



SPG-9 73 mm recoilless anti-tank gun rounds, abandoned by the Libyan Army in Chad in 1994.
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Unpacking Production: THE SMALL ARMS INDUSTRY

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INTRODUCTION

The inaugural edition of the *Small Arms Survey* notes that ‘the small arms industry is the most widely distributed sector of the global defence industry’ (Small Arms Survey, 2001, p. 7). It determines that the number of firms producing small arms and light weapons has increased since the end of the cold war. The three subsequent editions of the *Survey* assess the overall size of the industry by listing companies known to engage in production; considering trends in production across regions; and demonstrating how market changes affect the entire industry (Small Arms Survey, 2002; 2003; 2004).

Yet research to date indicates that ‘global trends’ have diverse impacts on firms that comprise the small arms industry. The production chapter in the *Small Arms Survey 2004* is a case in point. Entitled ‘Continuity and Change’, it describes both great shifts affecting the industry and, concurrently, continuity in the production and use of a number of basic weapons across the globe. It makes reference to growth among certain high-tech weapons producers, to the enormous increase in ammunition production in some countries following the US-led intervention in Iraq in March 2003, and to the decline in production elsewhere. These trends were not applicable to the industry as a whole; rather, they were specific to certain products and firms. They raise questions that call for a new approach to the study of production. Such questions include:

- Do broad changes in defence procurement affect all manufacturers of small arms and light weapons similarly?
- Are there great differences between companies that principally manufacture small arms as opposed to light weapons?
- What are the linkages between small arms and non-small arms-related production?
- How does the capacity to manufacture small arms vary qualitatively between countries?

It has become clear, furthermore, that researchers and policy-makers need to be able to: discriminate between types of manufacturing that produce different products and hence behave differently; situate these types of manufacturing within a country’s overall manufacturing capacity; and outline how different firms (and host nations) contribute differently to the problems of illicit proliferation.

What is the small arms industry? In response to this question, this chapter offers an initial answer: although it is frequently treated as a single entity, the industry is in fact highly differentiated. The chapter aims to demonstrate this and provides one set of foundations for future evaluations of small arms and light weapons production. It disaggregates the ‘industry’ into segments or sectors of like products and production practices and orients them in relation to all types of manufacturing industry, as opposed to simply arms production.

The chapter follows three broad lines of inquiry, which complement earlier explorations of companies and their production, financial, and workforce data:

- 1) the degree to which production technologies and processes differ from one variety of small arm and light weapon to the next;
- 2) the extent to which companies that produce various small arms and light weapons differ in terms of their size and manufacturing activities; and
- 3) the global distribution of companies operating in different sectors of small arms and light weapons manufacturing and its implications for the illicit trade in these armaments.

Many of the observations in this chapter are derived from a study of small arms and light weapons producers in the United States, largely because the country is the most diverse and data-rich case with which to develop a broad framework for assessing various forms of production. To illustrate the utility of the framework, as well as the limits of its application, the chapter contrasts and augments the findings derived from the US case with production patterns observable elsewhere.

It concludes that:

- There is a great deal of differentiation in the types of firms in the small arms industry and their products.
- Global trends thought to affect the industry as a whole often influence sectors within the industry very differently.
- The illicit proliferation of various types of weaponry has distinct implications for individual sectors of the industry.
- A number of these sectors and the products they manufacture have escaped even modest research and policy attention to date.
- Measures must be targeted at specific sectors and the countries and regions that host them.

WHY PURSUE A DIFFERENT APPROACH TO PRODUCTION?

Why approach production differently? The answer lies in one of this field's most important foundations: the 1997 United Nations definition of small arms and light weapons. Constituting a touchstone for both researchers and policy-makers, the definition is intentionally effects-driven. The UN Panel of Experts responsible for the definition produced a 'pragmatic and results-oriented report' in which small arms and light weapons that 'were of main concern' were defined according to a key characteristic: portability. In practice, the definition aggregates a number of very disparate weapon types because they comprise a broad category 'responsible for large numbers of deaths and the displacement of citizens around the world' (UN, 1997, para. 13). Importantly, therefore, the Panel of Experts defined a field of concern, not a unit of analysis. Distinctions between very different—albeit equally portable—weapons are thus often masked by general discussion of the 'small arms and light weapons industry'.

Measures must target specific sectors and the countries and regions that host them.

Indeed, this umbrella term suggests that firms share a number of qualities. It is typical, and often useful, to refer to similar manufacturers producing similar products as an industry—as the aerospace and automobile industries illustrate. As is the case in these enterprises, the small arms industry reveals fewer qualitative similarities as the focus of analysis narrows. Consequently, to arrive at a more differentiated view of small arms production, it is important to break down the industry into its constituent parts, thereby avoiding a number of limitations inherent in the industry-wide approach.

Box 2.1 Definition of small arms and light weapons

The *Small Arms Survey* uses the term 'small arms and light weapons' broadly to cover small arms intended for both civilian and military use, as well as light weapons intended for military use. When possible, it follows the definition used in the United Nations *Report of the Panel of Governmental Experts on Small Arms* (UNGA, 1997):

Small arms: revolvers and self-loading pistols, rifles and carbines, sub-machine guns, assault rifles, and light machine guns.

Light weapons: heavy machine guns, hand-held under-barrel and mounted grenade launchers, portable anti-aircraft guns, portable anti-tank guns, recoilless rifles, portable launchers of anti-tank missile and rocket systems, portable launchers of anti-aircraft missile systems, and mortars of calibres of less than 100 mm.

The *Survey* uses the term 'firearm' to mean civilian and military hand-held weapons that expel a projectile from a barrel by the action of an explosive. Unless the context dictates otherwise, the term 'small arms' is used in the *Survey* to refer to both small arms and light weapons, whereas the term 'light weapons' refers specifically to this category of weapons.

First, a uniform conception of the small arms industry masks a range of factors that distinguish companies. Firms make products that range from simple plastic mouldings and weapon components to complex integrated optical accessories and finished firearms. The differences are not unlike those between one company making brake pads, and another assembling satellite navigation systems in the automobile industry.

Second, although the linkages between manufacturers producing similar or complementary goods are often strong—as complete weapon systems often require joint ventures or contract work—manufacturers contributing to one type of finished weapon will rarely collaborate with manufacturers specializing in the production of a qualitatively different weapon. An extreme example is the absence of collaboration between most handgun manufacturers and producers of guided missile systems.

Third, given that ties between manufacturers are often weak, market forces are likely to affect sectors of the industry very differently. In fact, diversity of production—with producers specializing in such varied fields as metal machining, the fabrication of precision lenses, or electronic systems engineering—ensures that many producers do not limit themselves to defence-related products. Consequently, they are likely to be affected by market forces influencing the manufacture and sale of these non-arms-related items independently of forces thought to affect small arms and light weapons production and sales as a whole.

While some analysts have noted a high degree of differentiation in the industry, others have rightly suggested that research has not sufficiently emphasized this aspect (Lock, 2003). This chapter enters accumulated findings into a model of small arms and light weapons production that captures the significant differences in types of manufacturing.

INFERRING CATEGORIES

Recent discussions of small arms and light weapons production describe some very broad modes of manufacture. Examples include such categories as 'craft' production, which is used to denote often illicit, small-scale manufacturing and repairs that take place outside of recognized factories (Alpers and Twyford, 2003, pp. 16, 20; BASIC, 1996; Small Arms Survey, 2003, pp. 26–36). In addition, some research has drawn distinctions between private civilian market-destined

production and state-owned military production (Dreyfus and Lessing, 2003) and between high- and low-tech manufacturing techniques (Bevan and Wezeman, 2004).

While these categories remain loosely defined, they demonstrate that simple methods of classification improve our understanding of small arms production by allowing researchers to distinguish between broadly recognizable forms of production.

The common means of discriminating between different products involves segmenting industries and markets. It is important to note that specific types of producers manufacture broad categories of weapons, and that these find niches in markets that are often distinct. As a result, many issues concerning the qualities of a product, the technology needed to produce it, and the eventual user are closely related.

A basic model can combine these supply- and demand-side factors to create, in simple theoretical terms, ‘bundles of characteristics’ (Lancaster, 1971; Berry, Levinsohn, and Pakes, 2003, p. 1). Such bundles of characteristics may be derived by combining the qualities of the particular type of weapon produced, the technology and production processes needed to produce it, and the type of user for whom it is produced (see Table 2.1).

Table 2.1 Characteristics differentiating products, production processes, and markets

Factor	Characteristics	Examples
Product type	Finished product or service	Accessory, pistol, rifle, repair
Production process	Technology required	Operator or computer machining, single item or mass production
	Product variety	Capacity to produce only rifles or rifles, pistols, and accessories
	Linkages and parallel production	Firms producing components for small arms as well as for the automobile industry
Market characteristics	Weapon effects	Single-shot weapons, explosive rounds
	Intended users	Civilian, law enforcement, military

These bundles of characteristics may be used to define sectors of industry according to their relative mixture of factor characteristics.

Product type is the simplest means of differentiating between manufacturers. As past analysis has demonstrated, small arms and light weapons may be divided into broad groups, based, for example, on the distinction between small arms and explosive-firing light weapons, or between guided and unguided weapons. Such differentiations are generally illustrative of variations in production techniques and between potential users.

Production processes are very similar for a wide range of small arms, but they differ in several respects. *Technology* differentiates various manufacturing methods, from the simple repair and fabrication of new parts using hand tools, to manually controlled machinery, to the latest computer-controlled machines. *Product variety* is another broad indicator, not only of the size and development of a firm, but also of the type of markets to which it sells. For instance, the specialist rifle producer is clearly distinguishable from a firm that mass-produces a wide range of pistols, rifles, and accessories. *Linkages* between arms- and non-arms-related production and *parallel production* further aid in classifying firms, as they help in identifying the particular place that a firm occupies within a country’s overall industry.

Market characteristics are largely determined by the effects that a weapon is capable of producing—for instance, the single shot of a muzzle-loading rifle or the explosive impact of a rocket-propelled grenade (RPG) round are features that place limits on the expected utility of weapons for certain users. *Users*, defined as ‘intended users’, comprise an additional, if loose-fitting, means of differentiating weapon types.¹

Such bundles of characteristics can (a) define products with very similar technical characteristics, (b) distinguish those firms, or branches of firms, specializing in the production of particular products of similar qualities, both arms- and non-arms-related, and (c) relate these factors to broad categories of potential users in the market.

To a large extent, these characteristics establish parameters for the type of firm—and often the sector or stage of industrial development—that can engage in various forms of small arms production. Moreover, the division of products and manufacturing processes involved in non-arms-related production enables us to reverse our analysis and to examine, albeit roughly, which countries or regions, given certain levels of general industrial development, may be able to participate in certain types of arms production, or acquire the technology to do so in the near future.

The rationale for including repairs and the production of accessories in the analysis is simple. Repairs contribute to the ‘production’ of serviceable weapons from unserviceable weapons, while accessories contribute to the more effective functioning of weapons. Whether from an industrial, consumer, or effects perspective, these are key considerations. Furthermore, repairs and accessories comprise much of the activity covered in this study (see Table 2.2).

Table 2.2 Production of complete weapon systems in contrast to other productive activity in a selection of 349 US firms

Product	Firms	Percentage of total firms (rounded)
Complete weapon systems	179	51
Repair	86	24
Ammunition	56	16
Accessories	28	8
Total	349	100

Source: Hoover’s Inc. (2004)

SMALL ARMS PRODUCTION SECTORS

This section develops a framework for analysing small arms production worldwide. Based primarily on US firms and a comparison of these companies with firms elsewhere, this framework differentiates between product, production, and limited market characteristics to assess production and to pinpoint a number of relatively exclusive manufacturing sectors.

The initial step in the study was to identify the product, production, and market characteristics (see Table 2.3) of 511 known US producers and repairers of small arms and light weapons.² Annual sales and employment figures were available for 349 of the 511 companies, and only those firms were retained for investigation (Hoover’s Inc., 2004).³ Among the 349 firms in this study, there was a marked decline in available information for single-employee repairers and manufacturers in contrast to other forms of activity; it is consequently very likely that most of the excluded firms are single-employee operations.

One explanation for this discrepancy is that repair is very often a sideline activity. Repairers may register a company name, yet that name may represent a second business with a very low turnover. With the exception of the smaller firms engaged in repairs, however, product descriptions and, in most cases, catalogues were available for selected companies. Intended markets could easily be discerned by the way firms described their products to potential users.

Among the 349 firms evaluated, the most prominent activity is manufacturing, a feature of 75 per cent of the sample. As shown in Figure 2.1, repairs make up a large segment of other activities, yet it is likely that they represent a higher proportion of total activity, as many repairs are extremely small in scale and may go undeclared. Indeed, the vast majority (more than 70 per cent) of firms engaged in repairs employ only one person.⁴

While manufacturing is the most common mode of activity in the sample, the production of finished weapon systems—such as a complete pistol, rifle, or grenade launcher—does not constitute the bulk of activity. This finding underscores the importance of analysing repairs and the manufacturing of components and accessories, rather than focusing on the production of guns or complete systems. It is likely, moreover, that many manufacturers of small components are not included in the study; reasons for this are cited below.

This study does not include ammunition production. As the chapter on ammunition illustrates, little is known about the degree of difference among firms engaged in producing ammunition and components for ammunition. Until more information becomes available, categorizing products, production processes, and market characteristics will remain difficult (AMMUNITION). Nonetheless, preliminary investigations suggest that ammunition products, production, and markets are as differentiated as those of complete systems and components, and it is likely that ammunition production can be examined using the broad model outlined below.

Figure 2.1 Number of firms engaged in selected production activities (from a total of 349 US manufacturers)

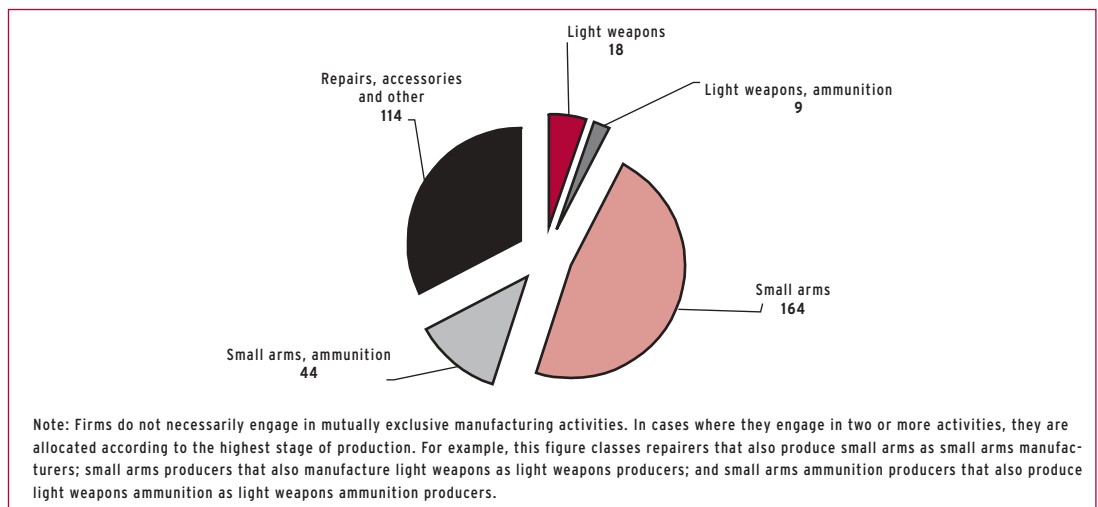


Table 2.3 lists a select number of characteristics that indicate key differences between products, the manufacturing processes needed to produce them, the range of goods made by firms, and the potential users of such items. When bundled together, they suggest clear differences between firms engaged in the production of small arms and light weapons. As the table illustrates, in some cases, one factor, such as the level of technology or the range of products,

is the primary means of distinguishing between firms. In others, several variables combine to make firms qualitatively different.

Table 2.3 Manufacturing sectors by product, users, process, range, and firm type, with distinctive features highlighted

Sector	Name	Product type	Users	Production process	Range	Firm type
1	Repairs and sporadic production	Repairs and sporadic production	Potentially all, although primarily civilian	Hand machining of replacement parts, assembly, modification, or amalgamation of existing weapon components	Various types of activity, but usually very similar basic operations	Usually small with a localized market
		Grips, stocks, and other plastic accessories Scope mounts, suppressors, and other machined metal accessories	Potentially all, with the exception of suppressors for security forces	Processes range from simple, hand-operated machining to Computer Numeric Control (CNC) machining processes	Producers usually specialize in one type of component or a limited range of items that are simple to manufacture	Usually a large contract engineering firm producing many types of non-small arms components
3	Specialized	Single-shot rifles and handguns	Civilian	Limited production using hand-operated and sometimes CNC machining processes or even Electrical Discharge Machining (EDM) processes	Frequently single product types, such as a grenade launcher, a single-shot rifle, or a sniper rifle	Smaller firms dedicated to producing for a limited niche market , either civilian or security-related
		Revolvers Bolt- and lever-action rifles	Civilian, law enforcement, military			
		Semi-automatic pistols Single-shot grenade launchers, heavy machine guns, sniper rifles	Military			
4	Household name	Revolvers	Civilian, law enforcement, military	Mass production using hand-operated and often CNC or even EDM machining processes	Very limited range of product types—for example, an assortment of similar pistols or rifles—although sometimes many configurations of the same basic type	Larger firms mass-producing for a broad range of consumers; production primarily aimed at civilians
		Bolt- and lever-action rifles				
		Semi-automatic pistols				
5	Extensive-range	Pistols, rifles, sub-machine guns	Law-enforcement, military	Mass production using hand-operated and often CNC or even EDM machining processes	Broad range of products—for instance, the manufacture of pistols, assault rifles, and sometimes non-electronic light weapons	Large firms with a great number of machines, producing or having produced almost exclusively for the military market ; often state-owned
		Semi- and fully automatic rifles	Military			
		Light and medium machine guns				
		Heavy machine guns				
		Single-shot grenade launchers				
		Automatic grenade launchers				
		Rocket launchers				

Table 2.3 Manufacturing sectors by product, users, process, range, and firm type, with distinctive features highlighted (continued)

Sector	Name	Product type	Users	Production process	Range	Firm type
6	High-tech	High-grade optics and fire-control systems	Civilian, law enforcement, military	Advanced computer-controlled grinding and milling of glass and metals; electronics engineering	Usually concentrate on one type of weapon or accessory	Firms produce primarily for the non-small arms field
		Guided weapon systems, night-vision sights	Military	State-of-the-art electronics engineering, metallurgy, and optical fabrication	Vast assortment of electronic products, including complete systems, but also components	Firms are very large and branch into many different types of production, from large defence systems to aerospace products

The following sections assess each of the six sectors highlighted in Table 2.3, which are derived from production trends observed in the study of the United States. Each section applies these US-derived sectors to a selection of cases from the rest of the world, compares the two, and concludes with a brief discussion on the implications for the small arms industry as a whole, as well as future directions for research.

Sector 1: Repairs and sporadic production

Product and service range: Repair, assembly, minor fabrication
 Examples: Gunsmith shops, craft production, contract repairs
 Principal markets: Mainly local civilian

Producers in this sector differ from all other types of productive activity in the small arms and light weapons industry in that most do not manufacture complete systems. The majority of producers listed

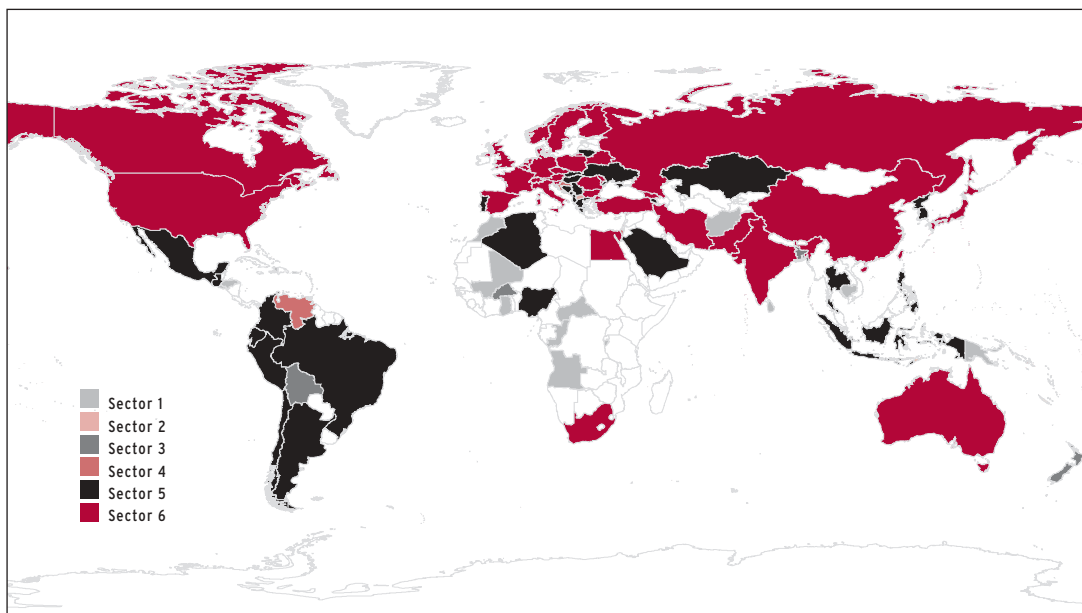
here specialize in repairs and only the larger enterprises engage in limited production. Even in these cases, production usually entails the assembly of parts made elsewhere, rather than on site.

Map 2.1 illustrates the ‘tip of the iceberg’ with respect to those countries known to host Sector 1 production. Even in well-documented cases, such as that of the United States, the extent to which actors are engaged in this activity remains unclear due to low technological barriers to entry. While some Sector 1 producers employ advanced machinery, most rely on hand-operated lathes and milling machinery common to all forms of basic metal product fabrication.

Two factors appear to relate to the stage of production achieved: the lower the level of development in a country or the lower the level of weapons proliferation, the greater the likelihood that enterprises will produce parts or even complete weapon systems. This is a simple function of, on the one hand, the availability of capital or supply networks for acquiring parts and, on the other, the availability of existing weapons as a source of parts. The following three groups of states in which repair and production occur are illustrative of how stages of production differ.

- 1) In developed countries, such as Australia, Germany, or the United States, parts for lawfully held weapons are plentiful and the purchasing power of consumers is relatively strong. In most cases, repairers may simply purchase and replace part of a weapon, rather than make it. If the weapon is beyond repair, the consumer is easily able to buy another—often from the repairer. The reverse of this phenomenon is equally illustrative. In the United Kingdom, following the 1997 ban on civilian handgun ownership—and hence a reduction in

Map 2.1 The six sectors of production worldwide



Notes: Map 2.1 highlights countries that are known to host the six sectors of small arms and light weapons manufacturing. Colour coding reflects the highest sector of production hosted for each country.

Sources: Dreyfus and Lessing (2003); Kante (2002; 2004); Godnick, Muggah, and Waszink (2002); Jones and Cutshaw (2004); Kiss (2004); NISAT (2005); Omega Foundation (2003); Small Arms Survey (2001; 2003; 2004); Weidacher (2005, forthcoming)

the availability of parts and weapons—the illicit fabrication of complete weapons, albeit on a very small scale, appears to have increased (House of Commons, 2000; NCIS, 2002).

- 2) In countries and areas where large numbers of illicit weapons are available, such as northern Pakistan or the Philippines, repair and assembly is also far more common than production, but the construction of complete weapons does appear to be more widespread in this sector than in more developed countries (BASIC, 1996; Capie, 2002). Like their counterparts in the United States, the very best gunsmiths produce complete weapons, but production rates remain low, and the reassembly of weapons from original factory components appears to be the norm (Small Arms Survey, 2003, p. 33).
- 3) In countries such as Ghana or Mali, where purchasing power is weak and factory-produced weapons are not particularly plentiful, complete weapons manufacture is more common (Small Arms Survey, 2003, pp. 29–30; Kante, 2004). Taking this argument further—and discounting cases such as Bougainville and the Solomon Islands, where construction of weapons has been crude in the extreme—perhaps the most striking examples of manufacture in the case of limited supply are those of Colombia and Sri Lanka. In both countries, the logistical skills of two large non-state armed groups—the Revolutionary Armed Forces of Colombia (Fuerzas Armadas Revolucionarias de Colombia, FARC) and the Liberation Tigers of Tamil Eelam (LTTE), respectively—have yielded large-scale repair and production of small arms and light weapons. Nevertheless, the majority of these weapon producers still utilize factory components when available (Dreyfus and Lessing, 2003).

Discounting non-state armed groups, repair and sporadic production appear to differ little across countries in terms of both size and structure of enterprise. Very often the basic setup of a shop in a developed country, such as Switzerland or the United Kingdom, differs little from one that might be found in Darra, Pakistan, or Danao City in the Philippines. Guns are sold in the front and the business will carry out limited repairs in the back using hand-operated machines (Capie, 2002; Small Arms Survey, 2003, pp. 26–36).



A Filipino gunsmith welds a crude sub-machine gun in a Sector 1 gun factory in Danao City, central Philippines, November 2003.

© Erik de Castro/Reuters

The vast majority of repair firms employ no more than one or two persons, and the analysis of US firms found none employing more than 25. In contrast, firms in the small arms manufacturing sector may employ hundreds of workers. Compared to producers as a whole, US firms specializing in the repair of weapons tend to constitute the lowest earners. Single-employee repair firms have an average turnover of approximately USD 40,000 per year, whereas single-employee small arms manufacturers (Sector 3) average around USD 70,000 per year (Hoover's Inc., 2004).

In the United States, most companies appear to specialize solely in the repair and production of small arms and light weapons. In less developed countries,

however, enterprises have often moved into weapons manufacturing from related productive areas, with workers active as blacksmiths or locksmiths. In Ghana, for example, larger operations produce simple non-arms items, such as handcuffs, metal parts for automobiles, and bed frames.⁵ Markets appear to be localized, or, in the case of larger firms, repairs may be conducted under contract for other companies. Firms may also serve a wider market because they are concentrated in an area that attracts many customers, such as Brescia, Italy, or Darra, Pakistan. On a smaller scale, this is true of hunting clubs in the Russian Federation and the United States, which act as centres for repair and production activity.⁶

The cases examined suggest that the skills needed to engage in repairs and sporadic production are widely available in a number of fields of industrial activity common to most, if not all, countries. Consequently, repair and sporadic production have become widespread, very difficult to assess in terms of likely scale and distribution, and hence hard to regulate. This review shows that very little is known about the extent to which these activities are performed in regions such as the Commonwealth of Independent States (CIS), or indeed in many of the nations not highlighted on Map 2.1. Yet, it does appear likely that, given a demand for weapons, small arms repairs and sporadic production would occur in localities with high concentrations of production activity in similar, non-arms-related fields, such as blacksmithing and other forms of metalwork. These factors, combined with appraisals of the level of weapons ownership in the locality, should suggest potential areas for future research, given that much activity appears to be driven by local demand.

As implied above, one point of concern is the extent to which weapon parts are available. The fact that most repair and sporadic production enterprises rely on factory-produced parts suggests that the production, exchange, and general availability of parts may be as relevant to small arms policy-making as the availability of complete weapons. As the following section illustrates, however, little is known about the global trade in weapons components.

Sector 2: Components and accessories

Components, defined here as parts essential for the functioning of a weapon, are diverse. In this sector, the emphasis is on machined metal parts and wooden or composite furnishings, which are components of

Product and service range:	Mass production of parts
Examples:	Barrels, grips, slides, stocks
Principal markets:	Civilian and military

a finished weapon. This chapter defines accessories as items that may be added to an existing weapon in order to improve its performance or adapt it to suit the user. Firms included in this sector manufacture simple accessories and do not produce such items as precision optical equipment and fire control systems. The latter are qualitatively different with respect to both composition and manufacture and are addressed in the commentary on Sector 6 producers. Examples of accessories include scope mounts, sound suppressors, and mounting rails, while components may encompass objects such as grips, slides, springs, and barrels. There is often little to distinguish the two, since most weapons may be enhanced beyond their original factory state, which can make components and accessories synonymous.

Several US companies produce accessories exclusively for target and sport shooting or expressly for security forces (Bravo, 2004; Mountain State, 2004; Sinclair, 2004). Others specialize in the production of a particular component, such as the grip or trigger, and produce for a variety of consumers (Pearce, 2004; Timney, 2004). Of particular note are so-called tactical weapon systems, which have mirrored the practice of customizing standard-issue weapons for Special Forces.

Little is known about the global trade in weapons components.

In contrast to their more sophisticated counterparts, most of these accessories are machined out of single pieces of aluminium or are injection-moulded using polymers, as reflected in the type of manufacturing machinery employed. Computer Numeric Control (CNC) machines are the norm in the United States, although a number of firms utilize more sophisticated equipment, including Electrical Discharge Machining (EDM) for more complex components (MGW, 2004; Dillon, 2004). The technologies involved elsewhere in the world do not differ markedly from those used by US firms. Producers in China and Taiwan, for example, manufacture a variety of products, ranging from magazines to scope mounts, for a wide assortment of pistols, sub-machine guns, and rifles, using the latest in CNC machines (Xianfeng, 2004).

Component manufacturers frequently make other products, such as precision hand and machine tools, or they perform specialized tasks such as deep-hole drilling (a core aspect of barrel-making) in fields as diverse as the aerospace, computer, optical, and oil sectors (Armatt, 2004; Lilja, 2004). Companies machining high-quality aluminium parts, including rails for weapons, also produce such goods as precision hose connectors and gas turbine rings for use in the transport industry (Yankee Hill, 2005). For many of these firms, components and accessories for small arms and light weapons represent only a small fraction of manufacturing output.

In the United States, component manufacturers are usually larger than repairers, with numbers of employees ranging between 3 and 20 and annual turnovers varying between USD 175,000 and USD 600,000 (Hoover's Inc., 2004).

Countries hosting Sector 2 producers appear to be those where select firms produce very high-quality and expensive products for a select market, such as the United Kingdom and the United States (LEI, 2004). Yet, although the United States appears to host more firms dedicated to producing only small arms-specific components and accessories, it is

Box 2.2 Assault weapons, the US Assault Weapon Ban, and the emergence of personalized tactical weapon systems

Whether and how the expiry of the Federal Violent Crime Control and Law Enforcement Act of 1994 (Assault Weapon Ban) on 13 September 2004 will affect producers has been the subject of much debate.

While some observers expect the expiry of the ban to lead to an increase in the production and sale of assault-style weapons and related accessories, this study finds that the ban was primarily cosmetic as assault-style weapons were not necessarily covered by it. Moreover, it encouraged some new production and, consequently, the lifting of the ban may hurt some Sector 2 producers rather than aid them.

In brief, the Act prohibited the manufacture and sale in the United States of 19 different semi-automatic weapons:

- Norinco, Mitchell, and Poly Technologies Avtomat Kalashnikovs (all models)
- Action Arms Israeli Military Industries UZI and Galil
- Beretta Ar70 (SC-70)
- Colt AR-15
- Fabrique Nationale FN/FAL, FN/LAR, and FNC
- SWD M-10, M-11, M-11/9, and M-12
- Steyr AUG
- INTRATEC TEC-9, TEC-DC9, and TEC-22
- Revolving cylinder shotguns, such as (or similar to) the Street Sweeper and Striker 12. (Brady Campaign, 2002)

Nevertheless, the Act did not outlaw all semi-automatic weapons, but only those with multiple 'assault-weapon' features. It thus targeted only semi-automatic rifles that had detachable magazines and two or more of the following characteristics: a folding or telescoping stock; a pistol grip; a bayonet mount; a flash suppressor, or threads to attach one; or a grenade launcher (Brady Campaign, 2002). With the exception of a grenade launcher (assuming grenades were available), the removal of any such configuration of features would not have curtailed a weapon's firepower or destructive potential. Between 1994 and 2004, moreover, producers continued to manufacture and market weapons that differed only slightly from those banned outright (J&T, 2003).

During those ten years, Sector 2 producers designed, manufactured, and marketed new components and accessories designed to give ban-era weapons the *appearance* of their banned counterparts (Kuehl, 2003). In short, the Act spurred some Sector 2 production.

Furthermore, the Act seems to have done little to reduce public interest in assault weapons. Entire publications have since been dedicated to advertising such products as 'security force', 'tactical', or 'military' accessories (*Small Arms Review*, various dates; Springfield Armory, 2005).

Now that the Act has expired, a significant portion of Sector 2 firms remain devoted to producing items designed for tactical purposes, which may well enjoy increased sales in future. Firms specializing in pre-expiry modifications seem to have lost the market for their products. This brief study thus reveals how barriers to trade can have distinct, and often unintended, effects on firms producing different products.



A Heckler & Koch MP5 9 mm sub-machine gun modified with accessories, including extra magazines, a magazine coupler, and under-barrel flashlight.

© Joe Saladin/www.armsexposed.com

difficult to determine the point of original manufacture of components of smaller weapons. Not unlike the components of many finished products, such as the switch on a table lamp or the handle of a saucepan, these parts remain anonymous to consumers.

To date, very little research has focused on the production of components and accessories, perhaps for the simple reason that this area of activity is extremely difficult to examine. As most of the items manufactured are not weapons in their own right, they are unlikely to be classified as weapons when traded. The manufacture of and trade in components and accessories—which may well serve to enhance the capacity of a weapon to cause loss of life or damage to infrastructure—are little regulated and have remained well out of the spotlight in small arms research and policy-making. As with repairs and sporadic production, the expertise and technology needed to produce components and accessories are widespread.

The findings presented here suggest at least two avenues for further research. The first should be to determine to what extent certain types of components and accessories augment the operational capacity of weapons—or to what extent they contribute to the prospect of individuals misusing them. A second valuable avenue of study would be to analyse the linkages between seemingly peripheral producers of components and accessories and ‘mainstream’ small arms manufacturers. This research could investigate to what extent major small arms producers outsource production of parts of complete weapons to manufacturers of components and accessories. For the most part, the items assessed here have been those targeted at users who wish to improve weapons already in their possession, rather than components purchased by major small arms manufacturers. The inter-firm trade in accessories and components may be considerable, yet it remains obscure and demands further attention.

Sector 3: Specialist production

In contrast to producers of components and accessories, the firms in this sector manufacture complete weapon systems. They remain distinct from household-name producers (Sector 4) in that they make a relatively limited set of product types, usually in few configurations, and typically of a quantity short of mass production.

Product and service range:	Labour-intensive small arms and light weapons production
Examples:	Sniper rifles, competition pistols and rifles, non-lethal weapons
Principal markets:	Some military, mainly civilian

Products vary widely, from single-shot muzzle-loading rifles to specialist high-precision competition pistols. In the United States, a small number of companies produce light weapons for the security forces and manufacture limited numbers of items, such as simple teargas and grenade launchers (Penn Arms, 2004). Some US firms manufacture specialist assault rifles—so-called tactical rifles—for law enforcement marksmen and military users (Hatcher Gun Company, 2004). Both inside and outside of the United States, the production of sniper rifles is a common activity (Truvelo, 2004),⁷ as is the manufacture of some sub-machine guns (Jones and Cutshaw, 2004, pp. 224–27) and light weapons, including heavy machine guns (Manroy, 2004). Some firms produce for both the military and a small group of civilian users; their products include a very large number of .50 calibre rifles (Action Gun Works, 2004; Spider Firearms, 2004).

Products made specifically for civilian use include target rifles, custom-made to the owner’s requirements, and a variety of shotguns (Cole Arms, 2004). In Western Europe, many of these shotgun-producing firms are well established, sometimes dating from the 18th and 19th centuries and serving the sporting market, where traditional craftsmanship is highly valued.⁸

Box 2.3 The micro business of .50 calibre rifles

Sniper rifles or anti-*matériel* rifles utilizing .50 calibre (12.7 mm) or larger ammunition are common products among small businesses. They are primarily employed against lightly armoured vehicles and communication installations, yet may be used to devastating effect against human beings (Small Arms Survey, 2004, pp. 27, 29).

Because they differ little in basic design from most bolt-action (sometimes semi-automatic) rifles but are labour-intensive to manufacture, these rifles are frequently made by specialist producers. Such is the case in the United States, where relatively small firms have supplied the military market for a number of years. Barrett Firearms Manufacturing, Inc., for instance, was created in 1983 and has since equipped the US Army, the US Marine Corps, and Special Forces in many countries (Barrett, 2004). Other US firms, such as Robar Companies Inc. and McMillan Bros. Rifles, also produce .50 rifles. These are primarily military weapons, but they are used by many civilians across the United States; the notable exception is the State of California, which banned the sale of .50 calibre rifles and above in September 2004 (California, 2005).

A number of firms producing .50 rifles in other countries are similar to those found in the United States, such as in Australia (PRS, 2004), South Africa (Truvelo, 2004), and the United Kingdom (Accuracy International, 2004; Jones and Cutshaw, 2004, pp. 125–39). Of 26 .50 calibre rifle models produced worldwide and listed in *Jane's Infantry Weapons*, however, only three—the British Accuracy International, the South African Truvelo, and the US Barrett—are known to be in service in nations other than where they were manufactured (Jones and Cutshaw, 2004, pp. 125–39). General trends in the transfer of small arms and light weapons suggest such a low number is unlikely and that trade in these specialist armaments is probably considerably higher than previously thought. The opaque nature of this sector of the small arms industry calls for more research.



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A gunsmith at London's Holland and Holland gun manufacturing company aligns a telescopic sight on the bore of a .244 magnum rifle, December 1962. Holland and Holland has handcrafted firearms since 1835.

All Sector 3 firms are distinct in that they produce perhaps only a single type of weapon—for instance, shotguns, machine guns, or muzzle-loaders—at low output volume, yet they differ globally with respect to their markets. For example, there appear to be few firms producing military-style or military-specific weapons outside of the United States.

The size of the firm is generally small. US companies have between 1 and 50 employees and have annual turnovers not exceeding USD 7 million. Firms in Western Europe are of similar size, with few staffs exceeding 70 persons; turnovers vary but do not appear to be greater than USD 10 million (Hoover's Inc., 2004).

Computer-aided design (CAD) and computer-aided machining (CAM) are common among larger firms. Those producing at lower volumes for the specialist market may also utilize computer-controlled equipment, although, for the most part, they rely on sophisticated hand-operated machinery (Famars, 2004).

Many specialist producers have strong links to the non-arms-related industries, as is apparent in the historical development of some of the firms under review. Many were set up by individuals who had an interest in firearms and were formerly employed in engineering. Their areas of expertise range from testing racing engines to transport engineering (Action Gun Works, 2004; Knight Rifles, 2004; Spider Firearms, 2004). One consequence is that many of these enterprises offer innovative products beyond the scope of Sector 4 firms. The skills and manufacturing processes are very much akin to those of non-arms-related firms; in addition to weapons, many companies produce a range of machined products and offer machining services.

Specialist production pertains to a number of very different weapon types, most of which are relatively simple to manufacture, albeit labour-intensive. While the production of muzzle-loading weapons, for example, may not be of great importance to global trends in the misuse of small arms, what is of considerable significance is that small enterprises are manufacturing a number of highly destructive armaments of largely military origin. A case in point is the production of .50 calibre sniper rifles (see Box 2.3). From a policy perspective, as researchers in the United States are beginning to recognize, the proliferation of weapons produced by such firms is worrying, particularly with regard to civil aviation and critical infrastructure, such as oil refineries and chemical plants (VPC, 2002; 2003). Indeed, for firms with some experience of firearms manufacturing, a switch to producing high-value, high-velocity .50 calibre sniper rifles will prove relatively unproblematic, largely because of the widespread availability of .50 calibre ammunition (AMMUNITION).

Of particular importance is the degree to which specialist companies supply the military market, and which militaries they supply. One related aspect is whether trends in the use of specialized tactical weapons—displayed most notably by the US Armed Forces—have encouraged other states and non-state armed groups to follow suit. Furthermore, specialist producers also manufacture teargas launchers, rubber baton launchers, and similar weapons—so-called less-than-lethal munitions—for security forces. The use of these weapons against protesters in Thailand in October 2004, and by Sudanese police forces to perpetrate human rights abuses in Darfur in November 2004, suggests that the trade in such armaments with security forces is of pressing relevance for today’s research and policy agendas (BBC, 2004a; 2004b).

In short, so little is known about specialist producers and their role in global production, save perhaps for the United States, that it is essential to investigate these firms further. With an emphasis on innovation, moreover, many of these companies may illustrate future trends in the types of products that will be in service tomorrow.

Specialist producers may illustrate future trends in weapons manufacture.

Sector 4: Household-name producers

Household-name producers manufacture complete weapon systems yet produce a relatively limited array of products (see Table 2.4), which are almost exclusively small arms. These firms differ from specialist producers in that they mass-produce weapons. To draw an analogy with the automobile industry, these companies appear to inhabit the kind of broad space occupied by manufacturers such as Ford or Renault. They tend to have long operating histories, sometimes of more than 100 years, and are distinct from extensive-range (Sector 5) producers in that most of their goods are destined for civilian use. Firms described as ‘household names’ are most common in the United States and either appear in states with extensive civilian small arms markets or produce primarily for such markets.

Product and service range:	Mass-produced small arms
Examples:	Pistols, revolvers, rifles, shotguns
Principal markets:	Mainly civilian

Table 2.4 A selection of Sector 4 firms worldwide

Firm	Weapons produced	Country of origin
Amadeo Rossi	Handguns, rifles, and shotguns	Brazil
J.G. Anschütz	Handguns and rifles	Germany
ArmaLite	Rifles	United States
Bersa	Handguns	Argentina
Henry Repeating Arm Co.	Rifles	United States
HS Product	Handguns	Croatia
Kahr Arms	Handguns and rifles	United States
The Marlin Firearms Co.	Shotguns and rifles	United States
O.F. Mossberg & Sons, Inc.	Shotguns	United States
Remington	Shotguns and rifles	United States
Savage Arms, Inc.	Rifles	United States
Smith & Wesson	Handguns	United States
Sturm, Ruger & Co., Inc.	Handguns, rifles, and shotguns	United States
Taurus International MFG, Inc.	Handguns, rifles, and shotguns	Brazil

Sources: Anschütz (2004); ArmaLite (2004); Bersa (2004); Henry (2005); Kahr Arms (2004); Kiss (2004); Marlin (2004); Mossberg (2004); Remington (2004); Rossi USA (2004); Ruger (2004); Savage Arms (2004); Smith & Wesson (2004b); Taurus (2004a)

In most countries, mass production for a principally civilian market follows the lead of US household-name producers; moreover, these firms often make goods extensively for the US market. One such firm is Taurus of Brazil, which, having purchased a former Beretta factory in Sao Paulo, successfully entered the US pistols market and later created an affiliated company in Miami, Florida (Taurus, 2004a). Likewise, Brazil's Amadeo Rossi and Argentina's Bersa sell well in the United States, but on a smaller scale (Bersa, 2004; Dreyfus and Lessing, 2003; Rossi USA, 2004). Croatia's HS Product is similar in having created a series of highly rated pistols and then having entered the US market, selling its products through Springfield Armory (Kiss, 2004, p. 28). A few exceptions are companies such as Germany's Anschütz, which began by supplying the German market with precision small-calibre sports weapons before turning to the US handgun and rifle market (Anschütz, 2004).

Manufacturing processes differ from those of specialist producers with respect to production runs rather than the range of technologies employed. Since these firms cater to the mass market, mass production is the norm. Technology is sophisticated: companies employ numerous CNC machines and engage in extensive research and development (R&D) as well as CAD and CAM work.

In the United States, firms tend to employ between 100 and 3,000 employees, with the majority employing between 200 and 500. Annual turnovers range from around USD 10 million to USD 150 million, although most companies report between USD 15 million and USD 50 million (Hoover's Inc., 2004). Firms in Western Europe appear to be similar to smaller household-name producers in the United States, with staff sizes of between 100 and 450 employees, and annual turnovers of between USD 30 million and USD 100 million (Anschütz, 2004; Walther, 2004; Weidacher, 2005, forthcoming). Italy's Beretta is something of an anomaly in that it produces for the military and civilian markets. The company employs some 2,300 workers and has annual sales of approximately USD 420 million, of which around 90 per cent is generated from civilian markets (Weidacher, 2005, forthcoming).

Household-name producers not only make very few types of small arms and light weapons, but also rarely devote much of their productive capacities to manufacturing non-arms-related products. Nevertheless, non-arms production

is probably more of a factor among household-name producers than it is among specialist producers. In 2003, for example, sales of non-arms castings made up around 12 per cent (USD 17.3 million) of the annual trade of Sturm, Ruger & Co., while approximately 4 per cent (USD 4.7 million) of Smith & Wesson’s annual sales came from metal processing and finishing, with a total of 13.2 per cent (USD 15.5 million) derived from non-firearm products (Ruger, 2003, p. 3; Smith & Wesson, 2004b, p. 4).

Similar to Sector 3 producers, a number of Sector 4 firms developed expertise in the non-arms industry before they became involved in weapons production (Kahr Arms, 2004). In the case of GLOCK, expertise in the field of metallurgy—or composites—provided it with the opportunity to move into the business of small arms production. Similar examples include Taurus of Brazil and HS Product of Croatia. Nonetheless, this pattern does not apply to the largest producers, which appear to have started out as small-time arms producers and only later branched out into non-arms-related production (Remington, 2004; Smith & Wesson, 2004b).

Household-name producers are typically associated with the civilian market for firearms, particularly in the United States, and have thus been the focus of considerable domestic research and frequent legal policy attention. As a result, their role in small arms and light weapons production is fairly well understood.

While Sector 4 products are not generally associated with violence in some of the world’s armed conflict zones, weapons collection programmes in places as diverse as the Central African Republic and Kosovo have taken receipt of significant numbers of armaments manufactured by household-name producers (KPIS, 2003). As the Small Arms Survey’s findings on transfers continue to reveal, weapons produced anywhere in the world have the potential to be used far and wide (TRANSFERS, CENTRAL AFRICAN REPUBLIC). This knowledge, together with the fact that these weapons have considerable military utility, underlines the need for close monitoring of the sector.

Sector 5: Extensive-range (primarily military) production

Extensive-range producers differ from household-name producers in that they manufacture a greater variety of qualitatively different products. These items are either targeted at the military market or are based on military-oriented products. Furthermore, these Sector 5 producers often manufacture explosive weaponry—often alongside large conventional weapons such as artillery—that are normally intended exclusively for the military. They are, however, distinct from Sector 6 producers in that the vast majority of products are characterized by relatively low technology and that the manufacture of electronics or optical equipment is rare.

Product and service range:	Mass production of small arms and light weapons (and larger weapon systems)
Examples:	Assault rifles, light and heavy machine guns, rocket launchers
Principal markets:	Mainly military

Firms range from (1) independent, primarily military-destined producers that diversified into civilian production some time ago, to (2) producers that are predominantly under state control, yet are beginning to focus on civilian markets, to (3) suppliers to state armed forces that continue to produce solely for the military market. While these enterprises differ greatly in terms of ownership structures, they are comparable in that they often manufacture a similar array of products for military markets *and* have to respond to market forces differently from primarily civilian-oriented Sector 4 producers.

The first set of firms has long manufactured an assortment of civilian-destined armaments but produces primarily for the security and military markets.

Colt and Springfield Armory, for example, have long histories of providing weapons to US security forces (Colt, 2004). The latter continues to supply Special Forces with rifles and has also received a contract to supply the US Federal Bureau of Investigation. Much of the civilian-destined product range reflects this history and is based on military-issue weapons, including the M1911 pistol, the M14 rifle, and the M6 carbine (Springfield Armory, 2004).

A number of European firms are very similar in that they moved into civilian-destined production after having produced for state security forces (Sauer, 2004; Swiss Arms, 2004). Turkey's Sarsilmaz was founded in 1888 and, although it has long been a supplier to the Turkish Armed Forces, it also produces a range of pistols and shotguns aimed at the civilian market (Sarsilmaz, 2004). Like their US counterparts, these firms manufacture a wide variety of weapons, from pistols and rifles to sub-machine guns, assault rifles, and single-shot grenade launchers (HK, 2004; Swiss Arms, 2004; 2005). Some traditional producers of military weapons, such as Germany's Heckler & Koch, have added civilian production under a separate subsidiary, but they remain primarily military suppliers (HK, 2004; HKJS, 2004; Weidacher, 2005, forthcoming).

The second set of firms includes enterprises that remain under state control or have inherited large-scale manufacturing plants from the state. These companies have only recently diversified into civilian-destined manufacturing.

Some of them produce a wide assortment of ordnance, such as Romania's RomArm and Serbia and Montenegro's Žastava Oruje. These two enterprises recently diversified production and now produce weapons targeted at the sport, hunting, and personal defence markets (RomArm, 2004; Zastava, 2004). Zastava recently signed a contract to export approximately USD 7.5 million worth of goods to the US civilian market (SEESAC, 2004). In the Russian Federation, firms offer a similar line of products. Izhevsky Oruzheiny Zavod, Izhevsky Mekhanichesky Zavod, and Tulsky Oruzheiny Zavod all produce hunting and sporting firearms in addition to weapons for the military market (Pyadushkin, 2004a). Ukraine's Fort Association and the Metallist Uralsk Plant of Kazakhstan have likewise begun to diversify into manufacturing civilian-destined weapons (Pyadushkin, 2004b).

The third and last set comprises companies that produce weapons almost exclusively for the military and have not diversified into civilian production, except in a few minor cases. Products range from light and heavy machine guns to shoulder-launched multi-purpose assault weapons, such as the M72 Law (US Ordnance, 2004; Talley, 2004).



A Marine reservist holds his baby while his wife aims a shoulder-launched multi-purpose assault weapon produced by the Sector 5 manufacturer Talley Defense Systems. Camp Pendleton Marine Base, February 2003.

© Mike Blake/Reuters

Companies including Industria de Material Bélico de Brasil (IMBEL) and Fábricas y Maestranzas del Ejército (FAMAE) of Chile manufacture assault rifles, some simple light weapons, and, in the case of IMBEL, pistols, but they do not produce for the civilian market (Dreyfus and Lessing, 2003). The situation is similar for European producers such as FN Herstal, which manufactures pistols, assault rifles, and machine guns for the law enforcement and military markets only (FN, 2004; FN Herstal, 2004). Larger firms, comparable to US companies such as Talley Defense Systems, produce a number of light weapons alongside larger conventional systems. They include: GIAT Industries of France, which produces the FAMAS assault rifle; the Hellenic Arms Industry, which produces various small arms and light weapons; Austria's Hirtenberger Group, which produces mortars and mortar ammunition; and Pakistan Ordnance Factories, which produces various small arms, light weapons, and ammunition.⁹

Most firms manufacture many different products and hence plants tend to be large and to utilize diverse equipment. In the more industrially developed countries, computer-controlled equipment is similar to that of firms in the United States and Western Europe. Less-developed countries engage in more labour-intensive production processes.

The size of firms varies according to the levels of technology employed. Some of the smallest European producers, such as Steyr Mannlicher, employ only around 100 employees, and annual turnover hovers around USD 20 million (Weidacher, 2005, forthcoming). Companies that are arguably less efficient, including Arcus of Bulgaria, employ as many as 3,000 workers but have an annual turnover of around USD 40 million (Kiss, 2004, p. 29). Similarly, Russian firms including Izhevsk Arms Plant and Tulskey Oruzheiny Zavod employ between 3,000 and 13,000 people and have annual turnovers of between USD 15 million and USD 50 million (Pyadushkin, 2004a). By contrast, the most advanced producers, such as Heckler & Koch, employ around 700 workers and have annual turnovers of about USD 120 million (Weidacher, 2005, forthcoming). Meanwhile, US companies employ as many as 500 people and have annual turnovers of somewhere between USD 2 million and USD 50 million (Hoover's Inc., 2004).

One observable trend in extensive-range production is that firms in the United States and Western Europe tend to be highly specialized and make few, if any, non-arms-related products.¹⁰ In these countries, company ties with non-arms industries stem largely from their R&D capacities and extensive experience of product testing.¹¹ State-owned firms often offer a range of R&D-oriented services, such as engineering management, assistance in establishing maintenance programmes, ballistic analysis, and systems testing (FN Herstal, 2004; GIAT, 2004; POF, 2004). In less-developed countries, firms, particularly those with reduced markets and financial troubles, often produce a greater variety of non-arms-related items. RomArm and Arcus, for example, have diversified into non-arms-related manufacturing, including of such diverse goods as wooden and metal furniture, vehicle parts, washing-machine components, bicycles, and back-massaging equipment (RomArm, 2004; Arcus, 2004).

The likelihood is high that extensive-range producers manufactured the weapons most commonly used in any instance of armed violence during any protracted conflict throughout the world. The reason is that, by and large, companies operating under government control or contract constitute the sector most heavily involved in supplying overseas militaries, which, in turn, often endure stockpile losses. Colt's M-16 series of rifles, FN's FAL, and the Kalashnikov AK series are examples of the most widely proliferated weapons. Nevertheless, Sector 5 producers also make larger, more destructive systems, such as mortars and RPG launchers.

Sector 5 weapons are still transferred in abundance to countries in conflict and states with poor stockpile security records. In 2002, for instance, Indonesia purchased some 10,000 Kalashnikov assault rifles from an undisclosed Russian firm (Jane's, 2003), and the United States recently transferred M-16 rifles to Nepal (Jane's, 2004b).

Less-developed countries engage in more labour-intensive production processes.

Sector 6: High-tech electronics and optics systems manufacturing

Product and service range: High-tech mass-produced accessories and systems
 Examples: Optics, thermal sights, fire control systems, man-portable air defence systems (MANPADS), anti-tank guided weapons (ATGWs)
 Principal markets: Some civilian, mainly military

High-tech producers manufacture high-precision components and systems, which, in many cases, parallel production processes in the aerospace, medical, and optical sectors. Among these producers are global giants of the defence industry, but also

far smaller firms specializing in the production of technology-intensive electronics and optical equipment.

These firms differ considerably from most other small arms-related industrial enterprises. Instead of manufacturing products based on designs that have changed little in decades, they employ some of the most advanced production methods possible.

Smaller high-tech optics and components manufacturers

The smaller companies in this sector display very similar characteristics worldwide, although they differ somewhat in terms of their reliance on automated machinery. While they may be sophisticated, many of the items produced by less technologically advanced plants tend to be based on older, tried-and-tested designs. In the most advanced firms, production practices range from computer-controlled grinding of lenses to biometric standards, to the machining of titanium and aircraft-grade aluminium alloys, and electronics engineering (ATN, 2005). Companies that manufacture electronic components, such as laser sights, are typically specialists in vision and sighting equipment or otherwise are suppliers—so-called original equipment manufacturers (OEMs)—of components to such firms. In China, Taiwan, and the United States, for example, a number of companies that specialize in laser modules for all purposes also make complete sight systems for small arms and light weapons (LaserMax, 2004; Poe Lang, 2004).

Company size varies greatly, as does the degree to which firms engage in small arms-specific manufacturing. For instance, while Swarovski Optik—a maker of rifle scopes—employs a staff of around 550, the Swarovski Group, which manufactures a wide variety of non-small arms-related items, employs more than 14,000 people globally. The company as a whole produces an assortment of products, from telescopes and stone-dressing equipment, to crystal items for jewellery, to rifle scopes and rifle-mounted night-vision equipment (Swarovski Optik, 2004; Swarovski, 2004a). Many of the major scope manufacturers make telescopes and binoculars in addition to rifle scopes.¹²



Part of the Zeiss Lens Factory in Jena, Germany, circa 1909. The Zeiss Company was founded in 1846 and manufactures, among other things, a wide range of rifle scopes.

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Manufacturers of electronic components may employ between a few hundred and 5,000 or more persons and devote only a tiny fraction of their productive capacity to small arms-specific production (Coherent, 2004b; Furukawa, 2004). Night-vision manufacturers frequently produce electronic sensors for civilian surveillance purposes, including such devices as parking sensors, speed guns, and cameras (ATN, 2005; Bushnell, 2004). Companies producing OEM laser

modules cater to all types of laser use, from machine alignment and process control, to medical technology, audio and visual applications, and telecommunications (Laser Devices, 2004; Surefire, 2004; WSTech, 2004).

The distribution of companies worldwide depends very much on the type of productive activity and the technology involved. Firms are located in countries and regions with reputable research establishments, such as China, the CIS, the United States, and Western Europe. Those selling on the optics market appear to be established businesses, and a large number, including Swarovski and Schmidt & Bender, hail from Germany and Austria, the early market leaders in the field (Swarovski, 2004a; Schmidt & Bender, 2004). Some more recently industrially developed countries, such as Japan, also manufacture precision optical accessories. Electronics companies, including those producing light-intensifying and laser equipment, tend to be located in areas with a high concentration of technology manufacturers, such as California (Rolyn, 2004; Lasermate, 2004; Coherent, 2004a), the south-east of England (Laser 2000; 2004; Lambda, 2004), and metropolitan Tokyo (NEC, 2004; Furukawa, 2004).

Global giants of the arms and aerospace industries

Countries hosting manufacturers of complete high-tech weapon systems, such as anti-tank guided weapons (ATGWs) and man-portable air defence systems (MANPADS), are states with a high density of high-tech production in most industrial fields. Nevertheless, countries differ in their level of high-tech development, and the firms they host differ in size, areas of productive activity, and the technology of weapons produced.

The most developed firms are typically in Japan, the United States, and Western Europe; they make the most sophisticated and, consequently, most expensive weapons currently available. The Raytheon Company of the United States, for example, produces the FIM-92 'Stinger' MANPADS, the Javelin ATGW, and thermal weapon sights (Raytheon, 2004a). Similarly, in Western Europe, companies such as Thales produce MANPADS, night-vision equipment, and thermal sights (Thales, 2004). The European Aeronautic Defence and Space Company (EADS), the largest producer in Europe, manufactures the Eryx and Milan ATGWs and the Mistral MANPADS, and is part of the European Stinger Project Group (EADS, 2004).

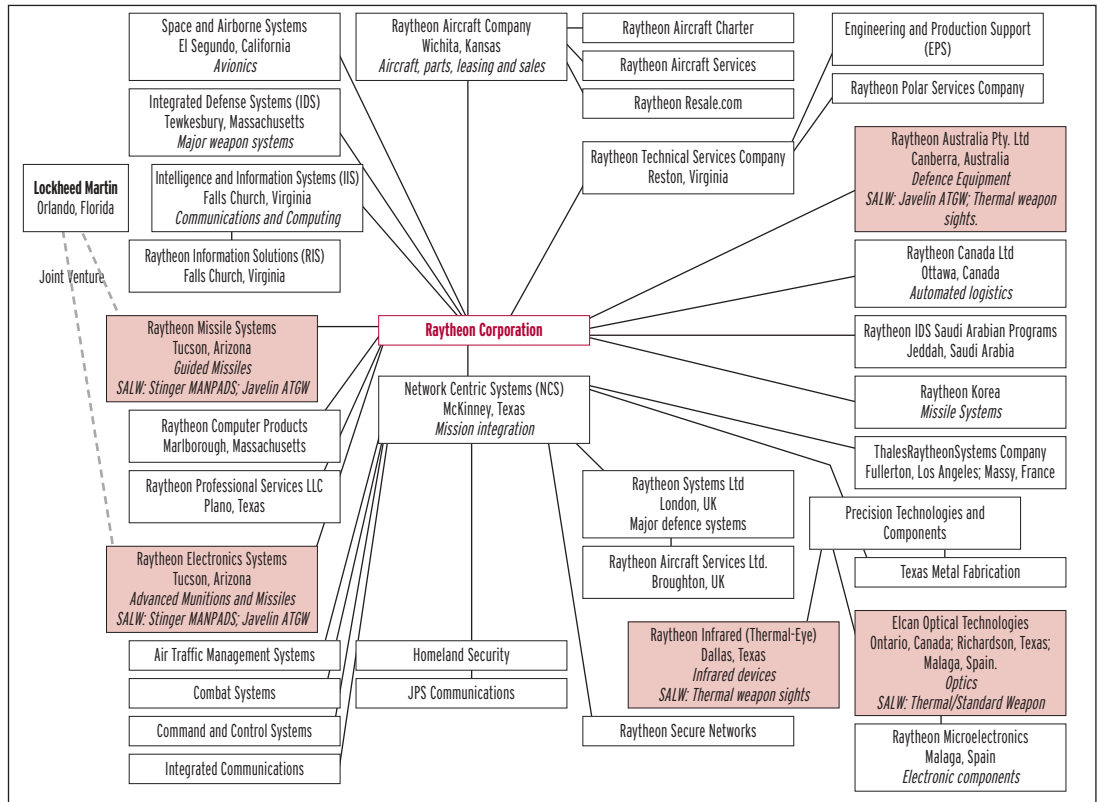
As Figure 2.2 illustrates, small arms and light weapons production occurs only in a few subsidiaries of most Sector 6 firms, with companies producing for areas as diverse as printing and medicine, although they may be dependent on defence sales (Raytheon, 2004b). Alliant Techsystems, Inc. (ATK) of the United States, for instance, manufactures parts for the space shuttle, ballistic missiles, and commercial aircraft, while General Dynamics makes nuclear submarines and executive jets (ATK, 2004a; 2005; GD, 2004a).

These firms differ in their focus on small arms and light weapons systems and components, to which they generally devote a tiny proportion of their total productive capacity. Around 30 per cent of activity at ATK, for example, centres on small and medium ammunition manufacturing, of which small arms and light weapons ammunition is but a part (ATK, 2004a). In the same way, small arms production only constitutes a minor portion of European Sector 6 activity. In the case of EADS, ATGW and MANPADS production comprises a fraction of the workload of its Defence and Security Systems division, which is responsible for generating only about 17 per cent of the company's total sales (EADS, 2003).

Most firms offer extensive R&D and testing facilities under contract, as well as consultancy services for a wide array of fields, including personnel management, air traffic control, and information technology. R&D expenditures in all areas of activity are high, ranging between around one and more than ten per cent of annual turnover (between roughly USD 30 million and more than USD 900 million).¹⁵

Most giant high-tech producers offer extensive R&D and testing facilities.

Figure 2.2 Corporate map of Raytheon Company (shading indicates small arms-related production)



Sector 6 firms are often concomitant with high-tech development in the civil industrial sector, and indicators of such development, as Table 2.5 illustrates, provide insight into the distribution of high-tech small arms and light weapons production. In a number of states, however, this relationship does not hold.

While products and production processes in these nations are similar to those of US and Western European producers, they are usually at a lower level of technological advancement. Smaller producers, such as A.Q. Khan Laboratories of Pakistan and the Sakr Factory for Developed Industry of Egypt, make older models of guided ATGWs and MANPADS, as well as laser range finders (FAS, 2000; Jane's, 2004a). Larger manufacturers produce ATGWs as well as a variety of small arms; this group includes Israeli Military Industries (IMI), whose range of goods is comparable to that of Russian producers including the V.A. Degtyarev Plant and the KBP Instrument Design Bureau (IMI, 2004; Pyadushkin, 2004a). Similarly, Denel of South Africa offers a wide assortment of small arms and light weapons and accessories. These products range from rifles and machine guns produced by Denel's subsidiary Vektor, to range-finders and fire control systems for small arms manufactured by another subsidiary, Eloptro (Denel, 2004a; Eloptro, 2004).

Like their US and Western European counterparts, these firms are often heavily engaged in non-arms-related activity and frequently produce less technologically sophisticated civilian products. Denel, for instance, owns property, engineering, aviation, and personnel companies, and most of its high-tech production remains arms-related (Denel, 2004a). In the Russian Federation, the trend is towards manufacturing concerns, such as automobile production and basic medical technology (Degtyarev, 2004; KPB, 2004).

Table 2.5 Countries hosting Sector 6 producers (in red) and the top global R&D spenders in all areas of industrial activity

1	Sweden		Slovenia
2	Finland	24	Ireland
3	Iceland	25	China
4	Japan		Italy
5	South Korea		New Zealand
6	Israel	28	Spain
	United States	29	Brazil
8	Switzerland		Hungary
9	Germany		Romania
10	France	32	India
	Taiwan	33	Greece
12	Denmark		Poland
	Singapore		Portugal
14	Belgium		Slovakia
	Netherlands		South Africa
16	Austria	38	Chile
	Canada		Hong Kong
18	United Kingdom		Turkey
19	Norway	41	Argentina
20	Australia		Malaysia
21	Russian Federation		Venezuela
22	Czech Republic		

Sources: Economist (2004); Jones and Cutshaw (2004); NISAT (2005); Small Arms Survey (2004)

To sustain production and services in a wide variety of fields, and often in a multitude of subsidiaries, companies are usually far larger than those in any other production sector. In the United States, the size of firms ranges between 13,500 and more than 130,000 employees at giants like the Lockheed Martin Corporation. Annual turnovers range between about USD 2 billion and USD 39 billion.¹⁴ In Western Europe, companies such as Thales report annual turnovers of around USD 13 billion and employ some 60,000 workers (Thales, 2003), while EADS has an annual turnover of USD 35–40 billion (EADS, 2003). Outside of the United States and Western Europe, firms tend to be much smaller, with Russian producers employing around 3,000–16,000 workers and companies such as IMI employing approximately 4,000 personnel. Turnovers range between USD 150 million and up to USD 250 million for Russian producers, with more successful companies like Denel and IMI turning over between USD 550 million and USD 700 million (Denel, 2004b; IMI, 2004; Pyadushkin, 2004a).

It is clear that there are gaps in current knowledge regarding production of and trade in high-tech small arms and light weapons. Complete systems, such as ATGWs or MANPADS, which are produced by the largest firms, are often the subject of costly government procurement programmes and are frequently well-publicized in trade publications; however, lower-value products, including optics and laser devices, remain largely beyond the scope of current research. While larger systems obviously constitute cutting-edge technology, a focus simply on firearms in the small arms and light weapons research field often obscures the symbiosis between high-tech accessories and low-tech firearms.

The direction of current research supports these observations. The debate over MANPADS suggests that these weapons are likely to remain on the policy agenda because they threaten the state-of-the-art armies of the most powerful nations (Small Arms Survey, 2004, p. 90). Although researchers have stressed the importance of ATGWs, the topic is only now beginning to attract the attention of policy-makers, and only states that are directly affected, such as Israel,

appear to be expressing sufficient concern. The more obscure types of high-tech weaponry, particularly those items designed to be retrofitted onto existing weapons, remain even further from the spotlight.

There is a need to improve the monitoring of trade in high-tech accessories.

As this chapter illustrates, Sector 6 products differ qualitatively from those of other sectors in the industry. Nevertheless, the field exhibits a great deal of synergy with producers of high-tech accessories, such as night-vision systems, laser sights, and scopes, and the less complex small arms and light weapons they are designed to complement. Like the production and trade in components and accessories (Sector 2), more research needs to be conducted on this sector to help determine the capacity of these products to change the shape and destructive effects of armed conflict. Recent events, such as the use of night-vision equipment by US troops in Fallujah, Iraq, in November 2004, underscore the degree to which high-tech accessories can enhance the effectiveness of weapons. There is thus a need to improve the monitoring of trade in such items, as their popularity is only likely to grow.

CONCLUSIONS REGARDING THE FRAMEWORK EMPLOYED AND RECOMMENDATIONS FOR FURTHER RESEARCH

The findings presented in this chapter have clear policy relevance. A systematic analysis of the various sectors of production can help to fill gaps in knowledge and present a more detailed picture of the industry. It will also serve to identify more accurately the point of manufacture of the small arms and light weapons of main concern.

The chapter highlights the very high degree of differentiation among types of firms, the goods they produce, and their markets. This differentiation alone warrants continued sector-oriented approaches to further research on small arms and light weapons production.

The findings presented here also demonstrate how production sectors are distributed differently across countries and regions with various levels of industrial development. This observation is a prerequisite to a qualitative understanding of the kinds of weapons that are, or are likely to be, manufactured in certain parts of the world. Focusing on the varied distribution of firms and sectors can locate parties responsible for irresponsible production, and enable the formulation of better-targeted measures to control the illicit proliferation of small arms and light weapons.

This method can also yield a better picture of the parameters of the industry, such as the size and scope of manufacturing. This approach can help produce generalizations regarding firm types and sizes, which can then be applied to cases for which little data is available. Countries with similar aggregations of firms and sectors can be compared and contrasted more easily, and reasons for irresponsible production understood more fully.

The implications of a highly differentiated industry

Given the limited time and resources at the disposal of researchers and policy-makers, it is important to target problem weapons, and hence problem production, efficiently. The framework outlined here goes at least some way in facilitating research specific to some crucial producers, yet it discounts production that is peripheral or even unconnected to particular matters of concern.

Current debates, such as those over the proliferation of MANPADS or the expiry of the US Assault Weapon Ban, illustrate how concerns over different types of small arms and light weapons implicate different sectors of the industry

(Small Arms Survey, 2004, ch. 3). The case of MANPADS clearly relates to high-tech producers, while the Assault Weapon Ban implicates specialist (Sector 3) and components and accessories (Sector 2) producers.

A differentiated approach also offers insight into sectors of the industry that are likely to be affected by changes in markets as well as government policies. For example, in the case of a sector that serves primarily military clients, the expansion of an infantry procurement programme in one country is likely to boost extensive-range production of small arms and light weapons (Sector 5) in that state or in supplier nations. Crucially, it is less likely to affect household producers (Sector 4). Along these lines, US action in Iraq may have increased demand for components and accessories (Sector 2) for the enhancement of existing rifles, in addition to heightening Sector 5 production, but US repair and sporadic production (Sector 1) is not likely to have been affected.

A high degree of differentiation is also observable in the degree to which sectors of the industry devote varying amounts of resources to small arms and light weapons production in relation to non-arms-related manufacturing. This chapter demonstrates that the firms that specialize most in small arms production—and are most dependent on small arms sales—are generally household-name producers (Sector 4), followed by extensive-range producers (Sector 5). Specialist producers (Sector 3) of small arms probably rank third. Yet components and accessories producers (Sector 2) and high-tech (Sector 5) manufacturers differ considerably; for them, small arms production is often a sideline activity with respect to overall industrial production and services. With regard to repairs and sporadic production (Sector 1), trends seem similar to the latter cases, although establishing the degree of specialization is often problematic.

These observations are of considerable importance for determining the effects of large-scale changes in markets for all products, both arms- and non-arms-related, and their effect on small arms and light weapons production in particular. Moreover, they are a prerequisite to any attempt to generalize about the size of the industry. With manufacturers, and indeed sectors, devoting different percentages of resources to the production of small arms and light weapons, better conclusions can be drawn concerning the role of a firm or sector in the overall industry. This might involve assessing the typical number of employees in firms in one sector, or the average revenue a firm in a particular sector is likely to generate from small arms sales. It might involve calculating the relative frequency of firms in a sector as a proportion of a country's overall industry. These figures can then be aggregated to create a better picture of the global small arms industry.

The implications of varied distribution of qualitatively different firms

By monitoring the varying volumes and values of small arms and light weapons exports around the world, researchers have been able to speculate as to which countries are the main suppliers and which states and regions are the most dependent on such products. These quantitative research tools can only be reinforced by a qualitative understanding of production as presented in this chapter, and their policy-relevant findings made more accurate.

The research offered here suggests that the distribution of firms is to a large extent dependent on a state's level of industrial development and its consumption patterns. Thus, the most advanced forms of Sector 6 production are largely the preserve of countries with well-developed high-tech industries in both the civil and defence spheres and modern, sophisticated military customers. Household-name production (Sector 4) usually requires strong domestic demand for civilian firearms, while Sectors 2 and above need a reasonable level of industrial capacity. These considerations help in determining the likelihood that production occurs in states where information concerning the extent of manufacture is scarce; they also aid in projecting the future distribution of the small arms and light weapons industry globally.

For instance, in recent decades, high overall growth in the manufacturing industries of states such as Singapore has been accompanied by concurrent developments in extensive-range and high-tech small arms and light weapons production. In contrast, Brazil's small arms and light weapons production is significant but not high-tech. Nonetheless, the country has a relatively advanced space programme and produces large conventional weapons. Given the trends observable among current Sector 6 producers, one should expect Brazil to move into high-tech production if there is sufficient political will.

From a policy perspective, focusing on the distribution of qualitatively different sectors—rather than on a country's overall contribution to the volume of small arms produced—yields important insight into the trade. The findings of this chapter suggest that certain states may contribute more to the small arms trade than previously assumed, while others may behave in more complex ways than hitherto acknowledged.

Nowhere is this more apparent than in the trade in components and accessories. Japan, for example, is not considered an actor in the global trade in small arms and light weapons, yet its Sector 6 production of optics is well advanced and it exports to countries and regions including the United States and Western Europe.

Trade patterns in all components and accessories shed light on trade patterns in small arms-specific products.

While knowledge of the components and accessories sector is limited, this review suggests that trade patterns in all components and accessories (be they arms-related or not) can help inform conclusions about trade patterns in small arms-specific products. The automobile and watch industries demonstrate that, while assembly of finished products often takes place in designated centres, such as Geneva or Detroit, components are often manufactured in regions with low labour costs, including South-east Asia. Sector 2 production may well follow this trend. Future research will be able to fill gaps with respect to crucial areas of manufacturing that have considerable input into the use and abuse of small arms and light weapons. In turn, these important findings will be able to inform the decisions of policy-makers.

Final note

This chapter is intended to lay a foundation for a better exploration of the dynamics at work in the small arms and light weapons industry. While noting a relative absence of linkages between certain sectors,¹⁵ it seeks to emphasize that the 'global trends' often assumed to impact on the small arms and light weapons industry as a whole actually influence its individual sectors in distinct ways. Not only are sectors often extremely different in composition, in the items that they manufacture, and in terms of their markets, but the products traded also take on differing political significance and are affected by different government regulations. Indeed:

The flow of defense hardware and software across national boundaries is not 'free', 'unrestricted', or 'unfettered'. Instead, it is subject to a wide array of nontariff barriers to trade such as 'export controls', the 'not invented here' syndrome, and, most importantly, the economically irrational but still widespread desire for national, and in one instance regional, defense industrial independence. (Ross, 2002, p. 35)

Importantly, such barriers to trade and integration differ greatly depending on the production sector. As a result, some goods may be subject to strict regulation, while others may be treated like any civil commodity. By presenting findings that underline such differences within the small arms and light weapons industry, this chapter suggests that, in future, researchers may find it useful to focus on the effects of market and policy trends on individual production sectors. Policy-makers stand to be better informed about the specific origins of the illicit small arms trade and how regulation affects it.

LIST OF ABBREVIATIONS

ATGW	Anti-tank guided weapon
ATK	Alliant Techsystems, Inc.
CAD	Computer-aided design
CAM	Computer-aided machining
CIS	Commonwealth of Independent States
CNC	Computer Numeric Control
EDM	Electrical Discharge Machining
IMI	Israeli Military Industries
MANPADS	Man-portable air defence systems
OEM	Original equipment manufacturer
R&D	Research and development
RPG	Rocket-propelled grenade

ENDNOTES

- ¹ The terms 'civilian' and 'military-style' weapons are common and have some utility. For instance, a Kalashnikov AK-74 is clearly designed as a weapon meant for military use. The fact that it is not uncommon in the hands of civilians throughout the world is indicative of how weapons circulate outside from state arsenals when the lines of demarcation between military and civilian become blurred.
- ² These firms appear in a 2003 list compiled by the Omega Foundation for the Small Arms Survey, which has been updated via product category searches on Hoover's online database (Omega Foundation, 2003; Hoover's Inc., 2004).
- ³ All figures, with the exception of Leupold & Stevens, Inc. (2004) and Leitner-Wise Rifle Co. (2004), are from Hoover's Inc. (2004), which compiles a wide variety of data on firms of all sizes. Data and market analyses were provided by Hoover's Inc. and included data from Dun and Bradstreet (D&B) Corporation (2004). For copyright reasons, a company-by-company breakdown of figures cannot be provided. Instead, trends in company size and turnover are aggregated and presented.
- ⁴ The sample as a whole can be depicted as an inverted pyramid—a Zipf or Pareto distribution—revealing very few large producers and many smaller manufacturers. This feature is common to the US industry generally (Axtell, 2001) and has been noted with respect to the US firearms industry (Diaz, 1999, p. 23).
- ⁵ Author interview with Dr. Kwesi Aning of African Security Dialogue and Research, Accra, Ghana. 8 October 2004. Geneva, Switzerland.
- ⁶ Author interview with Maxim Pyadushkin, Specialist in Russian defence industry production, Moscow, Russian Federation. 7 October 2004. Geneva, Switzerland.
- ⁷ Author interview with F. J. Gebert, Managing Director, Truvelo, 14 June 2004. Paris-Nord, Villepinte: Eurosatory 2004.
- ⁸ See Cogswell & Harrison, 2004; Piotti Fratelli, 2004; Poli, 2004; James Purdey & Sons, 2004; and J. Roberts & Son, 2004.
- ⁹ See GIAT, 2004; HRMND, 2004; Hirtenberger, 2005; POF, 2004; 2005.
- ¹⁰ A few companies, including Austria's Hirtenberger, produce items such as metal stamping parts and seat-belt pretensioners (Hirtenberger, 2005).
- ¹¹ See Colt, 2004; Picatinny, 2004; Springfield Armory, 2004; Talley, 2004; US Ordnance, 2004.
- ¹² See Burris, 2004; Bushnell, 2004; Leupold & Stevens, 2004; Zeiss, 2004.
- ¹³ See ATK, 2004a; GD, 2004b; EADS, 2003; IIT, 2004b; Raytheon, 2004b; Thales, 2003.
- ¹⁴ See ATK, 2004b; GD, 2004b; IIT, 2004b; Lockheed, 2004b; Raytheon, 2004b.
- ¹⁵ Such events as a joint venture between handgun-maker Taurus of Brazil and the Australian high-tech manufacturer Metal Storm have been rare to date and are thus excluded from this analysis (Taurus, 2004b). They may, however, become more common in future.

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Principal author

James Bevan

Other contributors

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