Chapter 8
Datasets for Combat Aircraft

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Contents

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R. Beeres et al. (eds.), *NL ARMS Netherlands Annual Review of Military Studies 2021*, NL ARMS,
https://doi.org/10.1007/978-94-6265-471-6_8

Abstract As part of an empirical investigation into factors contributing to the world-wide demand and supply of fixed-wing combat aircraft, the authors have conducted a search for data sources providing insight in the characteristics, types and qualities of aircraft designed for combat purposes, the total volume on the market (entries, movements and exits), as well as the financial equivalents of each in a specific period of time. This chapter discusses both the various pathways embarked on to this end, as well as the research results.

Keywords Combat aircraft · datasets · data providers · type of data collected · language · formats · price · weapon system detail · financial information

8.1 Introduction

As part of a research project into the factors contributing to the world-wide demand and supply of fixed-wing combat aircraft, we were looking for empirical data sources providing an insight into the characteristics, types and qualities of aircraft designed for combat purposes, the total volume on the market (entries, movements and exits), and the financial equivalent for each within a specific period of time. This chapter presents the results of this research. The questions the chapter addresses are: which empirical data sources on combat aircraft are available; what are the general characteristics of these data sources; and which data are provided by the data sources?

Empirical research regarding specific weapon systems has developed only relatively recently. Earlier studies applied separate 'weapon system counts' as a measure to assess a country's military strength. At the time, Lambelet construed indices to assess the strategic power of the global power blocks using data on conventional and nuclear weapon stocks.[1] His ideas have gained many followers, especially concerning the arms race literature.[2] Ward shifted the methodology from 'counting nuclear weapon stocks' to 'counting conventional weaponry' only.[3] Diehl and Crescenzi, in their methodology overview on future arms races literature, express a strong preference for Ward's method.[4]

[1] Lambelet 1973.

[2] Bolks and Stoll 2000; Desai and Blake 1981; Luterbacher et al. 1979; Kugler et al. 1980; McGuire 1977; 1981; Stoll 1992; Taagepera 1979–80, p. 67.

[3] Ward 1984.

[4] Diehl and Crescenzi 1998, p. 116.

Just now, in literature on segmentation between different weapons systems, the focus seems shifting from effect research to process research. For example, Caverley and Kapstein have supported their market analysis by regional trade data (amounts and cost price reflection) and a qualitative analysis of traded weapons systems (including combat aircraft).[5] Johnson has been the first to disaggregate major weapon systems into categories reflecting their strategic capabilities. His consecutive studies demonstrated that arms categories constitute a factor influencing interstate policy, both regarding procurement decision, as well regarding the political effects depending on the end to which arms are used.[6] To forecast future developments regarding Russia as an exporting country, Chizhov has studied the trends on the global market for fighter aircraft during the period 1950–2007. He concludes that the geopolitical situation, the level of military threat, scientific and technical progress and the level of regional economic development are factors influencing the fighter market.[7] From 2000 to 2009, Tsalikov has investigated the role and perspectives for Russia with regard to the multi-role fighters market. Based on this study, the Russian Federation has been advised on how to maintain its role as a leading state on the market. Tsalikov advises on future geopolitical cooperation and investment in Research and Development (R&D).[8] Saunders and Souva chose an altogether different theme; by redesigning the earlier notion of weapon systems counts as a proxy for military strength, and introducing a new dataset combining both quantitative and qualitative data on fighter, attack and trainer combat aircraft possession.[9] Rounds III, in the similar timeframe, studied fighter transfers, for better understanding of state-to-state relationships in the demand and supply of combat fighter aircraft.[10]

Two sources in English literature allow for a connection between data and a specific weapon system—in our case combat aircraft (i.e., the IISS Military Balance and SIPRI Arms trade database) as well as one source in Russian literature (i.e., the Centre for Analysis of World Arms Trade (CAWAT) World Arms Trade Statistics). When scrutinizing their data sources, we find Lambelet, Ward, Johnson, Saunders and Souva use the IISS Military Balance as their main dataset, whereas Caverley and Kapstein, Chizhov and Rounds III base their inquiries on SIPRI Arms Trade data. Tsalikov uses CAWAT statistics.

We proceeded then to find out whether it might be possible to answer our initial research question based on the above-mentioned three datasets. Unfortunately this proved not to be the case. IISS is useful for an indication of market size, market entries and exits, but lacks financial information. The SIPRI Arms Trade dataset provides an overview on market transfers and a cost indication of goods on the market. However, it lacks information on total volume on the market and transfer prices. CAWAT includes financial data, but lacks data before the year 2000. Although

[5] Caverley and Kapstein 2016.

[6] Johnson 2017; 2019; Johnson and Willardson 2018.

[7] Chizhov [Чижов] 2010.

[8] Tsalikov [Цаликов] 2011.

[9] Saunders and Souva 2019.

[10] Rounds III 2019.

we have considered a combination of these three sources, this has been rejected due to the differences in definitions and methodologies and the probable requirement for additional data on market diversity and market prices.[11]

To theoretically underpin our research questions, we have, therefore, embarked on another inquiry for new data sources, containing: (1) information about the heterogeneity of combat aircraft, (2) the presence and numbers of aircraft available during a specific time frame, (3) aircraft entries to, movements on and exits from the market, as well as (4) any supporting financial data. This inquiry has resulted in an overview containing 16 data sources concerning combat aircraft supply and demand (including SIPRI, IISS and CAWAT).

The remaining part of this chapter is structured as follows. Section 8.2 discusses the research methodology. Section 8.3 provides an overview of the results. Section 8.4 contains an in-depth analysis of our findings. The chapter ends by putting forward concluding remarks and our suggestions for future research within this realm in Sect. 8.5.

8.2 Methodology

While searching for data sources, three pathways have been followed. First, data originators' (i.e., states and their defense industries) reports on arms production, weapon stocks, arms transfers or abolishment of weapon systems have been investigated. Second, peace research and literature on arms control agencies has been reviewed. To this, academic databases (Scopus and Google Scholar), the library and internet have been searched using the terms: 'military alliances'; 'security through transparency'; 'annual defense assessments;' and 'combat aircraft'. Last, we have turned to commercial sources specialized in collecting, validating and spreading data as their main source of business. All specialized periodic publications in the aerospace industry have been searched for original database owners and commercial offerings. Internet has been explored for market reports on combat aircraft, and offering parties have been included in the analysis. Upon identification, each data source was checked based on open source information, to be followed by a request for any missing information or fact checking. Sources were then asked to deliver their data in a computer analysis friendly format. Most sources were willing to answer to our requests.

Each data source has been analyzed on the following aspects: (1) data provider (i.e., state- or non-state based agency); (2) type of data collected (i.e., production, transfer, abolishment, combat aircraft inventory, combat aircraft characteristics); (3) accessibility of data (i.e., language, format, price); (4) time frame (i.e., period covered, specificity of data and periodicity of updates); (5) actors (e.g., states, industries, armed forces, armed groups); (6) combat aircraft detail level (i.e., individual

[11] Colgan 2011.

configuration, weapon system family, weapon system category); (7) financial information included in the data set (i.e., availability, levels of detail, e.g., currencies and exchange year).

8.3 Results

This section first summarizes each of the 16 datasets general characteristics (Table 8.1). Second, each of the datasets is briefly characterized.

8.3.1 United Nations: UN Register of Conventional Arms (UNROCA)

UN General Assembly resolution 43/75 of 1988 initiated a study on the ways and means of promoting transparency in international transfers of conventional arms on a universal and non-discriminatory basis, resulting in the creation of UNROCA starting January 1992. The UNROCA database is maintained by the UN Office for Disarmament Affairs, with the aim of creating transparency, building confidence and preventing conflict among governments, encouraging restraint in the transfer or production of arms, and ultimately contributing to preventive diplomacy. UNROCA's standardized format allows for information about military inventory, national production, arms exports and imports. Occasionally states tend to provide information on arms abolishment (in comments) as well. Collection of data takes place by a yearly request for self-reporting of countries; no additional pressure methods are used. Data is public and free—the institution is financed as part of the state's contribution to the UN. The dataset is available online.[12] Though visually very impressive, the format does not allow for easy (machine) analysis. Contacting the UN does not lead to receiving the data in a more conventional format.

8.3.2 United Nations: Arms Trade Treaty Annual Reports

In 2013, the UN General Assembly adopted the Arms Trade Treaty (ATT) to regulate the international trade in conventional arms by establishing the highest international standards, in order to prevent and eradicate the illicit trade in and the diversion of conventional arms. The ATT entered into force on 24 December 2014 and seems to have taken over the role of UNROCA regarding information on arms exports and imports: the coordinating agency, intended audience and reporting categories are identical. There are some major differences as well. Firstly, the ATT imposes a

[12] https://www.unroca.org.

Table 8.1 Overview datasets

Data provider		Type of data	accessibility		Time frame	Actors	Financial information
Organization	General name reports		Language	Price	Period covered		Availability/detail level
UN	UNROCA	P, T, A, I	Multiple	Free	1992–present	170 states	Not available
UN	ATT	T	Multiple	Free	2015–present	67 states	Optionally, usually excluded Single transaction, actual currency
OSCE	Arms exchange reports	P, T, I	Multiple	Free	1998–present	45 states	Optionally, usually excluded Single transaction, actual currency
EU	Arms exports reports	T	Multiple	Free	1998–present	28 states	Available Yearly transaction per product group
SIPRI	Arms Transfers	T	English	Free	1950–present	260 unique actors	Own method based on known (competitive) production costs
CAWAT	World Arms Trade Statistics	T	Russian	Priced	2000–present	173 states	Available; US$, single transaction
IISS	Military Balance	I	English	Priced	1959–present	171 states	Not available
IHS Markit	Jane's	P, T, I, C	English	Priced	1909–present	163 states	Generally excluded
Informa	Aviation Weekly	P,T,I,C	English	Priced	Multiple years	103 states	Generally excluded
RELX	Cirium	P, T, I, C	English	Priced	Multiple years	Not disclosed	Not disclosed

(continued)

Table 8.1 (continued)

Data provider		Type of data	accessibility		Time frame	Actors	Financial information
Organization	General name reports		Language	Price	Period covered		Availability/detail level
Rheinische Post	World Air Forces report	I	English	Free/priced	2007–present	162 states	Not available
Forecast International	Military information library	P, T, I, C	English	Priced	1989–present	Not disclosed	Available Single transaction, actual currency
TEAL Group	Military information library	P, T, I, C	English	Priced	1989–present ara>	130 states	Available Single transaction, actual currency
Simplify compliance	Military Periscope	I, C	English	Priced	Multiple years	165 states	Not available
GlobalData	ADS Solution	P,T,I,C	English	Priced	Multiple years	Not disclosed	Not disclosed
Frost and Sullivan	Aerospace and Defense content	P, T, I, C	English	Priced	Multiple years	Not disclosed	Available Single transaction, actual currency

Source Saitova and Beeres 2021

legally binding obligation to report, with the exception of commercially sensitive or national security information. Secondly, the reporting format has changed as well, putting more emphasis on small arms and light weapons, distinguishing between authorization and the actual transfer of arms, requesting an indication of the value of transfer, and allowing for a better insight into the logistical chain of arms transfers (the producing state, the reporting state, and—optionally—the importing state). Data available to the public is free, financed as part of the state's contribution to the UN. The reports are available online.[13] The format does not allow for easy (machine) analysis. Contacting the UN/ATT secretariat does not result in receiving the data in a more conventional format.

8.3.3 Organization for Security and Co-operation in Europe (OSCE): Arms Reports Following the Vienna Document and the Treaty on Conventional Forces in Europe

The OSCE's founding document, the Helsinki Final Act of 1975, sets out the need to contribute to reducing the dangers of misunderstanding or miscalculation of military activities, particularly in a situation where the participating states lack clear and timely information about the nature of such activities. Since 1998, participants exchange information about arms inventory, national production, import and exports among each other. In September 2016, OSCE members decided to share the information exchanged—concerning imports and exports—by the participating States through posting on the OSCE's public website. Initial analysis shows that 45 of the 57 member states provide consequent (but not always timely) reports. Interestingly, states that do not report to UNROCA or ATT (e.g., the Russian Federation or the Holy See) do provide information to the OSCE made public.

Data available to the public is free, financed as part of the state's contribution to the OSCE.

The reports are available online.[14] The OSCE secretariat is not able to provide the data collected in a more conventional format. Scholars interested in the full dataset, including the non-published reports for the period 1998–2015, should consider enrolling in the OSCE Researcher-in-Residence Programme.[15]

8.3.4 European Union (EU): Arms Exports Reports

The EU has adopted a Code of Conduct on Arms Exports in 1998 as a politically binding instrument that seeks to create high common standards for all EU members

[13] https://thearmstradetreaty.org/annual-reports.html?templateId=209826.

[14] https://www.osce.org/forum-for-security-cooperation/332441.

[15] https://www.osce.org/documentation-centre-in-prague/researcher-in-residence-programme.

to make arms export decisions and to increase transparency among EU states on arms exports. The code has been replaced in 2008 by the Council Common Position and implemented in the domestic legislation of member states.[16] Amongst each other, the 28 members exchange detailed information, compiled (but not crosschecked) by the European External Action Service. This full information is not publicly available.[17] Reports are available from 1998 to the present. Dissimilation in arms categories following the EU Common Military List has become common practice from the 2003 report.[18] Data available to the public is free, financed as part of the state's contribution to the EU. Per state and arms category data is shared over export licenses issued and refused (both numbers and value), and value of actual arms exported in euros. In 2019 the EU Council expressed the intention to develop a searchable online database on to allow all stakeholders to consult and to analyze the data on Member States' arms exports in a user-friendly manner. At moment of writing, this database is not yet available. An alternative presentation of the same data is published by the European Network against Arms Trade.[19] Unfortunately, it is still not possible to conveniently retrieve the information presented.

8.3.5 Stockholm International Peace Research Institute (SIPRI): Arms Transfers Database

SIPRI is an independent international institute aiming to contribute to an understanding of the conditions for peaceful solutions of interstate conflicts and for stable peace, through scientific research. SIPRI maintains multiple databases, though only one (Arms Transfers) provides an insight into the level of individual weapon platforms. The database contains information on all transfers of major conventional weapons from 1950 to the most recent full calendar year. Data on nearly every country and armed group in the world is included. Information is arranged in arms' categories based on capabilities. SIPRI provides additional details on each transfer, next to a statement whether the reported year is an estimate. Transfer value is covered through a reflection of the known (competitive) production costs, using their own compiled Trend Indicator Value (TIV). Weapon systems with similar physical characteristics (limited comparison) are expected to have similar prices. This means that the actual deal value is not shown. Data originates from the national reports (including the UN Register), arms producing company's reports, and (independent) news sources (both on internet and on mass information channels). SIPRI data is available freely to all

[16] Council Common Position/2008/944/CFSP, supported by directive 2009/43/EC. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:335:0099:0103:EN:PDF.

[17] https://eeas.europa.eu/topics/security-defence-crisis-response/8472/arms-export-control-arms-trade-treaty_en.

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOC_2019_095_R_0001.

[19] https://www.eda.europa.eu/info-hub/defence-data-portal.

users. The Arms trade dataset is available online.[20] Upon request, a link is provided for easily retrievable data.[21]

8.3.6 *Centre for Analysis of World Arms Trade (CAWAT) (Центр Анализа Мировой Торговли Оружием (ЦАМТО)]: World Arms Trade Statistics*

CAWAT is a non-governmental independent research, information and publishing enterprise established in Russia in February 2010. CAWAT's main areas of interest include defense spending, the capacity of the defense industry, and the trade in arms and defense technologies. CAWAT produces both customizable projects (do mind that as a private person you receive no access—CAWAT deals with institutions only) and periodical editions for subscribers, including a Yearbook (in an electronic .pdf format) positioned as a full body catalogue and including several datasets on international *arms transfers*, covering 173 states and including transfer prices. The price of the yearbook is not published online, but it is estimated to range between €20.000 and €30.000. Universities and commercial sources are able to purchase information as part of an academic package. CAWAT publications are based on verifiable open source information, including national reports (including the UN Register), arms producing companies' reports, (independent) news sources and reports by international think tanks (e.g., SIPRI and IISS). Though acting as the main source for arms trade information within Russian media and academia, the organizational products are not generally known outside Russia, probably due to the orientation and language boundaries. The main information page is in Russian.[22] All periodic publications (weekly, monthly and yearly) are in Russian as well. An English webpage is available, but limited. Information about the yearbooks in English can be retrieved.[23]

8.3.7 *International Institute of Strategic Studies (IISS): Military Balance*

The Institute of Strategic Studies was founded in November 1958 in the United Kingdom to promote an informed debate on nuclear deterrence and arms control in the wake of the Second World War. Today the aim remains to conduct analyses on the issues of war and power for governments, the private sector and expert users. Its best-known publication—the Military Balance—provides an overview of states'

[20] https://www.sipri.org/research/armament-and-disarmament/arms-transfers-and-military-spending.

[21] http://armstrade.sipri.org/armstrade/html/tiv/index.php.

[22] http://armstrade.org/.

[23] https://armstrade.org/pages/en/magazines/yearly/report/methodics/index.shtml.

weapon stocks within their force structures. Currently, the Military Balance reports on more than 171 states. The IISS addresses defense policy and defense spending and includes detailed information on the organization and number of military forces. Datasets are available as part of the annual yearbook, in an electronic format and in print. Prices for a single copy start at £495. Recently, the IISS has started offering an additional online database: the Military Balance+, with data going back to 2014.[24] Full range and functionality are accessible with an Academic or a Corporate license (prices are not published, but are expected to range between €10.000 and €50.000). The Military Balance publications can be found online.[25]

8.3.8 IHS Markit: Jane's Publications

IHS Markit is a company providing information on a wide range of fields. With the purchase of Jane's retail group in 2006 (the brand name *Jane's* dates back to 1898 as a publisher of encyclopedia), IHS Markit has strengthened its grip on the aerospace, defense and security market. IHS Markit uses both first-hand and secondary information sources, including government and industry announcements, traditional and social media releases, extensive use of networks, freedom of information requests, (satellite) imagery and video analysis. The company maintains a specialized database, with digitalized data going back to 1988, available online and on alternative carriers. The price of full access is part of a commercial agreement between parties and is not disclosed; competitors estimate numbers reaching six digits. A request for access can be posted through the contact page.[26] Next to specialized data products, the company produces a wide range of periodicals (e.g., Jane's Defense Weekly, and the Defense Industry Newsletter). Within academia, IHS Markit is known for its yearbooks, which are often used as reference material. Three of those—concerning combat aircraft—are Jane's World Air Forces, which provides a yearly assessment of the airborne capabilities of global Air Forces. Arranged in a standardized way, the data covers fixed- and rotary-wing aircraft, UAVs and—to some extent—missiles, focusing particularly on upgrade information. Jane's All the World's Aircraft: In Service covers all aircraft from ultralights to multirole fighters, arranged by production company. Information on production and international trade is limited, prices of aircraft are occasionally provided, though generally for civilian aircraft only. Jane's All the World's Aircraft: Development & Production covers the production of 49 states with an aircraft industry, enlisting all (sub)contracting companies and their aircraft programmes. The price per yearbook is £915.[27]

[24] www.iiss.org/publications/the-military-balance-plus.

[25] www.iiss.org/publications/the-military-balance/the-military-balance-2019.

[26] https://ihsmarkit.com/about/contact-us.html.

[27] https://www.janes.com/products/yearbooks.

8.3.9 Informa: Aviation Week Network

Informa is a multinationally operating company in the field of information services, scholarly publishing, and international events, with a focus on business-to-business services. In the aviation field, Informa is known for its brand Aviation Week, covering developments worldwide and offering a portfolio of products across publications, data, market intelligence and events. The name dates back to 1916, when the first issue of Aviation Week magazine was published. After multiple name changes it is now known as Aviation Week and Space Technology. Aviation Week maintains a large amount of data including a constantly updated dataset on combat aircraft military inventory data. Extensive information on the various weapon systems is presented, including family groupings of aircraft types, specifications on weaponry, engines and contracts. Aviation Weekly has a strong focus on costs, including Maintenance, Repair and Overhaul cost data and unit cost information per aircraft. The Aviation Week data originates from the industry, specifically the original equipment manufacturer (OEM) government publications, specialized periodicals and think tanks. Moreover, the company maintains direct communications with military and government officials, as well as via freedom of information act requests and even occasionally open source satellite imagery. All information received is cross-referenced. The company serves both governmental and industrial clients. Individual information requests are possible. Depending on the request, customary commercial prices are agreed on.[28]

8.3.10 RELX: Cirium

RELX is a UK information and analytics company involved in intelligence and publishing, operating in 40 countries serving customers over the whole world. In its Risk & Business Analytics market segment, RELX provides its customers with data and analytics to improve operations and to manage risk. Since 2019, it has been brought under the umbrella of a new brand called Cirium (historically referred to as Milicas and Helicas, and before that it was known as Fleetsanalyser and ACAS Fleet database), focusing to serve the air travel industry. Through its focus on the commercial market, RELX serves clients in the field (e.g., OEM and aftermarket, airliners, airports, aircraft lessors, travel tech), financial specialists (e.g., banks and insurers), and governments.

The database combines both commercial and defense data, originating from industry relationships to producing and coordinating companies in the field. Over 2000 sources are combined with a sophisticated big data technology stack. No information is disclosed on access to the Cirium database.[29]

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[28] https://aviationweek.com/defense-space; https://aviationweek.com/products/awin-aerospace-defense.

[29] https://www.cirium.com/contact-us/.

8.3.11 Rheinische Post: Flight Global World Air Forces Reports

Rheinische Post Mediengruppe is a German medium-sized media and services company. In 2019, it purchased the historical weekly magazine Flight International, and its related information website Flight Global from RELX. Flight International—founded in 1909—is the world's oldest continuously published aviation news magazine. Flight Global, established in February 2006, maintains the heritage of Flight International and used to be the home base for initial databases on the aerospace industry. Since 2007, Flight Global annually offers a free insight into its databanks by publishing a global overview on military aircraft inventory and providing a short analysis of recent and expected developments. In 2007, data was published in multiple articles on the Flight Global webpage. Since 2008, each overview is compiled as a separate .pdf report in a standardized format. Despite a change of ownership, the company continues to publish the reports in the December edition of Flight International. The price of a single copy at a local shop or online is £4.99 per issue. Data includes information on ordered, but not yet received aircraft. And although the name suggests that only Air Force inventory is included, data on aircraft (both fixed and rotary wing) within the Navy and Army inventory is included as well.[30]

8.3.12 Forecast International: Military Information Library

Founded in 1973 by a former USAF officer, Forecast International is a provider of market intelligence, forecasting, proprietary research and consulting services for the worldwide Aerospace, Defense, Electronics and Power Systems industries; gathering and providing knowledge on Military Aircraft, Defense & Aerospace Companies (including subcontractors), international (military) markets and World's force structures. Forecast International specializes in long-range (15 years) forecasting in the most cost-effective way. The company collects and analyzes open, publicly available sources including government publications, industry, private companies, general and specialized press (following over 200 magazines, next to other paper- and online subscriptions), trade shows, seminars and conventions. The main customers include governments and industries at the supplier and subcontractor level. At full range, an annual access to the online library (dating back to 1989) including both historical and forecasted data on worldwide production, arms transfers, prices, military budgets, market (segment) analyses and reports containing information on weapons systems and geographical developments is offered starting from US$65.000. A more specific request can be covered separately (starting at approximately US$2.000).

[30] https://www.flightglobal.com/reports.

Next to its analytic products, Forecast International maintains major editorial support agreements with many key publishers and publications.[31]

8.3.13 TEAL GROUP: Military Information Library

TEAL GROUP (on the market since 1988) is a specialist provider of market analysis and forecasting services in the areas of international aerospace, with special interest in the field of defense electronics, engines, missiles and munitions. TEAL GROUP provides detailed information on military inventory of 123 states (accompanied with political and economic analysis and future forecast). A special section on US Defense Agencies provides an extensive insight into the budgets, capabilities and programs of the US Armed (and civilian) Forces. The Defense & Aerospace Companies Overview gives an insight into the capabilities of the (Western) industry. Weapon system reports cover production numbers, support chains and financial insights. Data is provided on the world's military aircraft systems, including aircraft, engines, military electronics, missiles and smart munitions, unmanned aerial vehicles, and space systems and -ports. TEAL GROUP analysts also contribute to a range of specialist publications. TEAL GROUP information reports draw on a wide range of sources: OEM information releases are intensively crosschecked using multiple (publicly available) data sources. The main customers are industry subcontractors, the financial community, prime contractors, and governments. Depending on the request, customary commercial prices are agreed on (no indication available). A(n) (online) demo of the data is free to use.[32]

8.3.14 Simplify Compliance: Military Periscope Datasets

Simplify Compliance is a provider of regulatory and business information, analysis, and tools. The company holds a general focus on US-based businesses in multiple industries, including healthcare, human capital management, and telecommunications. Military Periscope as a product is positioned in the latter one. Military Periscope, initially developed by the United States Naval Institute in 1986, is presented as a knowledge base for accurate open-source global defense information. The product is comprised of a daily news portal and three (online) databases providing information on weapon systems, nations' armed forces (air-, ground-, naval-, special warfare, paramilitary and strategic forces for 165 nations, including some information on deployment plans, programs and budgets), and terrorist organizations (per region known data are compiled on every international terrorist group including their

[31] https://www.forecastinternational.com/fistore/category.cfm.

[32] https://www.tealgroup.com/index.php/online-access-demo.

history and an annual chronology of terrorist activities). All information within Military Periscope is open source data. Multiple referenced sources are used to collect the weapons data. The data in Military Periscope is updated continuously and cumulatively. It is not possible to retrieve historical datasets, nor receive access to the raw data. Military Periscope serves a range of customers, ranging from individuals to governments, industries, and educational institutions. With an annual price starting at US$7.800 for a single-station single user access, Military Periscope is presented as an affordable library. Moreover, as a Federal Library and Information Network member, Military Periscope offers discounted prices for US users. A free 7-day trial is possible.[33]

8.3.15 GlobalData: ADS Solution/Strategic Defense Intelligence Database

GlobalData is a UK-based data analytics and consulting company with a heritage of over 50 years, covering multiple industries including Aerospace, Defense and Security. GlobalData provides intelligence on the world's largest industries helping clients to increase business value through growth. The company offers an extensive dataset known as ADS Solution, or sometimes referred to as the Strategic Defense Intelligence database. Data includes information on military inventory, production and transfer (including even the curated tracking of procurement portals for one third of the globe). Moreover, GlobalData includes tendencies analysis, by providing a real-time insight into the sentiment of the Top-100 global "influencers" in the Aerospace, Defense and Security industries, and unlimited access to its analysts.[34] A demo can be requested.[35] Prices are not published, but agreed between commercial partners. Next to data, the company offers a range of specialized forecasting reports, and a public website providing general analyses free to the public.[36]

8.3.16 Frost & Sullivan: Aerospace and Defense Content

Frost & Sullivan is a globally oriented, multi-industry business-consulting firm that helps companies to identify business opportunities and supports them in their growth strategies. Frost & Sullivan was the first company to offer its services on electronic tape media, delivering world military equipment market data in 1962, just a year after their establishment. Frost & Sullivan is often consulted by strategic departments, not only to retrieve information, but mostly as an expert and an advisor. The company

[33] https://www.militaryperiscope.com/join.

[34] https://www.globaldata.com/industries-we-cover/aerospace-defense-and-security/.

[35] https://www.globaldata.com/request-a-demo/.

[36] https://www.airforce-technology.com/.

provides a large number of in-depth standardized reports on various subjects forecasting future developments. To this end, Frost & Sullivan maintains a large database including information on the production, inventory, and trade in weapon systems, next to general information on aircraft characteristics. Data is retrieved from industrial and governmental partners. At the moment Frost & Sullivan offers access to their research reports (a single report starts at approximately US$4,000, licensed access to the full library is possible through a commercial agreement).[37] The report is accompanied by raw data used in the analysis. The company is also working on developing an interactive database in the Aerospace and Defense environment. This so-called iFrost platform is not available at the time of writing, but is expected shortly.[38] Frost & Sullivan analysts are known to contribute to IISS Military Balance.

8.4 Analysis

This section provides an analysis following the aspects collected in Table 8.1.

8.4.1 Data Providers

The basic presumption that there are two main origins for data (i.e., industry producing companies and governments producing or procuring weapon systems) seems correct. However, not all governments and industries are transparent on their actions on the combat aircraft market. A lot of data is retrieved through independent research. This is a difficult and time-consuming process that generally comes at a price. Table 8.1 (columns 1 and 2) present the organizations and the reports which disclose the results of this process.

We find that the peace research and arms control agencies (e.g., SIPRI, CAWAT, IISS) and the commercial parties sources (e.g., RELX, the TEAL Group, GlobalData) have one thing in common. Both aim to make the world a better place through data. The difference is in the focus and the customers. Commercial parties link data to opportunities and growth for their customers, usually other businesses; their focus is mainly on forecasting the future. Research agencies generally address governments and civil society, and provide a more explanatory focus on the geopolitical perspective.

Both research agencies and commercial sources also seem to follow a common data gathering methodology: starting at industrial or governmental publications, they add other sources such as (in)formal contacts within the industry or the government, usage of freedom of information requests, (social) media publications, and sometimes own intelligence as in image of video analysis, including owned satellite coverage

[37] https://store.frost.com/industries/aerospace-defence-and-security.html.

[38] https://store.frost.com/ifrost-databases.html.

(the latter is only available to the financially most solvable companies, such as IHS Markit and Informa). Data is crosschecked and enriched.

This means that although there exist substantial differences between databases (main focus, speed of incorporation, depth of details, and presentation of data), generally all sources are interconnected. Developments and findings are published—sometimes through specialized media (paid subscription, on- and off-line) or freely on internet (as a means of promotion and customer loyalty), meaning information will be picked up by other data collecting parties and reused.

Looking at the main customers for whom the data is collected, we see most often governments, research agencies, industrial partners in the field, sub-contractors, and (financial) investors. Commercial organizations most often collect data for other commercial parties, while research agencies' and governments' data is redistributed among other research agencies and governments. There are exceptions—Simplify Compliance's Military periscope is a commercial source, but its customers are individuals, governments and educational institutions.

8.4.2 Type of Data Collected

Table 8.1, column 3 shows that the "T" (transfer of combat aircraft) is best documented; both by direct states reports, peace research and arms control agencies and commercial parties. Reporting on "I" (combat aircraft inventory) is a close second, mostly covered by commercial data providers. However, 'inventory data' can mean the most up-to-date data only, thus lacking historic overview. This is the case with Informa's Aviation Weekly, and Simplify Compliance' Military Periscope. Within research agencies, IISS Military Balance is specialized in longitudinal data on conventional weapon inventory. UN's UNROCA also includes inventory data (60 states out of 196 are covered). OSCE-members, finally, do exchange inventory numbers amongst each other, but this data is not published. "P" (production data) is provided by commercial sources and UNROCA. The latter covers but a few of all aircraft producing states (e.g., Russian Federation and China are missing) and is not always detailed (US generally just puts a number, without distinction in combat aircraft type). OSCE-members do exchange production numbers against each other, but this data is not published. "A" (abolishment of weapon systems) receives no attention, except in some voluntary side notes within UNROCA reports. Multiple explanations are possible. First, abolishment of weapon systems may be of less interest to the industry—this is a reflection of a supply driven market. Second, data is difficult to master, since no standardized definition of abolishment is given (e.g., can 'stored' or 'cannibalized' aircraft be considered 'disposed'?). Finally, "C" (weapon system characteristics) is a specialization of commercial parties. Data on combat aircraft capabilities (e.g., speed, reach, ordnance) is not offered by research agencies or through direct reporting.

8.4.3 Accessibility: Language

Most datasets are in English (Table 8.1, column 4). The UN translates all documents into Arabic, Chinese, English, French, Russian and Spanish. The OSCE uses English, French, German, Italian, Spanish and Russian translations. The EU uses 23 official languages (i.e., Bulgarian, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hungarian, Irish, Italian, Latvian, Lithuanian, Maltese, Polish, Portuguese, Romanian, Slovakian, Slovenian, Slovene, Spanish and Swedish). CAWAT's World Arms Trade Statistics operates in a niche, appealing to a Russian-speaking public only.

8.4.4 Accessibility: Formats

Recent data is to be found in a digitalized format. Older data (approximately before 1990s) is best found on a bookshelf. There is much variety in the digitalized formats and its usability for machine-aided analyses. States reports are usually nothing more than .pdf scans of the original report—if you are lucky, in a standardized format—however, that is only the case with ATT reports. The UN, for example, produces beautiful presentations allowing multi-state comparison for arms transfers reports, but allows no easy data retrieval. The EU is the only organization supporting the initiative to make its data easier to access. The IISS' Military Balance and CAWAT's World Arms Trade Statistics are in a .pdf format as well, and very difficult to convert to a database. Flight Global also offers its World Air Forces inventory data in .pdf format, but is much easier to convert due to standardized size. SIPRI online data (including details of the transfers made) is not transferrable either. It is however possible, upon request, to receive a link to almost the same data (lacking transfer details, but including deal-value in TIVs) which allows the retrieval of data in a .txt format, making it easily analyzable. Databases are the easiest for machine-aided analysis. These are offered by IHS Markit (Jane's), Informa (AviationWeekly), RELX (Cirium), Forecast International (Military Information Library), and GlobalData (ADS Solution). Databases seem to have become general around the beginning of the 1990s: a 30-year historical dataset seems to be standard for a commercial party, looking at IHS Markit, Forecast International and the TEAL GROUP. This relative peak can be explained by the increased availability of digitalized data storage capability, the relaxation of the superpower tensions, or to show the correlation between the age of organization and the length of its data trail. Detailed analysis falls beyond the scope of this chapter. Recently, the IISS also started to offer its data in a database format, as Military Balance+, with a history going back to 2014.

8.4.5 Accessibility: Price

All direct states' reports are free to all users (Table 8.1, column 5). Two other free sources are SIPRI (which is supported by Swedish government) and historic Rheinische Post Mediengruppe's Flight Global World Air Forces reports (provided as part of the Flight International December publication). All other data sources require (significant) payment. Priced sources, generally provide easily retrievable and up-to-date data. The price setting seems to be related to reproducibility and user-friendliness of data. Access to data is part of a package deal offered by the provider, including analysis added (usually in a form of standardized reports and analyst support) and a form of customization of data. There seems a relationship between the format and the price. Documents in print are most liberally priced. These are perfectly suitable for reference purposes but cannot be shared simultaneously, are less usable for analysis purposes, and exclude customized analyst support. Digitalized documents in a flat format (such as .txt or .pdf) – often placed in the same price range—make it easier to share with multiple persons, but remain less suitable for analysis. Databases (independent of platform) are the easiest to use, but usually the most expensive. Cheap solutions are limited in the amount of entrances, comparability, or the capacity to retrieve data. Data on arms transfers is commonly free. The exception is CAWAT, which charges for data on arms transfers. The explanation could be that CAWAT is the only data source providing deal values. Military inventory data is usually priced; exceptions are UN's UNROCA and historic Flight Global World Air Forces reports. All arms production data must be paid for. Possibly, this is due to the sensitive nature of the data: production and holding data provides a direct assessment of military and industrial capability. Another suggestion could be the expensive nature of data: coverage of information on 193 states is much more difficult to perform, than just looking at the transfers. The third explanation is that the market is commercialized and customers are willing to pay for this data. It is interesting to see that UN and OSCE initiatives to share this data are much less successful at collecting data on arms transfers.

8.4.6 Time Frame Addressed

Table 8.1 column 6 shows that most longitudinal data history can be provided by IHS Markit (weapon system data since 1909, military holding since 1913), SIPRI (trade since 1950), and IISS (military holding since 1959). IHS Markit Jane's data and IISS Military Balance cover most of the period in plain text (digitalized or on paper), while SIPRI provides a database for the whole period. As mentioned before, data organized in databases seems to have become mainstream since the beginning of the 1990s in the commercial branches. State transparency on the (changes in) conventional weapon systems inventories appears to have become more common after the 1991 UNROCA initiative, are by and large available online, but not easily

analyzable. Looking at the timeliness of reporting, there seem to be only two main speeds: either a yearly or continuous updates. Direct states' reports and research agencies SIPRI, IISS and CAWAT follow a yearly routine, updating and publishing their information once a year. Commercial parties update their datasets constantly. Timely information is apparently important to their customers. Most commercial parties also provide periodic reports (often on a yearly basis) covering the general trends and providing a forecast for the future.

8.4.7 Actors

Table 8.1 column 7 provides an overview of the number of actors in each dataset. Direct states' reporting to support transparency among members has been launched with the UN initiative (UNROCA) in 1991. This initiative has been followed by internal information sharing between multiple political and military alliances in the Western world. Despite some strong alliances in South America, Africa and in Eastern Europe, no internal reporting initiatives on weapon transparency have been found. This could be explained by fewer strong military threats perceived, or by the sufficiency of UNROCA (and later ATT as well) reporting initiatives. A true global reach is difficult to attain. Due to the nature of the subject, it is as a rule clear that small, geographically distant, non-conflicting states are excluded from the datasets, due to the lack of military equipment. Specific state alliances (OSCE and EU) cover just the data of their member states, or treaty ratifications (UN ATT). Other data providers generally aim for the global reach. State-level remains the reporting standard both between states and by third parties. Research agencies and commercial companies though are able and often willing to provide data on the level below state: armed grouping, armed force branch, or company name. Sometimes the information is intermingled within a database (e.g. SIPRI includes arms transfers to armed groups next to arms transfers between states, and most commercial sources remark on combat aircraft in the possession of companies next to state-owned combat aircraft) or is separated (e.g., Military Periscope separates information on non-state groups in a specialized database, and IISS excludes non-state-owned combat aircraft from their overviews).

8.4.8 Weapon System Detail

Commercial sources excel on this part, most probably due to the customer requirements, which call for a high detail level and technical data. Still, research agencies SIPRI, CAWAT and IISS do provide configuration data on combat aircraft (i.e. not only the family/platform data). There are though remarks to be made on the consistency of naming conventions, e.g. the same aircraft—even without substantial modifications over the years—can be named differently in consequential publications of

the same source: for example JSF, F35, F-35, F-35A, F-35A/B/C, F-35 Lightning II, F-35 Lightning II type A. This makes it difficult to apply a computerized time-series analysis. States reports are generally much less detailed and mention only the weapon system category or—if you are lucky—a platform family. It would be interesting to match the findings in the latter analyses, outside the scope of this chapter.

8.4.9 Financial Information Provided

Finally, Table 8.1 column 8 presents evidence that financial information is seldom included in the data provided and normally comes at a price. The stated (cost or market) price of combat aircraft– as a reflection of the production price—is by and large known. SIPRI uses its own method through calculated TIVs. The traded price is in the main not disclosed; both the exact size of the package traded and the price agreed are not shown. CAWAT seems to be an exception, because it includes financial information on every transfer. ATT reporting has the potential to disclose the traded price as well. Unfortunately, up till now (in the four-year reporting period) only five states have been willing to reveal the value of their weapon transfers.

8.5 Conclusion

In the slipstream of the different pathways we took to search for relevant data sources, we gained additional insights into the multi-layered market of weapon system data and its broad range of customers with varying requirements. There are two main origins for data (i.e., industry and governments). While industry seems to be much less transparent, governments have increased reporting over the last decades. Governments share data, but the data is not crosschecked internally, neither is it made user friendly. Accessible, timely and complete information on combat aircraft market transactions seems not to be possible without independent investigation by peace research and arms control agencies, and commercial sources. Independent data gathering takes place through (in)formal contacts at the industry or the government, usage of freedom of information requests, (social) media publications, and sometimes own intelligence as in image of video analysis, including satellite coverage. This is a difficult and time-consuming process that generally comes at a price. The price setting seems to be related to the format of data. A positive relation is found between the price and user-friendliness, and a negative relation between the price and the reproducibility. We observe a relation between the price and type of data collected as well. Trade data is generally free, but production and inventory data is priced. All financial information is priced as well. The market for weapon system data is multi-layered. There is a broad range of customers with varying requirements. Businesses and financial institutions look for best investment options; industrial subcontractors are looking for growth possibilities; and civilian institutions and governments are looking at the

geopolitical developments. Some require just data (more or less timely provided), others require specialist analysis, and yet others look for the cheapest market solution and seek to compare reports. This market deserves further analysis. For our empirical investigation into the factors contributing to the worldwide demand and supply of fixed-wing combat aircraft, we have found that there is a sufficient amount of data available. However, this data comes at a price.

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