peace Institute, 2015).


Lee, Joyce, ‘South Korea picks KAI, with Lockheed, for $7.9 billion fighter jet development’, Reuters (online), Mar. 30, 2015, available from http://www.reuters.com/article/2015/03/30/us-korea-aerospace-lockheed-martin-idUSKBN0MQ0BB20150330.


