

1. Introduction: an important industry?

INTRODUCTION

Aerospace is often claimed to be an important industry. Is it important and, if so, why is it important? This chapter addresses these questions. It considers whether there is an economic case for government support for the industry or whether some of the arguments are spurious and examples of special pleading. The task of the economist is to identify myths and special pleading and subject them to rigorous and critical economic analysis and assess the supporting evidence. The chapter presents a preliminary review of these arguments, many of which are addressed in more detail elsewhere in the book. A starting point requires a definition of the industry.

DEFINITION

Government official statistics provide definitions of the industry. For example, the official European statistics (Eurostat) defines the industry as the manufacture of air and spacecraft and related machinery. This classification includes the manufacture of aeroplanes for the transport of goods or passengers for use by defence forces, for sport or for other purposes; the manufacture of helicopters, gliders and dirigibles. It also includes the manufacture of parts and accessories for the aircraft of this class, including engines and their parts, major assemblies (e.g. fuselages; wings; doors; landing gear; fuel tanks), propellers and helicopter rotor blades as well as aircraft seats. Further sectors included are the manufacture of ground flying trainers, spacecraft, launch vehicles, satellites and intercontinental ballistic missiles (ICBM) as well as the overhaul and conversion of aircraft or aircraft engines. There are some interesting exclusions comprising the manufacture of telecommunications equipment for satellites, the manufacture of aircraft instruments, the manufacture of air navigation systems and the manufacture of lighting equipment for aircraft (Eurostat, 2012). The advantage of using official statistics is their

international comparability. Also, the official statistics comprise information from enterprises whose main activity is the manufacture of aerospace products. Other data from industry trade associations use different definitions of the industry, including firms whose main activity might be classified elsewhere.

For our purposes, a broad working definition will be used. The aerospace industry comprises all those firms involved in the research, design, development, manufacture, repair, maintenance and disposal of aerospace products. These comprise military and civil aircraft and helicopters, business and pleasure aircraft, missiles and space systems. Also included are the firms supplying parts and components including aero-engines, avionics equipment, flight simulators for pilot training and ejector seats for combat aircraft. Examples include combat aircraft such as the American F-22 Raptor and the F-35 Lightning; Airbus A380 and Boeing 747 airliners; Bombardier and Embraer regional jet airliners; Tomahawk cruise missiles; space rockets such as the European Ariane series and their associated satellites. Elsewhere, firms specialise in supplying aero-engines (e.g. Pratt and Whitney (USA) and Rolls-Royce (UK)); major parts and components (e.g. wings; centre fuselages); seats and interiors for civil aircraft; undercarriages; and avionics equipment, including cockpit displays.

Major firms or prime contractors and systems integrators focus on R&D and manufacture. These activities embrace the design, development and testing of an aircraft, helicopter or missile followed by its manufacture. Manufacture comprises final assembly using a range of parts and components which are 'bought-in' from specialist suppliers of equipment (e.g. aero-engines) and a range of other suppliers and subcontractors which form an extensive supply chain. Similar organisational arrangements apply for the manufacture of motor cars which focus on final assembly.

Aerospace involves two alternative forms of industrial organisation. First, the typical industrial model in the USA, Europe and other nations involves prime contracting firms undertaking R&D, design, testing and manufacture. Second, some industries separate design and production. In such cases, there are separate and specialist design bureaux which specialise in the design, development and testing of an aircraft with separate and specialist production plants manufacturing the final design (e.g. Russia). These alternative forms of industrial organisation represent efforts to minimise a firm's transaction costs (the costs of doing business). The first organisational form has operated in competitive

markets and its survival and predominance suggests its superiority. Next, questions arise about whether aerospace is an important industry and why?

AN ECONOMIC CASE FOR THE AEROSPACE INDUSTRY: MARKET FAILURE

In private enterprise economies, any industry and its component firms survive on the basis of market forces and the profitability of its firms. But left to themselves, private markets might fail to work properly in the sense of failing to fully and accurately reflect consumer preferences. Such market failure provides a basis for government intervention to 'correct' these failures and 'improve' the operation of markets. Is there evidence of market failure in aerospace markets?

Private markets can fail to work properly because of market imperfections and externalities. Imperfections comprise monopoly, oligopoly (a few large firms in the industry) and entry barriers preventing new entrants to a market. Externalities arise where there are benefits and costs which are 'external' to the market. Examples of harmful externalities include pollution, aircraft noise and traffic congestion. Beneficial externalities include research and development which provides benefits to other firms in an economy (spill-overs) and flood controls which provide protection to large numbers of households. Some of the medical treatment for injured soldiers in Afghanistan and Iraq has been beneficial to the treatment of civilian personnel (a beneficial spin-off). Aerospace examples include the application of military aircraft technology to civil aircraft, including the jet engine, radar and composite materials.

A special class of externality comprises 'public goods' which have some distinctive features. These goods differ from normal private goods in that they are characterised by 'non-rivalry' and 'non-excludability'. Non-rivalry means that one person's consumption of the good is not at the expense of anyone else's consumption of the good and non-excludability means that once the good is provided, people cannot be excluded from its consumption. Defence is a classic example of a public good. For example, once a city is provided with air defence, one person's consumption of its air defence is not at the expense of anyone else's consumption; nor can any citizen be excluded from the protection provided by air defence (Hartley, 2011; Tisdell and Hartley, 2008).

Where market failures are identified, government has to decide whether to intervene to 'correct' such failures. At the outset, government needs to determine whether the market failure is substantial enough to

merit state intervention, bearing in mind that intervention is not costless. The form and extent of state intervention will depend on the precise causes of market failure. For example, where market failure results from monopoly and entry barriers, state intervention to correct such failure can embrace a variety of policy solutions. The options include competition policy (e.g. breaking-up a monopoly or allowing foreign imports) to state regulation (e.g. of prices or profitability) or state ownership of a private monopoly. Some of these policy measures have been applied to the world's aerospace industries. For example, a number of the world's aerospace industries (e.g. USSR; Indonesia) have been acquired by government whilst others have remained under private ownership (e.g. USA; UK) although state ownership has not always been the solution to a private monopoly problem. In some cases, state ownership has reflected a government desire to control wartime profitability to prevent excessive wartime profits being earned by aircraft firms. Or, state ownership has reflected a government desire to own and control an important and military strategic industry. This suggests that there are other arguments for an aerospace industry. One view is that aerospace is a strategic industry.

A STRATEGIC INDUSTRY?

Aerospace is a strategic industry in two senses. First, it is a militarily strategic industry and second, it is an economically strategic industry.

In the *military-strategic* sphere, aerospace products are a central component of national defence. Combat aircraft, helicopters and missiles provide both defensive and offensive air power. Transport aircraft and helicopters provide a capability to carry military personnel and equipment to various locations in the world. The question then arises as to whether a nation relies on the import of foreign aerospace equipment or whether it depends on a domestic source of supply. A national aerospace industry has a variety of military and economic benefits. These include independence, security of supply and re-supply, especially during conflicts, together with the ability to obtain equipment specially designed for the operational requirements of national air forces and the ability to be an informed buyer. There are also claimed to be additional wider economic benefits in the form of jobs, exports and advanced technology, including technical spin-offs to the civilian economy. These benefits need to be assessed critically identifying special pleading, myths, emotion and nationalism. When evaluating these claims, economists need to consider their underlying economic logic and the available empirical evidence. A

key economic question concerns the alternative use value of resources. Would the resources allocated to the aerospace industry make a greater contribution to jobs, exports and technology and ultimately national economic welfare if they were used elsewhere in the economy?

Aerospace is also viewed as an *economically strategic industry*. These are industries which are regarded as more important than others in national economic development (i.e. leading industries). Examples include civil aircraft, biotechnology, computers and telecommunications (Siebert, 1997). These economically strategic industries have some distinguishing economic characteristics. They are high technology and R&D-intensive industries with technical spill-overs (external economies) to the rest of the economy; they are decreasing cost industries reflecting scale and learning economies; and they are imperfectly competitive based on national monopolies and oligopolies (a few large firms) associated with monopoly profits. These economically strategic industries are seen as dominant in international trade: hence, the argument that governments should intervene and support such industries with the aim of enabling a nation to obtain a share of the monopoly profits.

Identifying a potential role for governments in strategic industries creates two problems. First, there is a belief that strategic industries can be identified by governments and that government should promote them. The alternative view is that properly functioning private markets will identify strategic and leading industries unless there are significant market failures. Here, possible market failures include externalities (e.g. technical spill-overs) and the short-termism of capital markets 'failing' to fund strategic industries (an argument which needs to be evaluated critically: see Chapter 10). Second, national governments will become involved in strategic rivalry supporting their 'national champions'. For example, in civil aircraft markets, foreign governments may retaliate by creating a new and rival civil aircraft industry (e.g. the original formation of Airbus). Governments will also become involved in international trade disputes (e.g. over subsidies). The outcome is highly complex 'game-playing' involving governments and their 'national champions'. It is not clear that the eventual outcomes are efficiency improving: they might well reduce efficiency through distorting international trade!

Civil aircraft is regarded as an economically strategic industry which has received extensive government support. European examples of state support include the funding of R&D, the finance of uneconomically low production rates, the provision of long-term financial support, state ownership, the provision of favourable export finance and government requirements for national airlines to buy from the national aerospace

industry. Overall, governments have changed market outcomes in the civil aircraft market.

Airbus is a good example of the new international trade theory based on imperfect competition, advanced technology, scale economies and the notion that governments can create a nation's comparative advantage. The entry of Airbus into the world jet airliner market prevented Boeing achieving a monopoly position enabling Airbus to obtain a share of these monopoly profits. But, the creation of Airbus as a world class firm was not costless (especially for French and German taxpayers). There also arose a policy conflict between the USA and Europe with Boeing accusing Europe of government subsidies for Airbus and Europe accusing Boeing of receiving support from military procurement. These conflicting claims were assessed by the World Trade Organization (WTO) which found that Boeing had received between \$3–4 billion of US subsidies and that Airbus had received \$18 billion in subsidies; but it did not view European repayable launch investment as a subsidy.

Airbus is also an example of the traditional *infant industry* case for state support of new entrants. Where there are significant scale and learning economies, it is often argued that state support is needed to allow an infant industry to enter a market and get started. It is claimed that new entrants need to be supported until they become as efficient as established foreign rivals and are able to compete on equal terms with their more experienced foreign suppliers. State support can take the form of subsidies, tariffs or preferential purchasing. Of course, the challenge for policy-makers is to determine when the infant industry has become established and is able to compete with its foreign rivals by achieving scale and learning economies. Otherwise, state support becomes permanent and enables a protected industry to remain sheltered and less efficient than its foreign rivals.

AN IMPORTANT INDUSTRY?

The analysis outlined above focusing on market failure and strategic industries provides a basis for answering the question of whether aerospace is an important industry and why it is important.

Typically, there are claims and assertions that aerospace is an important industry. Such claims focus on aerospace as a high technology and leading industry for national economic development. They point to its importance for jobs, technology, spill-overs and exports. Some of these arguments fail to address the opportunity cost question concerning the alternative use value of a nation's resources allocated to the aerospace

industry. Most economic activity creates jobs so to claim that aerospace is important for jobs is not a convincing argument in this form: it has to be shown that aerospace is better in the employment field than alternative uses of resources. Typically, there are other industries which provide more jobs (e.g. construction): the number of jobs provided by an industry will be determined by its production technology and by wage rates. Labour-intensive production and low wage rates will create larger numbers of jobs. However, the jobs argument for aerospace might be better presented in terms of the quality of jobs (skills) rather than their quantity (numbers). Here, it has to be shown that aerospace provides proportionately more high quality jobs than many other industries. Examples include scientists, technologists, engineers and skilled production workers, including the numbers and proportions with university degrees (see Chapters 8 and 10; Hayward, 1994).

A similar analysis applies to the technology, spin-off and export arguments for the importance of the aerospace industry. Other industries also contribute technology and exports benefits (e.g. computers; motor cars; pharmaceuticals). Does aerospace make a greater contribution than these other industries? This becomes an empirical question. The technology argument merits further exploration. Certainly, aerospace involves advanced technology and it has demonstrated its ability to solve complex technical problems reflected in the creation and development of manned flight embracing combat aircraft, civil jet airliners, space exploration and manned landings on the Moon. The new technology has been reflected in new products which have emerged over the past 110 years (see Chapter 2). Technical progress has been both evolutionary and revolutionary (e.g. the jet engine was a revolutionary technical change).

In addition to new advanced technology, some of the technology has 'spilled-over' into other fields. Examples of such 'spill-overs' include the application of military jet engines to civil aircraft; the development of radar; the application of composite materials from military aircraft to civil airliners; the application of aircraft technology to racing cars and motor cars; the use of jet engines on ships; and the application of helicopter rotor blade technology to wind turbines. Whilst these and other examples are impressive, they fail to address the key issue of the market value of such 'spill-overs'. A listing of *numbers* of examples is no substitute for *market values*. Nor does the technology spill-over argument identify the technology transfer mechanisms. These might include staff mobility and the relationship between prime contractors and their supply chains. Nevertheless, technical spill-overs form a beneficial externality and hence a possible source of market failure.

It is possible that aerospace markets are more likely to be characterised by major market failures than other industries and markets. Two possibilities come to mind. First, technology and R&D markets are likely to fail due to the costs of establishing property rights in valuable ideas and their 'spin-offs'. Second, governments dominate the demand side of defence markets and such dominance is a likely source of market failure (see Chapters 3, 6 and 9).

The strategic industry analysis provides a basis for identifying the importance of the aerospace industry. Aerospace is distinctive in that it is strategic in both the military and economic spheres. It is an important supplier of aerospace equipment for a nation's armed forces and it is an R&D-intensive and decreasing cost industry with beneficial externalities through technical spill-overs. Governments are central to understanding the industry, its behaviour and performance.

CONCLUSION

Aerospace is an advanced, high technology industry with an impressive record of innovation and developing and producing high technology products. These are believed to be a source of international competitiveness for modern developed economies which need to re-allocate resources from labour-intensive industries to areas where they are more competitive (creating new comparative advantages in international trade).

Aerospace is one such area which provides an R&D-intensive and knowledge-intensive manufacturing industry capable of providing the next generation of highly paid jobs able to sustain and raise living standards. The rhetoric is impressive and the identification of aerospace as a strategic industry provides a basis for identifying the industry as important. But these are only qualitative arguments which are valuable as a first stage in identifying aerospace as an important industry. However, a convincing case showing the industry's importance requires supporting empirical evidence. How does aerospace compare with other industries and the alternative use of its resources? Understanding of the issues requires a brief overview of the history of the industry's development and its current position in the world market.

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