The Employment Effects of Awarding Major U.S. Defense Contracts To U.S.-Based Firms, Compared to Foreign-Based Multinational Firms:

An Economic Case Study of the Competition To Produce the KC-X Refueling Tanker

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EXECUTIVE SUMMARY

The Employment Effects of Awarding Major U.S. Defense Contracts to U.S.-Based Firms, Compared to Foreign-Based Multinational Firms: An Economic Case Study of the Competition to Produce the KC-X Refueling Tanker

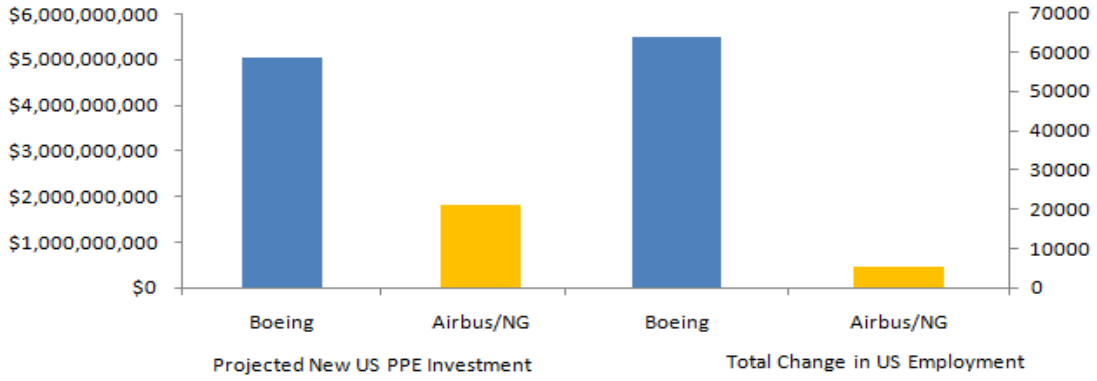
The U.S. Department of Defense is conducting a competition to develop and produce a new in-flight, refueling tanker aircraft, currently called the KC-X tanker. The two competitors for the contract are the Boeing Company and Airbus, a subsidiary of the European Aeronautic Defence and Space Company (EADS), in partnership with the Northrop-Grumman Corporation. This report examines the employment effects of sourcing this major U.S. military procurement program with a U.S.-based company (Boeing), compared to a foreign-based firm (Airbus) teamed with a U.S. company (Northrop-Grumman) that would design and manufacture most its tanker aircraft in Europe.

Using publicly available data, this report concludes:

- **Based on the new direct investments in property, plant and equipment entailed in carrying out this contact, Boeing would create 10-12 times as many new U.S. jobs as Airbus/Northrop-Grumman.**
- **If Boeing develops and produces the tanker, it should lead to the creation of an estimated 62,605 to 70,706 new U.S. jobs.**
- **By contrast, if Airbus/Northrop-Grumman develop and produce the tanker, it should lead to the creation of an estimated 5,113 to 7,080 new U.S. jobs.**

Both companies propose to meet the Pentagon's requirements by developing certain new refueling technologies and applying them to aircraft which each already produces. Based on the proposals submitted for the last competition, as well as economic analysis and historical experience, the vast majority of the production of the new refueling tanker will occur at the existing facilities and operating assets of the winning competitor. In this context, the different U.S. employment effects for the two companies arising from the KC-X tanker contract reflect the fact that the U.S.-based Boeing maintains 96 percent of its operating assets and facilities in the United States, while the foreign-based EADS and Airbus maintain 96 percent of their operating assets and facilities in Europe.

Figure I. Projected New US Investments and New U.S. Employment From the KC-X Tanker Contract, Boeing and Airbus/Northrop-Grumman



The conclusions of this analysis are not based on the jobs estimates and projections provided by the two companies. Rather, they are based on long-term, public data tracking the relationship between increases in U.S. investments and increases in U.S. job creation, when those investments are undertaken by U.S.-based aircraft manufacturers compared to a foreign based multinational with a small U.S subsidiary operation. Whether Boeing or Airbus/Northrop-Grumman ultimately produces the aircraft, much of the $35 billion contract will go for goods and services provided by each company's worldwide network of suppliers and vendors. While these purchases will indirectly create many jobs, there are no verifiable data regarding where these vendors and suppliers are located – in the United States or abroad – nor can we predict how much work would be carried out at specific locations or how the companies' supply chains will change over the lifetime of this contract. Therefore, this analysis focuses on the new fixed investments in property, plant and equipment (PPE) which these companies would themselves undertake to build the new tanker, and the new U.S. jobs associated directly with those investments. Based on the historical relationships between new PPE investments and job creation, these data show that the U.S.-based Boeing would produce 12 times as many new U.S. jobs as the Airbus/Northrop-Grumman partnership. These estimates are affected only modestly if we assume that under the Airbus/Northrop-Grumman partnership, Airbus would be responsible for three-fourths of the new investment and Northrop-Grumman would carry out the remaining one-fourth.

The company that is awarded the KC-X tanker contract will also generate other important, economic effects. While much of the new tanker's basic structure will come from existing aircraft, developing the KC-X tanker's unique capabilities will require significant research and development. Extensive economic research has found that such R&D for new aircraft and other military assets often produces large "spillover" effects, where a new technology, piece of equipment or manufacturing technique or process can be applied in other uses and industries. These spillovers can generate additional economic benefits through higher productivity, enhanced efficiency, and contributions to subsequent innovations. Productivity, efficiency, and innovation are critical factors in sustaining international competitiveness and preserving a country's domestic industrial base, with significant economic *and* national security implications.

Economic research also has established that many of these spillover effects occur in geographically-based "clusters," transmitted through the working relationships that link large firms such as Boeing or Airbus with hundreds of smaller producers and suppliers in the same geographic area. These smaller producers and suppliers may also provide products and services to companies in other industries. Through these supply chains, innovations in aircraft manufacturing can help generate economic benefits for a range of local and regional firms, across many industries. The U.S. aircraft and aerospace industries are highly concentrated in California and Washington State, while their European counterparts are highly concentrated in France and Germany. The decision in the KC-X tanker competition, therefore, will determine whether such critical spillover effects occur in the United States or in Europe.

Considerations of national security and cost, along with technical issues, will naturally play central roles in the KC-X tanker contract award decision. Policymakers, however, should also be fully informed about the economic implications of that decision, as documented here. We find that awarding the contract to U.S.-based Boeing would generate up to 63,626 more U.S. jobs than would awarding the contract to Airbus and Northrop Grumman. We further find that the spillover benefits from the development of the new tanker would be concentrated in the United States if the U.S.-based Boeing does the development, but in Europe if the European-based Airbus does it. These differences could have significant economic impact, as well as longer term implications for the U.S. industrial base.

The Employment Effects of Awarding Major U.S. Defense Contracts to U.S.-Based Firms, Compared to Foreign-Based Multinational Firms: An Economic Case Study of the Competition to Produce the KC-X Refueling Tanker[1]

Robert J. Shapiro and Aparna Mathur

1. Introduction

With the globalization of production and trade, airplane manufacturers in one country now compete for defense contracts in other countries. The Pentagon should always award its contracts to whatever firms can best meet U.S. military requirements, within the bounds of American national security. However, members of Congress, Executive Branch officials and economists have raised important questions about the economic effects of foreign sourcing of major U.S. military programs. To address these security and economic issues, foreign-based defense manufacturers competing for Pentagon contracts often partner with U.S.-based companies and pledge to carry out substantial shares of those contracts in the United States. Yet, there have been no systematic analyses of the economic effects of sourcing defense contracts with foreign-based firms, as compared to sourcing the same contracts with U.S. based firms. Using publicly-available data, this study conducts this analysis for the KC-X in-flight refueling aircraft tanker contract currently being competed between the U.S. airplane manufacturer Boeing and the European-based producer Airbus in partnership with the U.S.-based Northrop-Grumman.

The analysis finds that sourcing this contract with Boeing would produce estimated gains of between 62,605 and 70,706 new U.S. jobs, compared to 5,113 to 7,080 new jobs if Airbus/Northrop-Grumman were awarded the contract. This 10-12 fold difference arises from the distinctions and differences between a U.S.-based company which conducts nearly all of its investment and production in the United States, and the U.S. division of a foreign-based multinational which conducts nearly all of its investment and production outside America. These findings are *not* derived from the promises of job creation made by the competing companies, but rather from the long-term relationships between U.S. job creation and the new U.S. investments that would flow from the contract, when those investments are undertaken by U.S.-based aircraft manufacturers compared to the U.S. subsidiaries of foreign-based aircraft makers.

Most of this analysis of the jobs effects assumes that the primary company in the Airbus/Northrop-Grumman partnership would be Airbus, a division of EADS, the European Aeronautic Defence and Space Company that maintains 96 percent of its operating assets in Europe. This judgment reflects the partnership's own proposals, in which they proposed first to build the new aircraft in sections at various Airbus facilities in Europe, assemble them in Toulouse, France, add a new cargo door in Dresden, Germany, and complete the plane's militarization in Madrid, Spain. In their proposal's subsequent iterations, they shifted the militarization, cargo door, and final assembly stages first to a Northrop-Grumman facility in Melbourne, Florida, and subsequently to a new facility to be built in Mobile, Alabama. It is clear

[1] The research for this study was supported by the The Boeing Company. All of the analysis and views are solely those of the authors.

that the vast majority of production by Airbus/Northrop-Grumman would be carried out by Airbus in Europe. By contrast, some 96 percent of Boeing's operating assets are located in the United States, where production and assembly would occur. Nevertheless, we also performed an alternative analysis in which we assumed that Northrop-Grumman would be responsible for one-fourth of the new investments under the contract. This analysis confirms that Boeing would create up to 10 times as many U.S. jobs as Airbus/Northrop-Grumman to produce the KC-X tanker.

Globalization dictates that whether Boeing or Airbus/Northrop-Grumman ultimately produces the aircraft, much of the $35 billion contract will go to payments to the domestic and worldwide networks of outside suppliers and vendors maintained by these firms, and so indirectly create many more jobs. Since Boeing's production and headquarters facilities are located almost entirely in the United States while Airbus's production and headquarters are highly concentrated in Europe, we could fairly assume that a larger share of Boeing's vendors and suppliers are located in the United States. However, there are no public data on the geographical distribution of these companies' vendor and supplier networks. Therefore, our analysis focuses on the new fixed investments in property, plant and equipment (PPE) which these companies would undertake to build the new tanker and the new U.S. jobs associated with those investments which each company could be expected to create.

The finding that Boeing would create some 10-12 times as many new U.S. jobs in developing and building the tanker as Airbus/Northrop-Grumman is derived from technical analysis, but it also reflects the objective business conditions of this competition. The submissions by both companies propose to modernize and modify aircraft which each already produces. In the last competition, Boeing had proposed to base the new tanker on its long-range freighter aircraft, the 767-200 LRF, with elements coming also from other Boeing aircraft including the 767-200ER, 767-300F, 767-400 ER, 737 and 777. Similarly, Airbus/Northrop-Grumman proposes to base the new tanker on the Airbus A330-200 commercial aircraft. Given these plans, the only way that these companies can produce the new aircraft in a cost-effective manner will be to draw on the huge, sunk investments in their existing production facilities and supply chains, as their proposals state plainly. Boeing is a domestic U.S. company with nearly all of its capital stock and production facilities located in the United States. Consequently, Boeing has to produce the new aircraft almost entirely within the United States, which accounts indirectly for the large employment effects derived in this study. To be cost-competitive, Airbus/Northrop-Grumman also will have to perform most of the production of the tanker using existing capital stock and facilities, located mainly in Europe according to their proposal, which also accounts indirectly for their modest U.S. job effects derived in this study. The alternative for Airbus/Northrop-Grumman of duplicating its European facilities in the United States would entail huge, additional costs that would have made their proposal uncompetitive.

While this analysis focuses on the direct job creation associated with this competition, the decision also will carry other economic effects. While much of the basic structure of the new tanker will be derived from existing craft, large-scale research and development (R&D) will be required to produce the new system's unique capabilities. A long line of economic research has found that such innovations often have "spillover" effects that can produce additional, substantial economic benefits, by raising productivity, enhancing efficiency, or contributing to subsequent

innovations. Moreover, a number of studies have documented such spillover effects in the development and production of new aircraft and other military assets.

The most important feature of these spillovers for this analysis is that many of these effects occur in and through geographically-based economic "clusters." The U.S. aerospace/aircraft manufacturing industry is highly concentrated, especially in California and Washington State, where a few large companies and hundreds of smaller producers and suppliers are found in particular places in which knowledge spillovers can be easily transmitted through the supply chains linking the large firms and their suppliers. Researchers have found further that suppliers to large aerospace companies provide products and services to companies in other industries, so that through these other supply chains, innovations in aircraft manufacturing can contribute to innovations in other settings. As result, aircraft innovation can produce economic benefits for a range of local and regional firms. The decision in the KC-X competition, therefore, may determine whether such cluster-based spillovers occur in America or Europe.

Finally, the contract to develop and produce the KC-X tanker carries implications for the U.S. aerospace industrial base. Reportedly, the FY2011 budget request includes few if any new aircraft or aerospace programs, while several other aircraft production lines are expected to close in coming years. The end of those programs will lead to the closure of numerous aerospace facilities and the termination of thousands of highly-specialized aerospace positions. These losses could compromise the country's domestic capacity to meet future defense-related aerospace needs, especially as those requirements evolve at times of conflict. In this regard as well, the decision in the KC-X tanker competition will affect whether substantial numbers of highly-skilled aerospace workers and facilities are maintained for the future in the United States or in Europe.

II. Background

The U.S. aircraft equipment and parts manufacturing sector is part of the larger aerospace industry comprised of companies producing aircraft, guided missiles, space vehicles, aircraft engines, propulsion units, and related parts. The aerospace industry has a significant economic presence in the U.S. economy: It directly employs some 631,000 workers, most with relatively advanced skills earning relatively high wages, and indirectly supports about two million additional jobs through some 30,000 domestic suppliers. The industry also is known for innovation, investing more than $100 billion in research and development over the last 15 years.[2] A few large firms dominate aerospace sales and employment, mainly producers of military and civilian aircraft, and these firms subcontract the production of many specific systems and parts to smaller companies.

The data show that before the recent financial meltdown and recession, the aircraft manufacturing part of aerospace contributed nearly $100 billion to U.S. GDP (2007), or nearly three-fourths of one percentage point, paid out more than $26 billion in wages and benefits, and employed more than 400,000 workers.[3] Moreover, over the last decade, the sector's

[2] Stevens, J. P., Written Testimony: Committee on Transportation and Infrastructure: Subcommittee on Aviation: US House of Representatives," Aerospace Industries Association, unpublished work (2009).

[3] Our analysis of the economic impact of aircraft manufacturing is based on data on the sector's employment, compensation and output, in terms of its value added, from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA). While the BLS data on employment and compensation are available at disaggregated

contributions to GDP and total compensation have both risen steadily even as its U.S. workforce has declined. U.S. aircraft producers also contribute substantially to the U.S. trade position, with aerospace products and parts being the largest single contributors to U.S. exports for the past several years.[4] Table 1, below, examines the economic impact of aircraft manufacturing on U.S. employment, wages, and international trade.[5]

Table 1: The Economic Footprint of U.S. Aircraft Manufacturing, 1994-2007

Year	GDP (million)	Share of GDP	Employee Compensation	Share of All Compensation	Employment	Share of All Employment
1994	$47,105	0.67%	$17,877,216,058	0.45%	454,000	0.37%
1995	$45,525	0.62%	$16,736,948,488	0.40%	425,000	0.34%
1996	$52,304	0.67%	$18,020,771,704	0.41%	432,000	0.34%
1997	$54,418	0.66%	$20,886,465,366	0.45%	472,000	0.36%
1998	$63,344	0.72%	$22,047,309,440	0.44%	495,000	0.37%
1999	$64,253	0.69%	$20,538,495,562	0.38%	468,000	0.34%
2000	$64,439	0.66%	$20,583,745,676	0.36%	438,000	0.32%
2001	$69,175	0.68%	$21,035,860,040	0.35%	435,000	0.31%
2002	$69,642	0.67%	$19,293,607,970	0.32%	397,000	0.29%
2003	$62,352	0.57%	$18,374,341,232	0.29%	372,000	0.27%
2004	$70,877	0.61%	$19,323,385,588	0.29%	370,000	0.27%
2005	$80,573	0.65%	$21,239,020,530	0.30%	380,000	0.27%
2006	$87,665	0.67%	$24,034,069,904	0.32%	399,000	0.28%
2007	$96,140	0.70%	$26,207,508,912	0.34%	414,000	0.29%
Average	**$66,272**	**0.66%**	**$20,442,767,605**	**0.36%**	**425,000**	**0.32%**

Aircraft manufacturing is also a small sub-sector of all manufacturing, and its role in GDP, national employment and total employee compensation is modest compared to sectors such as finance, insurance and real estate, or wholesale trade. However, it still accounts for about 8 percent of the contribution of all manufacturing to GDP and some 3 percent of all manufacturing compensation and employment. As noted above, aircraft equipment manufacturing also provides significant trade benefits. Together, exports of aircraft launching gear, civilian aircraft engines and parts, and military aircraft totaled $77.5 billion in 2007, or 6.75

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levels, BEA data on contribution to GDP are not. The BLS tables show data for "Aircraft, Engines and Parts Manufacturing" and comparative data for other broad industrial groups. This economic analysis, therefore, has two limitations. First, with the exception of trade data, the BLS and BEA do not distinguish between civil and defense aircraft. Therefore, the analysis covers all air transportation equipment manufacturing. In addition, the BEA data used to assess the sector's role in GDP uses data for "other transportation equipment" (other than motor vehicles) to approximate the contribution of aircraft, engines and parts manufacturing, even though it includes some shipbuilding and spacecraft as well. Therefore, we may overestimate the sector's economic contribution to some degree, and these estimates provide an upper bound on its contribution to the economy.

[4] United States International Trade Commission (USITC). www.usitc.gov.

[5] We also note that demand for aircraft is what economists call "derived" demand, since it is driven significantly by the demand for the goods and services which the use of aircraft makes possible, such as consumers' preferences for vacations. As a general rule, growth in the air transportation sector substantially affects growth in the aircraft manufacturing sector. For several decades, air transportation revenues have grown rapidly, both here and worldwide, and these gains have helped sustain the growth in aircraft manufacturing. The International Air Transport Association reports, for example, that worldwide revenues for scheduled carriers increased nearly 10 percent from 2005 ($413 billion) to 2006 ($452 billion). IATA Financial Forecast, June 2008.

percent of all U.S. exports of goods. In contrast, U.S. imports of the same goods totaled $34.4 billion in 2007, or 1.85 percent of all U.S. good imports. Therefore, aircraft manufacturing ran a $40 billion trade surplus in 2007. A table with detailed data on U.S. exports and imports of each of these sub-categories from 1994 to 2007 is provided in Appendix A, Table I.

Most U.S. government investments and purchases in this area are defense-related. Typically, the Department of Defense (DOD or Pentagon) announces plans to purchase military aircraft or missile systems with specific features and capabilities, and large firms specializing in the development and production of such aircraft or systems submit bids that detail their proposed technical solutions and designs, and related cost estimates. Following often-extended negotiations over technical and financial issues, DOD selects a manufacturer to develop and build a prototype for testing and evaluation. If the prototype meets the Pentagon's requirements, the contract is approved and the aircraft or other system enters production.

For a number of reasons, defense procurement and aerospace spending can have greater impact on U.S. employment and incomes than some other forms of procurement and spending, but principally because the advanced equipment and supplies purchased by the DOD are mostly made in the United States.[6] The Pentagon requires that the companies producing most of its advanced equipment and supplies operate in facilities that it deems secure and use employees with U.S. security clearances, which usually require U.S. citizenship.[7] Most of these procurements, including subcontracts extending through the supply chain, also are subject to U.S. export controls which restrict access to sensitive facilities, materials, and information included in the United States Munitions List (USML) to "U.S. Persons," unless they secure prior license or other approval from the State Department.[8] In addition, regulation by the U.S. inter-agency Committee on Foreign Investment in the United States (CFIUS) restricts acquisitions of U.S. aerospace and defense contractors by foreign-based companies.[9] The result is that U.S. domestic companies dominate U.S. aerospace and defense procurements to a greater degree than other areas of procurement or domestic spending.

III. Job Creation by U.S. Companies Compared to U.S. Subsidiaries of Foreign Firms

In order to analyze the employment effects of a defense contract fulfilled by a U.S. company, compared to a U.S. subsidiary of a foreign-based multinational firm, we begin by examining overall employment generation by the two classes of firms. The Tax Statistics issued by the Internal Revenue Service (IRS) include balance sheet data for samples of domestic corporations and corporations operating in the United States with more than 50 percent foreign

[6] Nackman, M. J. "The Case for Aerospace and Defense Spending as Economic Stimulus," *Georgetown Law Fiscal Law and Policy Reform Briefing Papers Series*, (2009).
[7] Department of Defense, DoD 5220.22-M, National Industrial Security Program Operating Manual (NISPOM), (2006). https://www.dss.mil/GW/ShowBinary/DSS/isp/fac_clear/download_nispom.html.
[8] See 22 U.S.C. § 2751, The United States Munitions List (USML), 22 C.F.R. pt 121 (2008); also, U.S.C. § 2751; International Traffic in Arms Regulations (ITAR), 22 C.F.R. pts. 120-130 (2008); *see also* Export Administration Act, 50 U.S.C. app. § 2401 (2000); Export Administration Regulation (EAR), 15 C.F.R. pt. 730 (2008).; *see generally* Borich, R. A. Jr., *Globalization of the U.S. Defense Industrial Base: Developing Procurement Sources Abroad Through Exporting Advanced Military Technology*, 31 PUB.CON.L.J. 623 (2002).
[9] Exec Orders 11858 (1975); 12661 (1988); *and* 13456, (2008).

ownership, by sector.[10] We use those data to derive estimates of the total wages paid by U.S. and foreign-owned companies producing aircraft.[11] We then use the average wage in the sector to estimate the numbers of jobs created each year by the sample of U.S. and foreign-owned aircraft manufacturers. The details of these calculations and a discussion of data limitations are provided in Appendix B.

This analysis found that the IRS sample of foreign-owned aircraft producers employed an average of 20,827 workers each year over the period 1994 to 2005, trending up from 4,522 in 1994 to 36,273 in 2005; and the sample of U.S.-owned aircraft makers employed an average of 219,795 workers, ranging from 149,279 in 2003 to a high of 264,597 in 2002, declining to 217,867 workers in 2005 (see Appendix B, Table I**)**. These estimates are necessarily rough: The original data cover a broader transportation group than aircraft manufacturing, which requires that we adjust those data. In addition, the data come from a sample, so while the employment trends correspond to those found by Bureau of Economic Analysis, the absolute numbers cited here are significantly smaller.

Nevertheless, the data show that domestically-owned aircraft and air transportation companies, on average, create 10 times as many jobs as foreign-owned companies in the same sector, and nearly six times more jobs in the most recent year, 2005. We attribute much of this difference to the significantly greater numbers of domestic firms than foreign-owned firms in this sector. However, domestic firms also generally invest more in the United States than foreign-owned firms, because foreign-based companies conduct much of production activities in their home countries. These higher levels of U.S. capital investment by the U.S. based firms, compared to the U.S. divisions of foreign-owned companies, lead to higher levels of job creation. These differences may be particularly important in this case because, as noted earlier, defense procurements often involve strict requirements that contractors and sub-contractors be U.S. citizens with U.S. security clearances.

IV. Domestic Investment by Aircraft Manufacturers and the Effects on Employment

While globalization creates benefits for companies undertaking foreign direct investment for production purposes – from cheaper access to certain inputs and labor, to economies of scale – the extent of a firm's domestic investment directly affects its employment needs in that market. Here, we use the amount of capital investment in the U.S. market as a proxy for what is commonly called "domestic content," because such investment directly creates jobs. Other forms of domestic content, such as a firm's use of domestic suppliers for administrative goods and services, may indirectly support employment; but they do not involve the firm directly creating new jobs.[12] Also, in evaluating the impact of increases in domestic investment or content on employment, the absolute level of the domestic investment is more important than its

[10] Internal Revenue Service, SOI Tax Stats: Corporate Data by Sector or Industry, produced by the Statistics of Income Division and Other Areas of the Internal Revenue Service, (2009)., for all corporations; and,
Internal Revenue Service, SOI Tax Stats: Foreign Controlled Domestic Corporations, produced by the Statistics of Income Division and Other Areas of the Internal Revenue Service, (2009)., for foreign corporations.

[11] *Ibid.*

[12] In principle, multinational firms with operations across much of the world could be more profitable and thereby generate higher employment than firms operating only in the domestic market. However, that additional employment could be located anywhere across the firm's global production network.

share of the firm's total investments. To illustrate, a foreign-based firm investing 40 percent of 100 units in the United States would have greater American domestic content than a U.S. firm investing 80 percent of 40 units in the United States.

The data used here on capital investment come from the IRS Tax Statistics balance sheets used earlier for wage data. These data show total investments in plant, property and equipment (PPE) by sector and year; and these data are reported separately for U.S.-based companies and U.S. subsidiaries of foreign-owned firms. We use these data to calculate changes in capital stock or investment over time, by U.S. and foreign -owned aircraft manufacturers operating in the United States.[13] These data show that domestic aircraft manufacturers create more jobs, relative to the increases in their PPE investments, than the U.S. operations of foreign-based aircraft makers. In economic terms, we would say that the elasticity of employment to investment is higher for U.S. companies than for the U.S. subsidiaries.[14]

Table 2, below, shows that each 1.0 percent increase in PPE investments by U.S.-based aircraft makers is associated with a 0.79 percent increase in their workforce, as compared to the U.S. subsidiaries of foreign-owned multinational aircraft manufacturers, which show a 0.42 percent increase in employment associated with each 1.0 percent increase in PPE investment. This difference likely reflects the global network structure of multinational corporations, in which much of the manufacturing occurs in the home country or developing nations with cheaper labor and other inputs. The data show, therefore, that a U.S. aircraft maker investing a given amount in the U.S. market will generate nearly twice as many jobs as a U.S. subsidiary of a foreign-based aircraft manufacturer undertaking the same level of investment.

Table 2. Capital Investment and Employment by U.S.-Owned and Foreign-Owned Aircraft Companies in the United States, 1994-2005

	U.S.-Owned		Foreign-Owned	
	Investments in PPE	**Employment**	**Investments in PPE**	**Employment**
1994	$42,555,096,000	199,925	$941,841,000	4,522
1995	$46,076,924,000	233,136	$1,254,326,000	5,362
1996	$47,180,471,000	244,071	$1,395,656,000	6,949
1997	$73,707,847,000	240,967	$1,692,653,000	9,328
1998	$68,277,842,000	242,180	$4,980,453,000	22,866
1999	$76,476,755,000	256,883	$6,218,323,000	25,120
2000	$62,820,375,000	214,225	$8,375,394,000	26,923
2001	$34,481,273,000	207,971	$8,823,633,000	26,137
2002	$38,268,378,000	264,597	$8,640,401,000	28,079
2003	$40,539,292,000	149,279	$9,102,631,000	30,192
2004	$50,825,046,000	166,444	$10,167,748,000	28,168
2005	$58,472,963,000	217,867	$11,183,399,000	36,273
Elasticity	**0.79**		**0.42**	

[13] Internal Revenue Service, SOI Tax Stats: Corporate Data by Sector or Industry..., for all corporations; Internal Revenue Service, SOI Tax Stats: Foreign Controlled Domestic Corporations…, for foreign corporations.

[14] The elasticity is calculated as the percentage change in employment (per return) divided by the percentage change in investment (per return).

These findings bear directly on analysis evaluating the economic effects of the current competition between Boeing and Airbus, especially since in other respects the two firms may be considered comparable. Together, they dominate the worldwide market for large jets, including narrow body aircraft, wide-body aircraft and jumbo jets. From 1999 to 2008, the firms operated at effective parity: Airbus received orders for 6,378 aircraft, and Boeing received 6,140 orders.

V. The Terms of the Refueling Tanker Competition

The KC-X tanker is designed to transfer fuel to another aircraft during flight, a capacity that directly supports U.S. airpower in military operations and therefore is an important component of national security. The Air Force's current tanker assets, the medium-sized KC-135 and the larger KC-10, are old; in fact, the KC-135 is the oldest system in the Air Force inventory, with an average age of 46 years. The Air Force plans to replace this aging fleet in three stages, starting with the older KC-135 tankers and then proceeding to the rest of the current tanker fleet. The initial contract will cover 80 aircraft, but the Air Force intends to procure up to 179 new tankers. The solicitation provided that contract would be awarded on a "best value" basis, using a detailed set of system requirements and performance characteristics, and a "most probable life cycle cost" estimate for each proposal. In March 2008, the Pentagon initially awarded the $40 billion contract to Airbus in partnership with U.S.-based Northrop-Grumman.

The contract remains unassigned, because the Pentagon cancelled its initial award to Airbus/Northrop Grumman after the Government Accountability Office (GAO) found that the competition contained "significant errors," including its cost evaluations and the application of the relative weights of different aspects of each firm's proposal.[15] For example, after comparing the assessed advantages of the two proposals, the GAO found that the Air Force had failed to take proper account of the fact that many of Boeing's assessed advantages were linked to requirements and features of the aircraft which the Air Force had identified as more important than those from which Airbus/Northrop Grumman's assessed advantages were derived. The GAO also found that the Air Force had failed to credit Boeing for satisfying more of the solicitation's features and functions than Airbus/Northrop Grumman. GAO concluded further that the Air Force failed to establish that the Airbus/Northrop Grumman aircraft could refuel all current fixed-wing, tanker-compatible U.S. aircraft under current Air Force procedures, after twice informing Airbus/Northrop Grumman that the maximum operating velocity for the firm's proposed aircraft would be insufficient to achieve overrun speeds for various Air Force aircraft in accordance with current Air Force procedures.[16]

[15] Gordon, D., Statement: Testimony before the Air and Land Forces Subcommittee, Committee on Armed Services, House of Representatives, Air Force Procurement: Aerial Refueling Tanker Protest, United States Government Accountability Office, (2008).

[16] The GAO also found that the Air Force had not reasonably evaluated the capability of the Airbus/Northrop Grumman aircraft to initiate emergency breakaway procedures, consistent with current Air Force procedures, for current fixed-wing, tanker-compatible Air Force aircraft. The report further found that the Air Force had conducted misleading and unequal discussions with Boeing regarding key performance parameters. The agency also concluded that the Air Force had improperly accepted Northrop Grumman's proposal, since the firm had not committed to achieve "initial organic depot-level maintenance within two years after delivery of the first full-rate production aircraft," as required in the solicitation. The report also found that the Air Force had not reasonably evaluated military construction costs in its analysis of each firm's cost proposals. Finally, the agency concluded that the Air

For these and other reasons (see footnote 16), the GAO recommended that the Air Force hold a new competition, which is currently underway. This study does not attempt to evaluate the two previous proposals. Instead, it focuses on evaluating the claims made by the competitors, should it win the contract, about its plans to invest in the U.S. economy and the associated job creation.

VI. The Tanker Contract and Projected Job Creation by Boeing and Airbus

While the Air Force has stated that its decision will not be based on domestic job creation considerations,[17] the job effects associated with the award have been discussed widely by members of Congress and the media. Furthermore, both companies have made claims about how much each would invest in the United States to fulfill the contract and the job gains associated with that investment. Airbus/Northrop-Grumman has asserted that up to 60 percent of the content of the new tankers would come from the United States and generate between 25,000 and 48,000 new jobs. Boeing has claimed that it would source 85 percent of its new investments for this project in the United States and create some 44,000 jobs here.

The following analysis assesses these claims objectively. We begin this assessment with the value of the initial contract, $35 billion, and by accepting the commitment by Boeing to expend 85 percent of this total value in the United States (the "domestic content"), compared to the pledge by Airbus/Northrop-Grumman of up to 60 percent domestic content. This spending would be allocated between new, fixed investments in plant, property and equipment (PPE), payments to suppliers and other vendors, labor costs, and shareholder returns. Since both firms maintain large, global supply chains but do not publish data on where their suppliers and vendors are located, we cannot estimate the indirect job effects arising from how much of their payments to those suppliers and vendors would go to purchase goods produced by workers inside the United States or outside the country. Therefore, we focus on the two firms' domestic content claims and the associated domestic investments in PPE, in order to estimate the additional jobs that would be generated directly to work with the capital created through those investments.

These estimates depend, first, on how much of the total value of the contract would be used for PPE investment in the United States. We assume that all of the spending goes to either capital or labor; and since aircraft manufacturing is highly capital-intensive, we calculate the ratio of investment to worker compensation, covering all available years (1994 to 2006). We find that for both domestic-owned and foreign-owned aircraft makers, approximately 80 percent of new spending goes to create or purchase assets, and 20 percent goes for labor. It would be unrealistic, however, to assume that 80 percent of the domestic content of this contract would go to PPE investments, since both Boeing and Airbus propose to produce the new tanker by modifying aircraft which they currently manufacture. Therefore, much of the infrastructure or

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Force had improperly increased Boeing's estimated non-recurring engineering costs, in calculating the firm's most probable lifecycle cost. (Gordon, D., Testimony before the Air and Land Forces Subcommittee, *op. cit*.)

[17] The five factors to be considered in a "best value determination" by the Air Force include "mission capability, proposal risk, past performance, cost/price, and an integrated fleet air refueling assessment—performance in a simulated war scenario" (AFPN 2008b). Statements of Assistant Secretary of the Air Force for Acquisitions Sue Payton, as reported in AFPN (2008a). Air Force Print News Today (AFPN). 2008a. Officials announce tanker contract award. March 4. http://www.af.mil/news/story.asp?id=123088862. *Air Force Print News Today* (AFPN). 2008b. Tanker contract award announced. February 29. http://www.af.mil/news/story.asp?id=123088392.

physical property, plant and equipment needed to produce the new tankers already exist, located in the United States in Boeing's case and mainly in Europe for Airbus. As noted above, the bulk of the capital spending in both cases will go to suppliers and other vendors. Therefore, we use data from the companies' annual reports to estimate how much of the domestic value of the tanker contract would likely go for new capital investment. Based on Boeing's annual reports, we calculate that about 15 percent of the company's total revenues over the course of the contract would go to new PPE investment. Airbus is a division of EADS, which does not report PPE investments and revenues by division. Therefore, we use the 15 percent level derived from the Boeing data, in investments which presumably would be concentrated in the new assembly plant Airbus has committed to build in Mobile, Alabama.

Earlier, we found that increases in PPE investment by aircraft manufacturers lead to increases in direct employment, because when aircraft makers invest in new plant and equipment, they hire new workers to use that plant and equipment. We found that a 1.0 percent increase in a firm's PPE investments is typically accompanied by a 0.79 percent increase in U.S. jobs by domestic aircraft companies, and a 0.42 percent increase in U.S. jobs by foreign-owned aircraft makers operating here. To apply these ratios, we collected data on the current levels of PPE investment and employment for Boeing and Airbus, so we can calculate the rate of increases in PPE that would accompany the contract.[18] From Boeing's annual report, we find that the company's stock of PPE investments at the end of 2008 came to $8.76 billion. Airbus does not report its capital stock; but the parent company EADS reports that it has invested about 400 million Euros in PPE in countries other than France, Germany, Spain and the United Kingdom. If we assume that all of that investment represents Airbus capital stock in the United States, it would come to some $569 million.[19]

Similarly, the data on current U.S. employment by Boeing are available from its 2008 annual report: Boeing employs about 162,000 people worldwide, of which 155,598 are located in the United States. The current U.S. employment data for Airbus are less clear. The Airbus website claims that the company "supports" 120,000 jobs in the United States, but does not provide any measure of direct job creation. Therefore, we estimate Airbus's direct U.S. workforce using information from EADS and other public sources. EADS reports that 97.5 percent of its worldwide employees in 2006 were located in Europe, with approximately 2,200 or 1.7 percent located in the United States.[20] We assume here that Airbus directly employs all of those roughly 2,200 workers in the United States.

Using these data, we can estimate the U.S. direct job impact from awarding the new tanker contract to either company. To review, the initial contract is worth $35 billion, of which the U.S.-based Boeing pledges to devote 85 percent to purchases and investments in the United States, or $29.75 billion, while the multinational Airbus pledges to devote up to 60 percent to U.S. spending and investment or $21.0 billion (Table 3, below). We estimated that both

[18]The Boeing Company, 2008 Annual Report, (2008). http://www.envisionreports.com/ba/2009/12ja09001m/document_0/Boeing_AR_03-11-09_Preflighted_01.pdf ; The European Aeronautic Defense and Space Company (EADS), Financial Statements 2008, (2008). http://www.eads.net/xml/content/OF00000000400004/4/02/42491024.pdf

[19] EADS, Financial Statements 2008.

[20] The European Aeronautic Defense and Space Company, EADS Annual Review 2006, (2006). www.reports.eads.net/2006/en/book3/3/6/1.html.

companies would devote 15 percent of this domestic spending to new U.S. investments in property, plant and equipment, which would come to $4,462.5 million by Boeing ($29.75 x 0.15) and $3,150.0 million by Airbus ($21.0 x 0.15). We also already determined the base of each firm's current PPE investments in the United States -- $8,762.0 million for Boeing and $569.3 million for Airbus – so these additional PPE investments in the United States would represent an increase in U.S. PPE investment of 50.93 percent for Boeing and 553.33 percent for Airbus.

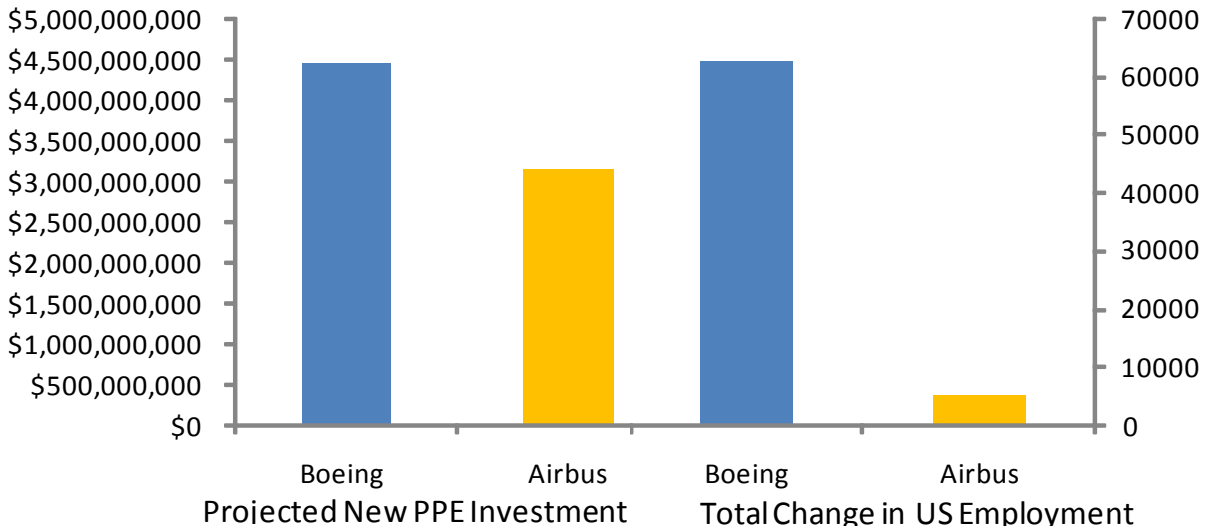
We also determined earlier that Boeing directly employs 155,598 workers in the United States, compared to some 2,200 employed here by the foreign-based Airbus. Now we can apply the data we derived from the IRS statistics on the rate at which new jobs are created by U.S.-based and foreign-based aircraft manufacturers here, in response to increases in their investments in property, plant and equipment. Since a 1.0 percent increase in PPE by a U.S.-based aircraft maker leads to a 0.79 percent increase in its U.S. labor force, and the tanker contract would increase Boeing's PPE investments in the United States by 50.93 percent, we can estimate that the contract would lead Boeing to expand its U.S. labor force by 40.23 percent (50.93 x 0.79 = 40.23). Based on Boeing's current U.S. labor force of 155,598, this means that if Boeing won the new tanker contract, the company would create up to 62,605 new U.S. jobs.

Turning to Airbus, a 1.0 percent increase in PPE investments by the U.S. subsidiary of a foreign-based aircraft maker leads to a 0.42 percent increase in its U.S. labor force. The tanker contract would increase Airbus's current PPE investments in the United States by 553.33 percent. Therefore, the additional U.S. PPE investments by Airbus would lead directly to an increase in its U.S. labor force of 232.4 percent (553.33 x 0.42 = 232.4). Based on Airbus's current U.S. labor force of 2,200, this means that if Airbus won the new tanker contract, the company would create up to 5,113 new U.S. jobs, or 8 percent of the job growth associated with Boeing winning the contract. These calculations are summarized in Table 3, below, and the comparisons on PPE investment and job generation in the graph that follows, Figure 1.

Table 3: Estimated Increases in U.S. PPE Investment and U.S. Employment By Boeing and Airbus to Produce the New Air Force Tanker

	Boeing	Airbus
Value of the Contract	$35,000,000,000	$35,000,000,000
Share of Domestic Content	0.85	0.60
Total Domestic Spending and Investments	$29,750,000,000	$21,000,000,000
Domestic Allocation To PPE Investments	0.15	0.15
Projected U.S. PPE Investment	$4,462,500,000	$3,150,000,000
Current U.S. PPE Investment	$8,762,000,000	$569,280,000
Percentage Change in PPE Investment	50.93	553.33
Current U.S. Employment	155,598	2,200
Elasticity of Employment to PPE Investment	0.79	0.42
Percentage Change in Employment	40.23	232.40
Total Change in U.S. Employment	**62,605**	**5,113**

Figure I. Projected New US Investments and New U.S. Employment From the KC-X Tanker Contract, Boeing and Airbus



VII. An Alternative Approach to Estimate the U.S. Jobs Impact of the Tanker Contract

These estimates of the employment effects of the new tanker contract depend in part on the pledges made by Airbus and Boeing about how much of their spending would occur in the United States. These claims of projected domestic content also can be compared to data on how much of each company's actual worldwide investment occurs in the United States. Here, since Airbus has partnered with the U.S.-based Northrop-Grumman in its proposal – and even though their proposal acknowledges that most of the production would occur at Airbus's European facilities – we use data provided by all three companies on the geographic distribution of their operations and investments. Again, we focus on PPE investment, because only those investments are associated with direct job creation, and the geographic locations of their suppliers and vendors cannot be determined.

Boeing's 2008 annual report notes that 96 percent of its operating assets are located in the United States,[21] and this is the same level reported by Northrop-Grumman in its 2008 annual report for its PPE investments.[22] By contrast, EADS's 2008 annual report notes that 96 percent of its worldwide PPE investments are located outside the United States. If we use these data as a proxy for the domestic content of each company's investments, our projections of the effects on U.S. job creation by Airbus fall dramatically, offset in part by assuming that the contract activity would be divided between Airbus and Northrop Grumman. Given the partnership's announced

[21] Operating expenses include PPE, natural resources and intangible assets. Therefore, this represents an upper bound of all outside investment, and Boeing's non-U.S. PPE investments are likely to be even less.

[22] Northrop-Grumman Corporation, 2008 Annual Report, (2008), www.northropgrumman.com/pdf/2008_noc_ar.pdf. Note that the employment numbers exclude employment in non-aerospace sectors such as shipbuilding and information services.

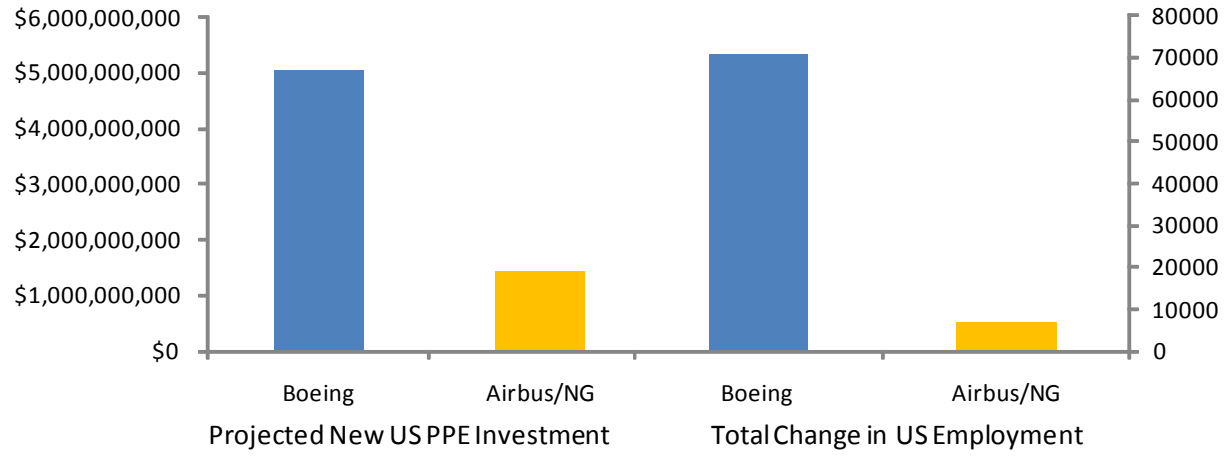
plans to conduct most of the manufacturing at Airbus's European facilities, we allocate three-fourths of the contract to Airbus and one-fourth to Northrop-Grumman.

This approach produces generally similar results as our initial analysis. If Boeing carries out the contract, we project that it would directly create 70,706 new U.S. jobs or about 13 percent more than estimated under the initial approach. Under this alternative estimating method, we also project that the Airbus/Northrop-Grumman partnership would create 7,080 jobs, or about 38 percent more than estimated using the initial method. The calculations are summarized in Table 4, below, and the comparisons on PPE investment and job generation are presented in the graph that follows, Figure 2.

Table 4: Estimated Increases in U.S. PPE Investment and U.S. Employment By Boeing and Airbus/Northrop-Grumman to Produce the New Air Force Tanker

	Boeing	Airbus	Northrop-Grumman
Total Value of Contract	$35,000,000,000	$35,000,000,000	$35,000,000,000
Share of Contract	100.0%	75%	25%
Value of Contract	$35,000,000,000	$26,250,000,000	$8,750,000,000
\Share of U.S. Domestic Content	0.96	0.04	0.96
Total Domestic Spending and Investment	$33,600,000,000	$1,050,000,000	$8,400,000,000
U.S. Domestic Allocation To PPE Investment	15%	15%	15%
Projected U.S. PPE Investment	$5,040,000,000	$157,500,000	$1,260,000,000
Current U.S. PPE Investment	$8,762,000,000	$569,280,000	$6,199,000,000
Percentage Change in U.S. PPE Investment	57.52%	27.66%	20.32%
Current U.S. Employment	155,598	2,200	42,500
Elasticity of Employment to PPE Investment	0.79	0.42	0.79
Percentage Change in U.S. Employment	45.44%	11.62%	16.06%
Total Change in U.S. Employment	**70,706**	**256**	**6,824**

Figure2. Projected New US Investments and New U.S. Employment From the KC-X Tanker Contract, Boeing and Airbus/Northrop-Grumman



Using this method, we find that Boeing's direct domestic investments to build the new tanker should create nearly 10 times as many new U.S. jobs as would Airbus/Northrop-Grumman new direct U.S. investments for the same purpose, or about the same proportions derived using the first estimating method.

VIII. The Potential Spillover Effects of the New Tanker Contract

For contracts involving the development of new technologies and production methods, choosing a U.S.-based company, as compared to the U.S. subsidiary of a foreign-based company, may also affect the economic benefits associated with "spillovers" from those innovations. More precisely, the spillovers from developing new technologies and production methods, which can be powerful economically, are likely to concentrated or "clustered" in the company, region and nation where they're developed, especially initially. If Boeing were to carry out the tanker contract, such spillovers will produce economic benefits mainly for itself and other U.S.-based companies, while the spillovers arising from Airbus research and development (R&D) for the same contract will produce economic benefits largely for EADS and other European companies.

By almost any measure, the aircraft manufacturing sector is highly research-intensive. The design and manufacture of technologically-advanced aerospace products require large R&D investments; and data collected by the Bureau of Labor Statistics show that the highly-skilled professionals who perform this work accounted for nearly 31 percent of the sector's workforce in 2006.[23] A more direct measure of an industry's R&D intensity is the share of assets represented by intangibles, which include patents and copyrights. IRS data show that nearly 5 percent of all industrial assets in 2006 were intangibles, while the share in the aircraft manufacturing sector was close to 27 percent. At the firm level, one proxy for innovation is the number of new patents: The U.S. Patent and Trademark Office reports that from 1997 to 2008, Boeing was granted 2,138 patents and Northrop-Grumman was granted about half that number, or 1,191 patents.[24] In 2008, Boeing ranked 41st across all corporations in both patents filed and patents granted, and Northrop-Grumman ranked number 160.[25]

Economists have long investigated how high levels of R&D tend to produce indirect, spillover benefits, both within the companies which undertake the investments and beyond them. Generally, this research has found that the productivity of firms and industries is related to both their own R&D investments and the R&D undertaken by other firms and industries. Specialists in economic growth also have found that both knowledge capital and innovation generally contribute significantly to increases in the trend growth rate of the economy, which represents the ultimate spillover effect.[26]

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[23] Bureau of Labor Statistics, U.S. Department of Labor, *Career Guide to Industries, 2010-11 Edition*, Aerospace Product and Parts Manufacturing, (2009).

[24] United States Patent and Trademark Office, "Report Breakouts by Inventor," Reports Available for Viewing, (2009).

[25] United States Patent and Trademark Office, "Patenting by Organizations 2008: Part B," Electronic Information Products Division, Patent Technology Monitoring Team, 2008

[26] Romer, P., "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, XCIV (1986), 1002-37; Romer, P., "Endogenous Technological Change," *Journal of Political Economy*, XCVIII (1990), S71-S102;

Using firm level data, researchers over many years also have also examined the strong "learning effects" associated with aircraft production.[27] The earliest work from 1936 noted that labor, material, and overhead requirements declined with cumulative production in aircraft manufacturing. This work led to wide acceptance of what is called in the engineering literature "the 20-percent learning curve," which holds that based on engineering advances, every doubling of cumulative past production reduces input requirements by 20 percent. This work was later refined using data for 22 World War II military aircraft divided into four major classifications, which that the spillover "learning" rate varied across plane types. More recent research has linked the production function and learning curve data, and taken account of various kinds of scale effects and profit maximization behavior.[28] This research applied the established spillover model to data for several more recent military programs and confirmed that the production of new military systems produced significant learning effects.[29]

There also is growing research showing that these spillover benefits are often associated with economic "clusters," in which various companies producing goods and services for a single industry cluster in a certain geographical area and interact in ways which increase productivity. The U.S. aerospace sector and aircraft manufacturing industry are both highly concentrated geographically, with nearly 50 percent of their direct employment in 2000 located in the two states of California and Washington.[30] These clusters usually consist of one or a few large firms, such as Boeing and Northrop-Grumman, and several hundred smaller suppliers of parts and services; and the knowledge spillovers, centered on new technologies are transmitted through the supply chains linking the large firms and their suppliers. Research further shows that these suppliers to large aerospace and aircraft manufacturing companies also provide products and services to firms in other industries, so that innovations in the aerospace and aircraft manufacturing supply chains can contribute to innovations in other settings and so can produce economic benefits for a much broader range of firms.

The research on the spillover benefits from industry clusters and regional innovation systems emphasize face-to-face communication along with transmissions of new knowledge through the many channels available for local transfers, such as conferences and participation in local associations. A survey of this research suggests that these local knowledge benefits may not be available in multinational or even national settings. At a minimum, the research found

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Grossman, G., and E. Helpman, *Innovation and Growth in the Global Economy* (Cambridge, MA: M.I.T. Press, 1991).

[27] Wright, T. P., "Factors Affecting the Cost of Airplanes," *Journal of the Aeronautical Sciences* 3.4 (1936), pp. 122-28; Asher, H., *Cost-Quantity Relationships in the Airframe Industry* (Santa Monica, CA: Rand Corporation, 1956); Alchian, A., "Reliability of Progress Curves in Airframe Production," *Econometrica* 31.4 (1963), pp. 679-94.

[28] Gulledge, T. R. and N. K. Womer, *The Economics of Made-to-Order Production* (New York: Springer-Verlag, 1986).

[29] Researchers also have found these relationships pertain not only to aircraft engine development and production, but also to other industries such as machine tools, metal products, nuclear power plants, chemical processing, semiconductors, and shipbuilding. These spillover effects may take many different forms, depending on the nature of the production. In the aircraft and shipbuilding industries, for example, these effects are often evident in higher worker efficiency, especially in repetitive tasks.

[30] Niosi, J. and M. Zhegu, "Aerospace Clusters: Local or Global Knowledge Spillovers?" *Industry and Innovation* Vol. 12. No. 1. (2005), 1-25.

that such knowledge spillovers across regions or countries are more expensive and thereby their incidence and benefits are lower, compared to local and regional spillovers.[31] This conclusion is consistent with other research which found that citations to patents are much more likely to be domestic than international, again suggesting that most knowledge spillovers are local or at most national, rather than global, at least initially.[32] Finally, researchers have found that greater clustering of innovative activities occurs in industries where knowledge spillovers are relatively powerful and important, again supporting the conclusion that these spillovers are at least initially limited to local areas[33]

There are no estimates of the precise economic value of these spillovers in aircraft manufacturing, but one important study has estimated the spillover benefits generated by four industries in the larger transportation equipment sector, covering motor vehicles and railroads as well as aircraft.[34] The study found that this broad industry group generated significant spillovers for the non-electrical manufacturing sector as well as the scientific instruments industry. As a result, they found that the social rate of return on the transportation equipment sector's investments – the benefits for the economy – were 10 percent to 20 percent higher than the private rate of return for sector itself.

The large body of research shows that the KC-X contract will likely lead to substantial R&D by the firm which wins the contract, and that this R&D will likely produce significant spillover benefits for the firm itself, its local and regional suppliers and vendors, and other companies in the same geographical area. Since the benefits from these spillovers are concentrated in the geographical clusters where the innovation occurs, especially initially, the U.S. economy will almost certainly capture much greater spillover benefits if the contract goes to a U.S.-based firm compared to a foreign-based company.

Implications for the U.S. Defense-Industrial Base

America's military preparedness and capacity rely on a broad, sustainable defense-industrial base, and this base depends in important part on steady flows of contracts and funding from the Department of Defense (DoD).[35] The DoD has identified a number of criteria to evaluate the country's industrial base, including a range of producers that can maintain a stable or expanding business base over a long term, earn fair operating margins, and invest in research and development and capital equipment in ways that promote their competitiveness and innovation. These factors are also critical elements in attracting and maintaining a workforce

[31] Cameron, G. "Innovation and Economic Growth," London School of Economics Centre for Economic Performance, Discussion Paper No. 277 (1996).
[32] Jaffe, A. B., M. Trajtenberg, and R. Henderson, "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations," *The Quarterly Journal of Economics*, Vol. 108, No. 3 (1993), pp. 577-598.
[33] Audretsch, D.B. and M. P. Feldman, "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review*, Vol. 86 (1996), pp. 630-640. Orlando also found evidence that geographic clustering of firms may be a response to the higher impact of knowledge spillovers between firms located in the same local region. Orlando, M.J. "Measuring Spillovers from Industrial R&D: On the Importance of Geographic and Technological Proximity," *RAND Journal of Economics*, Vol.35, No. 4 (2004), pp. 777-786.
[34] Bernstein, J. I. and M. I. Nadiri, "Research and Development, and Intraindustry Spillovers: An Empirical Application of Dynamic Duality," *Review of Economic Studies*, 56 (1989), pp. 249-269.
[35] Office of the Director, Industrial Policy, "Industrial Policy: Frequently Asked Questions," DoD, Office of Undersecretary of Defense, Acquisition, Technology & Logistics, Industrial Policy, www.acq.osd.mil/ip/faq.html.

with the highly-specialized design, engineering and manufacturing skills required to develop and produce next generation defense systems.

Other dimensions of this industrial base are also pertinent to this analysis. The "cost-effectiveness" of the defense-industrial base can be measured by its companies' ability to deliver their contracted products and services at or below their cost targets, which in turn depends on effective acquisition strategies and, most important, on maintaining a number of competitive suppliers in key technology areas. Perhaps most important, the defense-industrial base must be able to deliver products and services that meet the Defense Department's performance requirements, including during periods of conflict when those requirements and priorities may shift and evolve. This capacity requires that major U.S. defense-related companies are able to maintain flexible technology and technology development programs, and the requisite staff with specialized skills to meet new DoD needs.

These criteria raise serious issues about the current sustainability of the U.S. aerospace industrial base. According to reports, the 2011 Pentagon budget will feature few if any new aerospace and aircraft programs, while several other production lines could close in the next several years, including the F-22, F/A-18 and F-16 fighter jets and the C-17 cargo plane.[36] The 2009 *Annual Industrial Capabilities Report to Congress* noted, for example, that, "with the announcement of the C-17 program shutdown, coupled with the end of domestic F/A-18E/F production in FY 2012, the industrial base infrastructure at Long Beach, CA, and St. Louis, MO (solely supporting foreign military sales) may have insufficient business to continue in place."[37] Moreover, some analysts contend that the end of these programs could severely affect the dimensions and capacity of the current highly-skilled aerospace workforce and the consequent ability to sustain certain core military capabilities.[38] At this juncture, the major long-term investments associated with the KC-X tanker refueling program could help sustain critical parts of the U.S. aerospace industrial base.

IX. Conclusion

This report has examined certain economic effects which will follow the Pentagon's upcoming decision about which company will develop and produce the refueling tanker. The analysis has not addressed the various technical, security and cost factors which presumably will play significant roles in this decision. Instead, we have focused on the impact of this decision on direct employment. We find a sharp contrast: The selection of Boeing would be expected to lead to the creation of an estimated 62,605 to 70,706 new jobs in the United States, compared to an estimated 5,113 to 7,080 jobs if Airbus is awarded the contract.

These findings are based not on the two companies' various job-related promises and claims, but on analysis of the long-term relationship between new investment and domestic job

[36] Bennett, J., "Uncertain Skies for US Industrial Base: Multiple Production Line Closures Anticipated," *Defense News* (2009).
[37] Department of Defense, "Annual Industrial Capabilities Report to Congress," Office of Undersecretary of Defense, Acquisition, Technology & Logistics, Industrial Policy (2009), pg 5.
[38] Eaglen, D. and E. Sayers, "Maintaining the Superiority of America's Defense Industrial Base," *Backgrounder* No. 2276, (2009).

creation by U.S.-based aircraft manufacturers compared to the U.S. subsidiaries of foreign-based multinational aircraft companies. As expected, both companies would be expected to distribute most of the new investment across their existing manufacturing operations, since any other approach would drive up costs and be highly inefficient. This expectation is reinforced by the two companies' announced intentions to meet the new contract by adapting current aircraft now being produced in their existing manufacturing plants.

The result is that the U.S.-based Boeing Company would have to focus most of the new investment arising from the tanker contract on its existing facilities in the United States, creating the estimated 62,605 to 70,706 new U.S. jobs to carry out and use this investment. In contrast, Airbus, a division of the European-based EADS, would have to focus most of its new investment from the KC-X contract on its existing facilities, located almost entirely in Europe, leaving only 5,113 new jobs for its subsidiary located in the United States. These findings are not affected substantially when we assume that Airbus's U.S. partner, Northrop-Grumman, would account for one-fourth of the new investment under the contract: With most of the manufacturing necessarily still concentrated in Europe, we would expect the Airbus subsidiary in the United States and its Northrop-Grumman partner would create some 7,080 new U.S. jobs to fulfill the contract. These estimates are strictly consistent with Airbus's announced plans to develop and build most of the new planes at its various European facilities, with only the construction of a new cargo door, certain aspects of the aircraft's militarization, and its final assembly occurring in the United States.

We also find that the decision to select a U.S.-based company to develop the KC-X tanker, as compared to a foreign-based multinational, could have additional economic effects through spillovers from the development process. Recent research has found not only many forms of innovation are more likely to occur in certain locations where the resources for development are "clustered." In addition, the economically useful or beneficial spillovers from the development of innovations are more likely to occur, especially initially, in the same geographic area or region as well, or through the innovator's supply chain. These patterns of spillovers largely reflect the importance and impact of face-to-face contacts in communicating about new developments. Therefore, the refueling tanker contract decision also may determine whether American or European businesses are the first or principal beneficiaries of whatever spillovers are generated through the development of the new refueling tanker aircraft.

While technical, security and cost consideration should be central factors in the Pentagon's decision, policymakers should also be fully informed about its direct, economic implications. The development of the new tanker will likely produce spillover benefits, including support for the aerospace-industrial base, which would be concentrated in the United States if an American-based company does the development or in Europe if a European-based firm does it. Moreover, a U.S.-based aircraft company will use the direct investments coming from the new contract to create 10-12 times as many new jobs in the United States as would a foreign-based multinational aircraft manufacturer. We find that in these economic respects, there is no real competition.

Appendix A

Table I. Aircraft Manufacturing and the U.S. Trade Balance, 1994-2007[39]

	Exports ($ million)					Imports ($ million)			
Year	Aircraft Launching Gear	Civilian Aircraft, Engines & Parts	Military Aircraft, Engines & Parts	Total Exports	Share of Goods Exports	Civilian Aircraft, Engines & Parts	Military Aircraft, Engines & Parts	Total Imports	Share of All Goods Imports
1994	37	31,475	1,123	32,635	6.37%	11,298	636	11,934	1.80%
1995	38	26,128	1,615	27,781	4.75%	10,709	621	11,330	1.52%
1996	43	30,792	3,837	34,672	5.55%	12,671	740	13,411	1.69%
1997	54	41,359	2,411	43,824	6.36%	16,598	1,136	17,734	2.04%
1998	55	53,547	3,859	57,461	8.42%	21,814	1,263	23,077	2.53%
1999	54	52,921	4,242	57,217	8.22%	23,773	1,167	24,940	2.43%
2000	55	48,091	2,558	50,704	6.48%	26,376	1,159	27,535	2.26%
2001	73	52,620	2,199	54,892	7.53%	31,358	1,148	32,506	2.85%
2002	149	50,425	1,672	52,246	7.54%	25,458	1,242	26,700	2.30%
2003	171	46,723	2,159	49,053	6.77%	24,085	1,010	25,095	2.00%
2004	215	46,075	2,360	48,650	5.97%	24,299	1,245	25,544	1.74%
2005	306	55,889	2,417	58,612	6.50%	25,752	1,610	27,362	1.64%
2006	345	64,502	4,465	69,312	6.76%	28,384	1,566	29,950	1.62%
2007	330	73,019	4,175	77,524	6.75%	34,407	1,856	36,263	1.85%

[39] Bureau of Economic Analysis, U.S. Department of Commerce, *International Economic Accounts*, (2009). http://www.bea.gov/international/index.htm#trade.

Appendix B

The limitation of these data arises from their categorization: Aircraft equipment manufacturing is not listed separately from "Total Transportation Equipment" for 1998-2006 and from "Other Transportation Equipment, Except Motor Vehicles" for 1994-1997. To develop a consistent time series, we calculate the average ratio of "Motor Vehicles Equipment" to "Other Transportation Equipment, Except Motor Vehicles" for the years 1994-1997, apply it to "Total Transportation Equipment" for the years 1998-2006, and then use that ratio to develop a uniform series on "Other Transportation Equipment" for the entire period. The table below shows the total number of returns and the total wage and salary payments for all available years for all aircraft manufacturing corporations. We use a similar methodology to allocate the total number of returns between the two industries. Further, we note that the IRS data are based on a sample of returns. Therefore, it is important to take account of the number of returns when working with these data. In the tables following this, we distinguish between foreign and domestic corporations operating in this industry.

Table II. Employment Generation in All U.S. Corporations: Aircraft Manufacturing

	Total Returns	Wages & Salaries	Average Annual Wage	Jobs Created
1994	2,155	$7,696,116,000	$37,644	204,447
1995	2,515	$8,965,813,000	$37,593	238,498
1996	2,598	$10,025,774,000	$39,940	251,020
1997	3,117	$10,592,734,000	$42,321	250,295
1998	4,227	$11,270,695,000	$42,524	265,046
1999	4,260	$11,792,425,000	$41,817	282,004
2000	3,056	$10,769,308,000	$44,659	241,147
2001	3,363	$10,769,308,000	$46,002	234,108
2002	2,777	$13,560,162,000	$46,332	292,675
2003	3,286	$8,461,238,000	$47,145	179,472
2004	2,928	$9,596,387,000	$49,310	194,612
2005	3,613	$13,366,024,000	$52,593	254,140
2006	2,747	$8,420,083,000	$56,886	148,016
Average	**3,126**	**$10,406,621,000**	**$44,982**	**233,498**

The table above shows total wage and salary payments within the "Other Transportation Equipment" sector using the methodology described earlier. On average, the share of "Other Transportation Equipment" in total compensation is about 40 percent of "Total Transportation Equipment." To estimate the jobs created, we obtained data on average annual wages in the aircraft equipment manufacturing industry for the relevant years from the BLS. The annual wage trended up over this period from about $38,000 to $57,000.[40] Dividing total compensation by the average wage provides an estimate of jobs created by all firms in the U.S. aircraft manufacturing sector. Note, we assume that all firms pay the same average wage, whether they are foreign-owned or domestic-owned. This may not be correct in practice and could lead to different estimates of job creation.

[40] Note that data on wages and salary for 2001 are missing in the IRS data. They have been set equal to the 2000 value.

By our estimates, these jobs averaged about 233,500 over the period 1994-2006. As noted before, this may overestimate the total jobs created, since we are looking at a broader industrial group than just aircraft manufacturing. Further, these jobs estimates differ significantly from those derived using BEA data in Table 1 of the report. Most of these differences arise from the fact that the IRS data use only a sample of total returns, rather than all returns. However, they follow the same trend over the period 1994 to 2006. During those years, employment declined in the transportation equipment manufacturing industry according to both the BEA data and the sample of firms from the IRS data.

Next, we use the same assumptions to derive estimates of job creation in domestic-owned and foreign-owned firms. For domestic-owned firms, we use the difference in total wages paid between all U.S. corporations and foreign corporations.

Table III. Employment Creation in Foreign-Owned Aircraft Manufacturing Firms

	Total Returns	Wages & Salaries	Average Annual Wage	Jobs Created
1994	39	$170,222,000	$37,644	4,522
1995	41	$201,570,000	$37,593	5,362
1996	184	$277,534,000	$39,940	6,949
1997	194	$394,757,000	$42,321	9,328
1998	93	$972,340,000	$42,524	22,866
1999	99	$1,050,436,000	$41,817	25,120
2000	118	$1,202,327,000	$44,659	26,923
2001	156	$1,202,327,000	$46,002	26,137
2002	147	$1,300,929,000	$46,332	28,079
2003	150	$1,423,421,000	$47,145	30,192
2004	145	$1,388,987,000	$49,310	28,168
2005	237	$1,907,710,000	$52,593	36,273
Average	**134**	**$957,713,000**	**$43,990**	**20,827**

Table IV. Employment Creation in Domestic-Owned Aircraft Manufacturing Firms

	Wages & Salaries	Average Annual Wage	Jobs Created
1994	$7,525,894,000	$37,644	199,925
1995	$8,764,243,000	$37,593	233,136
1996	$9,748,240,000	$39,940	244,071
1997	$10,197,977,000	$42,321	240,967
1998	$10,298,354,000	$42,524	242,180
1999	$10,741,989,000	$41,817	256,883
2000	$9,566,981,000	$44,659	214,225
2001	$9,566,981,000	$46,002	207,971
2002	$12,259,232,000	$46,332	264,597
2003	$7,037,817,000	$47,145	149,279
2004	$8,207,400,000	$49,310	166,444
2005	$11,458,314,000	$52,593	217,867
Average	**$9,614,452,000**	**$43,990**	**219,795**

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