Trade Disputes in the Commercial Aircraft Industry

Nina Pavcnik

1. INTRODUCTION

THE recent launch of Airbus's new super jumbo, the A-380, has provoked yet another trade conflict between the United States and European Union (EU) in the aircraft industry.[1] The industry has strained trade relationship between the US and the EU ever since the Airbus's entry into the market in 1974. These tensions tapered with the signing of the 1992 US–EU agreement on trade in civil aircraft (the 1992 agreement). In fact, Boeing and Airbus shortly considered cooperating on the superjumbo project during the early 1990s, but the collaboration faltered because the two sides disagreed on the commercial viability of the aircraft. While Airbus forecasted that over the next 20 years, airlines would demand approximately 1,500 superjumbos, yielding around $345 billion in revenues, Boeing's projections were much more reserved. It forecasted only 700 planes. Hence, Boeing doubted the project could break even (*The Economist*, 2001). As a result, Airbus proceeded with the development of the new aircraft on its own.

Like in previous Airbus's programmes, the EU will provide some direct financial support to Airbus to partially cover the A-380's $12 billion launch costs. US trade officials question the legitimacy of this financial arrangement, especially since Boeing doubts the commercial viability of the project. Their objections are illustrated in the 2000 Foreign Trade Barriers Report of the US Trade Representative:

> The Airbus governments continue to subsidize their member companies. … The US believes that government support of Airbus raises serious concerns about the [EU] adherence to their bilateral and multilateral obligations in [the aircraft] sector (p. 103).

Consequently, the US has warned the European Commission that it might file a complaint regarding the A-380 financing with the WTO.

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[1] I focus on the large commercial aircraft with 100 or more passengers.

The main goal of this paper is to outline and discuss the US–EU trade dispute regarding the A-380 financing and to evaluate the implications of A-380 entry on the large commercial aircraft market. Although Tyson (1992) and Busch (1999) provide excellent discussions of the trade conflict in the aircraft industry up to 1992, studies have not examined the recent developments in the industry. The current dispute is unique for several reasons. First, the US and EU trade officials disagree whether the 1992 agreement or the 1994 WTO Agreement on Subsidies and Countervailing Measures (WTO subsidy agreement) should be used to assess the legitimacy of the A-380 government funding. I therefore outline the provisions of the two agreements and discuss EU compliance with the two agreements. Moreover, industry experts expect the A-380 to compete directly with the Boeing 747. The 747 has dominated the long-range market segment during the past 30 years and has accounted for as much as a third of Boeing's commercial profits in some years. As a result, some suggest that unlike in the past, the US will be more insistent on pursuing the disputed topic and potentially retaliate. The cost of a potential US retaliation would be substantial, so it is important to evaluate the extent to which the entry of the A-380 might alter competition in the commercial aircraft market and harm Boeing's market performance. In this context, I discuss the recent findings by Irwin and Pavcnik (2001) that simulate the impact of the A-380 entry on the pricing and market share of Boeing and Airbus wide-bodied aircraft.

In order to better understand the A-380 dispute, the second goal of the paper is to provide industry background and explore the evolution of competition in the industry. Although trade tensions in the industry have occupied trade officials in Washington and the EU during the past 30 years and have motivated the theoretical trade literature on strategic trade policy in academic circles, the industry has received little empirical attention. Using detailed product-level data on the aircraft industry from 1969 to 1998, this paper illustrates the crucial role of international trade in the industry and summarises why competition in the industry has strengthened over time despite the small number of firms in the industry.

I proceed as follows. In Section 2, I provide industry background and synthesise previous theoretical and empirical work addressing trade disputes in the industry. I then present some empirical evidence on the importance of export markets and summarise the evolution of competition in the industry from 1969 to 1998. In Section 3, I discuss the 1992 US–EU agreement on trade in civil aircraft. The provisions of this agreement play an important role in the current controversy. Section 3 focuses on the recent A-380 conflict. It provides the background on the escalation of the conflict and discusses whether the EU financing of the A-380 project complies with the 1992 agreement and the 1994 WTO subsidy agreement. I then summarise the recent research by Irwin and Pavcnik (2001) that quantifies the impact of the A-380 entry on the pricing and market share of other Boeing and Airbus aircraft. Section 4 concludes.

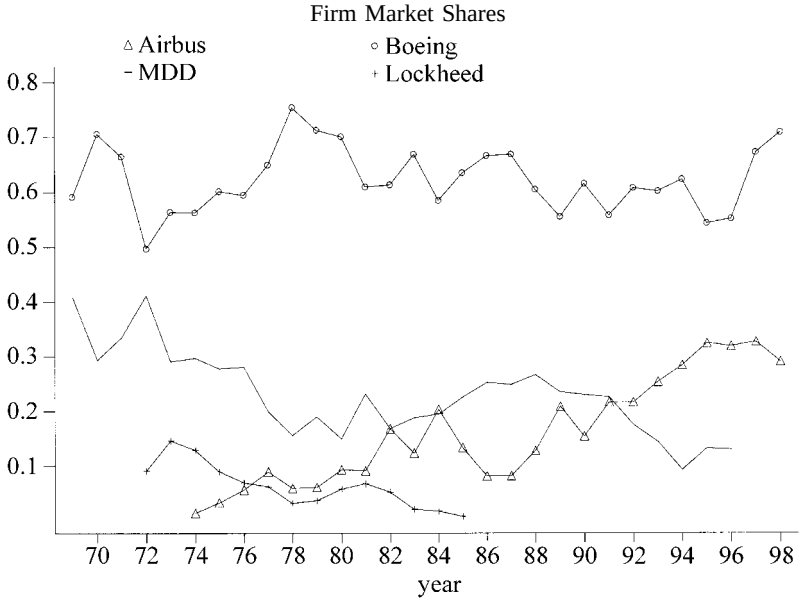
2. INDUSTRY BACKGROUND AND THE ORIGINS OF THE TRADE CONFLICT

a. Industry Background

Ever since Airbus entered the aircraft market in 1974 with generous financial backing by EU governments, the aircraft industry has provoked recurring trade disputes between the US and the EU. The EU governments justified the subsidies that covered the development cost of the first Airbus product, the A-300, with the infant industry argument and US monopoly in the industry. However, over the past 30 years, Airbus has successfully penetrated the world aircraft market and challenged the US dominance. Figure 1 presents the market share of Airbus, Boeing, McDonnell-Douglas, and Lockheed-Martin in the large commercial jet industry from 1969 to 1998. Airbus's market share has persistently grown since its introduction at the expense of US producers. By 1998, Airbus accounted for about 30 per cent of the large commercial jet market. Some recent reports suggest that Airbus provided 40 per cent of the market deliveries in the year 2000. In addition, Airbus captured 46 per cent of the market orders, which corresponds to 520 aircraft orders worth $41.3 billion in future revenues (Airbus, 2001).

International trade plays a central role in the industry. Large economies of scale and learning by doing in production require producers to rely extensively on export markets to lower average production costs. The development costs of an aircraft average on the order of $4 to $5 billion (Busch, 1999, p. 36), although the

FIGURE 1
Firm Market Shares

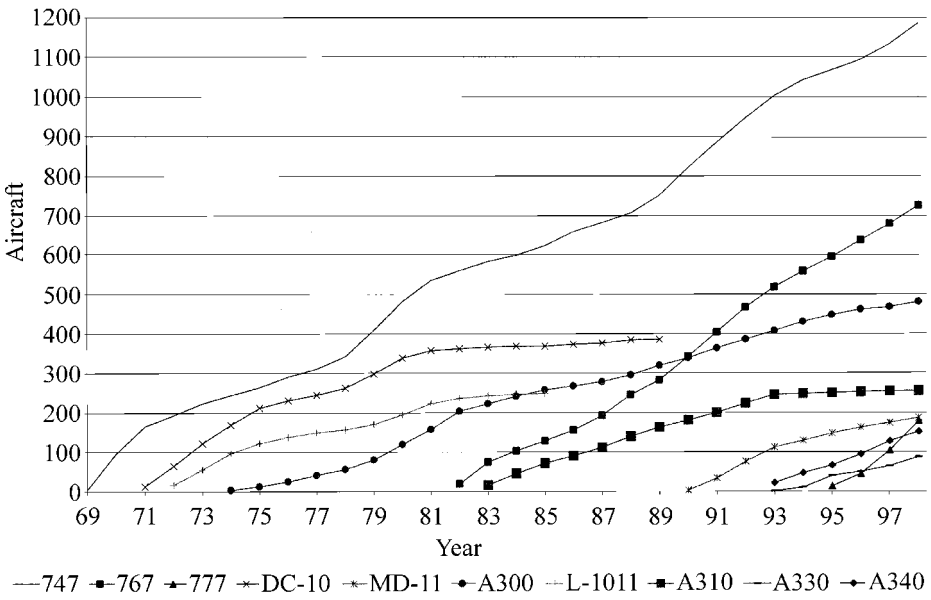


Source: Author's calculations based on the Airline Monitor.

estimated launch costs for the new Airbus A-380 are about $12 billion. However, large cumulative output not only enables producers to recover these large launch costs, but also enables firms to learn through production and lower their marginal production costs. The labour production requirements rapidly decline with the cumulative output. Using detailed data on labour production requirements for the Lockheed-Martin's aircraft, the L-1011, Benkard (2000) estimates the extent of learning by doing in production. His results suggest that as the cumulative output doubles, the production labour requirements decline by 30 to 40 per cent. It is thus crucial that aircraft producers expand their sales worldwide.

However, despite growing commercial air travel, the potential market for large commercial aircraft is limited and producers face difficulties in achieve large cumulative output. This is especially the case in the wide-body market segment where the annual worldwide aircraft deliveries have ranged from about 150 to 250 during the 1990s.[2] Figure 2 shows the cumulative output of wide-body aircraft through 1998. The cumulative output of Boeing 747, the best-selling wide-body, only reached 1,100 units in 1997, 28 years after its introduction. The

FIGURE 2
Cumulative Output of Wide-body Aircraft



[2] Within the large commercial aircraft market, industry sources distinguish between wide-body (double-aisle) and narrow-body (single-aisle) aircraft. These two categories are imperfect substitutes for each other and are designed to serve different markets. Wide-body aircraft carry more passengers and fly longer ranges than do narrow-body planes. As a result, competition is fiercest within each market segment.

TABLE 1
Geographic Distribution of Active Fleet in 1998

	Fleet	*Per Cent of Total World Fleet*	*Boeing's Share (%)*	*Airbus's Share (%)*	*MDD's Share (%)*	*Others (%)*
Airlines						
United States	5,397	39.2	55.0	5.5	30.6	8.9
Europe	3,131	22.7	47.8	19.5	16.8	15.9
Asia/Pacific	2,151	15.6	60.1	21.2	10.6	8.1
Latin America	953	6.9	55.7	7.0	26.9	10.4
Canada	392	2.8	42.9	27.8	8.7	20.7
Other	945	6.9	61.6	22.4	5.9	10.1
Other Operators/Brokers	794	5.8	57.7	13.0	10.5	18.9
Total Active Aircraft	13,763		54.4	13.3	20.7	11.6

Notes:
Author's calculations based on data from the Airline Monitor (1999). All numbers include regional jets and large commercial aircraft. The last four columns denote the market share of the aircraft producers within each geographic market. MDD stands for McDonnell-Douglas. Although MDD merged with Boeing in 1997, I report the fleets separately.

best-selling Airbus aircraft, the A-300, sold less than 500 units between 1974 and 1998. The potential market size is somewhat bigger in the narrow-body market segment, so the narrow-body planes often sell well above 1,000 units over their lifespan. The narrow-body segment is dominated by Boeing 737 that has sold over 3,200 units through 1998.

Export markets account for a large share of these sales. Table 1 illustrates the geographic distribution of the total active fleet in 1998. The reported numbers include both large commercial aircraft and regional jets. Column 1 provides the number of active aircraft owned by airlines in various geographic areas, while column 2 reports the per cent of the worldwide active fleet in each region. The last four columns show the share of Boeing, Airbus, McDonnell-Douglas, and other aircraft producers in the active fleet of each region.[3] Although US airlines account for the largest share of the active fleet (39 per cent), Europe and Asia provide important markets comprising 23 and 16 per cent of the worldwide fleet, respectively. Moreover, the table clearly shows the advantage that a national producer enjoys in its home market. While Airbus accounts for almost 20 per cent of the fleet in Europe, it comprises only 5.5 per cent of the US fleet. Similarly, the presence of Boeing and McDonnell-Douglas planes in the US market is much higher than in Europe. Finally, all aircraft producers rely heavily on export sales. Boeing, for instance, provides 47 per cent of the active fleet in Europe and 60 per cent of the active fleet in Asia.

[3] Boeing and McDonnell-Douglas merged in 1997, but I report totals for their aircraft separately.

b. The Origins of Trade Conflict

The US and the EU governments have often affected the competition between Airbus and US producers for worldwide market share through various domestic and trade policies. In fact, the aircraft industry has served as a textbook example of an industry where governments use trade policy to alter the strategic interaction between the domestic firm and its foreign rival with the goal of shifting market share and profits from a foreign to a domestic firm. However, the benefits of practising strategic trade policy in the aircraft industry are not clear. To begin with, the theory work has shown that the implications of the strategic trade policy are sensitive to the mode of oligopolistic competition among the firms in the industry. In the case of an international Cournot duopoly, Brander and Spencer (1985) suggest that an export subsidy shifts profits from the foreign to the domestic producers and increases national welfare. Eaton and Grossman (1986) demonstrate that when firms are price setters, the export subsidy actually intensifies competition between the domestic and foreign firms. They suggest that a policy that increases firms' marginal costs (for example, an export tax) might be an optimal strategic policy to enhance domestic profits. Moreover, Maggi (1996) analyses the implications of strategic trade policy in a model, where the oligopolistic mode of competition (price setting vs. quantity setting) is an endogenous function of the capacity constraints in the industry. His model suggests that a capacity subsidy to a domestic producer maximises national income regardless of the equilibrium mode of competition.

Although it is difficult to ascertain whether aircraft firms compete in prices or quantities, most anecdotal evidence points to firms competing in prices. The firms often use price discounts and favourable financing options to lure the customers. Moreover, Tyson (1992) reports that industry sources claim that capacity constraints have not been binding since the 1980s. This increases the likelihood that firms compete in prices. This anecdotal evidence questions the benefits of using export subsidies to raise national welfare. Nonetheless, the US and EU aircraft producers continue to receive direct or indirect subsidies from various government sources. There is no public information on the total value of these subsidies. However, Busch (1999) reports that the European Commission and the US Department of Commerce conducted independent studies to indirectly assess the total value of government subsidies to US producers and Airbus, respectively. The EU report suggests that US producers collected $18 to $22 billion in subsidies through NASA, the Department of Defense, and EXIM loans to the buyers of Boeing planes between 1976 and 1991 (p. 57). Similarly, the Gillman report issued by the Department of Commerce suggests that the subsidies to Airbus amounted to $26 billion by 1989 (p. 55).

Due to data hurdles, no empirical evidence exists on how government support affected the firms' strategic interactions and profits. Most studies have instead

focused on whether government-supported Airbus's entry into the industry has enhanced welfare in the US, EU, and the rest of the world using industry simulations. The evidence is mixed. Baldwin and Krugman (1988) consider competition between Airbus and Boeing in a dynamic Cournot setting. The two firms produce a homogeneous product. Unlike the theory model by Brander and Spencer (1985), Baldwin and Krugman (1988) also allow for US and EU consumption. They find that aircraft prices are 40 per cent higher without Airbus's entry, so that the entry of Airbus enhances consumer surplus.[4] Klepper (1990) extends the model to capture market segmentation between small, medium, and large aircraft. His simulations indicate that Airbus's entry limits a producer's ability to benefit from scale economies, so that Airbus's entry actually lowers overall welfare. Neven and Seabright (1995) build on Klepper's (1990) framework and show that earlier research may have overstated the benefits of price declines for consumers from Airbus's entry, because it has neglected the presence of a third producer such as McDonnell-Douglas.

These simulations provide insight into the initial entry of Airbus in the aircraft market. However, the now established market presence of Airbus also raises the question whether competition has intensified over time. This is particularly interesting because Lockheed Martin exited the commercial aircraft market in 1986 and McDonnell-Douglas merged with Boeing in 1997. The industry now comprises an international duopoly. An indirect way of addressing the degree of competition in an industry is by examining industry concentration over time. Table 2 depicts the average Herfindahl index in the aircraft market as a whole, and in the narrow-body, medium-range wide-body, and long-range wide-body aircraft market segment over five-year intervals from 1969 through 1998.[5] The calculations in Table 2 are based on annual worldwide aircraft deliveries published by the Airline Monitor. The Herfindahl index can range from 0 to 1, with the higher number indicating higher market concentration (more market power and less competition). Column 1 shows that market concentration has not declined over time despite Airbus's entry when the aircraft market is modelled as a market with no segmentation. This finding is reconfirmed when the aircraft market is divided into various market segments. One exception is the long-range wide-body segment, where Boeing held monopoly with the 747 until the 1990s. Boeing's market dominance in the long-range wide-body segment has been substantially reduced with the entry of the Airbus A-330 and the A-340. Overall, market concentration figures suggest that competition in the industry has not increased. However, a better measure of a firm's market power is given by the

[4] Their simulations indicate that although the US consumers gain, the losses in producer surplus by Boeing make the United States worse off. The overall welfare benefit is ambiguous for Europe and it declines with demand elasticity, since a higher demand elasticity implies lower markup margins and bigger subsidies. The rest of the world unambiguously gains.

[5] The Herfindahl index equals the sum of the squares of the market shares of firms.

TABLE 2
Herfindahl Index and Estimates of Markups in the Aircraft Industry
(Period Averages)

	Herfindahl Index				*Lerner's Index*
Period	*(1) All Segments*	*(2) Narrow-body Segment*	*(3) Medium-range Wide-body Segment*	*(4) Long-range Wide-body Segment*	*(5) Multi-product Bertrand*
1969–1973	0.488	0.575	0.658	1.000	0.899
	(0.070)	(0.098)	(0.199)	(0.000)	(0.192)
1974–1978	0.476	0.682	0.388	1.000	0.711
	(0.065)	(0.071)	(0.051)	(0.000)	(0.090)
1979–1983	0.490	0.674	0.381	1.000	0.671
	(0.047)	(0.101)	(0.029)	(0.000)	(0.099)
1984–1988	0.472	0.544	0.458	1.000	0.611
	(0.037)	(0.033)	(0.026)	(0.000)	(0.135)
1989–1993	0.434	0.436	0.509	0.612	0.494
	(0.022)	(0.039)	(0.012)	(0.243)	(0.113)
1994–1998	0.481	0.489	0.610	0.451	0.455
	(0.069)	(0.066)	(0.076)	(0.106)	(0.128)
1969–1998	0.474	0.553	0.468	0.744	0.589
	(0.055)	(0.114)	(0.111)	(0.279)	(0.176)

Notes:
Author's calculations based on data from the Airline Monitor (1999). The estimates of the Lerner's Index are from Irwin and Pavcnik (2001). The reported figures are period averages. Standard deviations are reported in parentheses.

Lerner index, defined as a firm's price-cost markup relative to price. A lower markup suggests lower market power and more competition. The final column of Table 2 summarises the average Lerner index over five-year intervals from 1969 through 1998.[6] The Lerner index has been decreasing over time. This implies that competition has been increasing over time despite the highly concentrated market.

The evidence suggests that Airbus's presence has strengthened competition and challenged the US market dominance in the aircraft market. This finding is consistent with the response of the US producers and trade officials to Airbus. As Airbus gained its market share, Boeing and other US producers alleged that Airbus benefited from unfair subsidies and pressured US trade authorities to counteract Europe's financial support. Despite numerous threats, US authorities and producers never retaliated because they perceived that the retaliation might jeopardise their access to European markets (Tyson, 1992). Instead, the two sides have tried to resolve the disputes in negotiations. Many of the attempts to end the

[6] The Lerner index estimates are from Irwin and Pavcnik (2001). See Section 3*b* for the details of their empirical model.

conflict such as the 1979 GATT agreement on trade in civil aircraft failed to provide binding constraints on government support.[7] The conflict was resolved at least temporarily when the US and EU signed the 1992 US–EU agreement on trade in civil aircraft that limits government financing and subsidies. Since the agreement plays an important role in the current dispute, I discuss it in the next section.

3. THE 1992 US–EU AGREEMENT ON TRADE IN CIVIL AIRCRAFT

In 1992, the United States and European Community reached a bilateral agreement on trade in large civil aircraft. While the US was mostly preoccupied with limiting the direct subsidies that benefited Airbus in the past, the EU negotiators focused on restraining the indirect support of aircraft producers through military and space agencies. The US International Trade Commission report (1998) outlines the agreement in detail. In this section, I discuss the main provisions of the agreement.

The agreement contains 13 articles that regulate various forms of government financing. First, the agreement prohibits the use of production subsidies (Article 3), where production encompasses manufacturing, marketing, and sales activities. The agreement also restricts the government's ability to help the domestic aircraft producer offer financing to airlines (Article 6). Financing can only occur through official export credit channels that adhere to 'the Large Aircraft Sector Understanding of the OECD Understanding on Official Export Financing' (USITC, 1998, p. E-8). These provisions likely reduce the producer's capacity to underbid its competitors. The prohibition of production subsidies implicitly increases a firm's marginal cost of an aircraft. Higher marginal costs imply higher equilibrium prices of aircraft when firms compete in prices or quantities (i.e. Bertrand or Cournot competition).

The agreement also provides several measures restraining government funding of the launch cost of a new aircraft. The agreement limits the direct subsidies used to finance the development of a new aircraft to repayable government loans (Article 4). The maximum allowable direct subsidy is 33 per cent of development costs, and governments are only allowed to fund projects that are likely to repay the loan within the 17 years. According to the USITC report, the first 25 per cent of total development costs must be repaid at the government's borrowing rate. The remaining eight per cent must be repaid at the government's borrowing rate

[7] The 1979 GATT agreement limits the use of traditional trade barriers such as tariffs in the aircraft industry, but it fails to rigorously address the issue of subsidies to aircraft producers. A detailed discussion of the 1979 WTO agreement is beyond the scope of this paper. See Tyson (1992) for an overview.

plus one per cent. Although the US wanted the agreement to limit the government's ability to offer development loans to aircraft producers at the government's cost of borrowing rather than at the commercial interest rates, the Europeans strongly opposed this provision (Tyson, 1992). The two sides settled on a repayment provision regarding borrowing costs. The provision requires that the aircraft companies repay the loans to the government on a per-plane basis rather than at the end of the loan. Since Airbus was previously able to postpone the payment late into the loan, this new provision reduces the net present discounted benefit of the loan. Overall, the 33 per cent limit on direct government support and the stricter borrowing terms reduce the ability of aircraft producers to launch products that are not commercially viable. This could particularly influence future Airbus launches. In the past, the EU provided support to Airbus through repayable loans at favourable interest rates that covered 60 to 100 per cent of the launch cost of various aircrafts.[8]

However, the provision that limits indirect government support (Article 5) mostly curtails benefits received by Boeing from government-sponsored projects in the military and space programmes. The agreement allows the producers to receive indirect support amounting to a maximum of four per cent of annual commercial sales of a firm or three per cent of industry-wide annual commercial sales in each country. Indirect support is defined as cost reductions to a firm that occur from government-sponsored research and development. It is very difficult to quantify these cost benefits, and US compliance with this provision continues to be subject to EU criticism (USITC, 1998, p. E-3).

Finally, the agreement establishes procedures to monitor the implementation of the agreement: it requires detailed reporting on subsidies, interest rates, and repayment conditions (Article 8). The US and EU also agree to try to resolve the disputes over direct and indirect government support covered by the agreement through consultations rather than through the use of national trade laws (Article 10). These two provisions aim to minimise the risk of retaliation in the industry. However, the US and EU can abrogate the 1992 agreement if the other country does not comply with it.

Overall, the 1992 agreement seems to have decreased the tensions between the EU and the US in this industry until the recent launch of the Airbus A-380. However, the role of the 1992 agreement has been questioned in the A-380 dispute, because the European Commission and the US disagree whether the bilateral 1992 agreement or the multilateral 1994 WTO subsidy agreement provides a binding constraint on the government subsidies for the large commercial aircraft. This is discussed in detail in the next section.

[8] See www.airbus.com/news_faq.html

4. TRADE DISPUTE SURROUNDING THE A-380 ENTRY

The current US–EU dispute in the aircraft market surrounds the entry of the Airbus A-380, whose first delivery is scheduled for 2006. As the world's largest commercial aircraft, the A-380 directly challenges the Boeing 747, which has been a cash cow for Boeing throughout the past 30 years.[9] Some fear that the A-380 entry will further undermine Boeing's market share and enable Airbus to emerge as the dominant aircraft producer. This section first describes the sources of contention and the escalation of the conflict. The second part of this section reviews recent evidence on how the new entry could impact the existing competition between Boeing and Airbus.

a. The Evolution of the Conflict

The Airbus A-380 has been controversial since its inception. As discussed in the introduction to the paper, the US and the EU disagreed from the beginning whether the market for a superjumbo is big enough to justify the immense development costs and whether Airbus could launch the project without government support. Moreover, Airbus began marketing the A-380 soon after the 1999 WTO ruling that Foreign Sales Corporations constitute export subsidies and are prohibited by Article 3 of the WTO subsidy agreement (WTO, 2000c).[10] This ruling was a significant setback for Boeing, which is one of the main beneficiaries of the Foreign Sales Corporation tax laws. For example, in 1998, Boeing saved $150 million in taxes because it was able to exempt 15 per cent of its gross income from exporting sales that occurred through Foreign Sales Corporations (*The Economist*, 2000). This has further escalated the tensions between the US and the EU. At the US–EU summit in December 2000, former President Clinton warned the EU that A-380 financing might provoke a new trade war.

The US questions whether EU financing of the A-380 development costs complies with the 1992 agreement and the 1994 WTO subsidy agreement. Although funding details are not publicly available, the EU submitted information on the financing arrangement to the US in April 2001 (European Commission, 2001). Seven European governments have provided financial support to the project (France, Germany, the UK, Belgium, Spain, the Netherlands and Finland). Italy and Sweden may provide some funding in the future. The financing is in the form of a repayable loan with an interest rate that reflects the government cost of

[9] The A-380 can carry 550 passengers and can fly over 14,000 km. In comparison, the Boeing 747 can carry about 420 passengers and can fly around 13,000 km.

[10] The US appealed the ruling, but the Appellate Body upheld the initial finding in March 2000 (WTO, 2001).

borrowing plus 0.25 per cent. Airbus needs to repay the loan within 17 years. Although the Commission did not reveal the exact amount of the loan to the press, government funding does not exceed 33 per cent of development costs. These borrowing terms comply with Article 4 of the 1992 agreement on direct support. However, the agreement allows governments to fund only projects that are expected to repay the loan within 17 years. EU officials insist that the project is commercially viable and that the assistance should be thus viewed as a repayable loan, but the US is hesitant. US trade officials argue that the financing constitutes a subsidy because the terms of the funding do not reflect the commercial risk of the project. As a result, the financing does not adhere to the 1994 WTO subsidy agreement that according to the US takes precedence over the 1992 agreement.

The WTO subsidy agreement restricts government financing of domestic firms and spells out the mechanisms through which disputes that result from non-compliance with subsidy rules can be resolved among the member countries.[11] Article 3 of the agreement directly prohibits export subsidies and import-substitution subsidies. The WTO subsidy provisions have been applied previously to resolve a trade dispute between Brazil and Canada in the regional jet segment of the aircraft market (WTO, 2000c). Brazilian firm Embraer and Canadian Bombardier are major world suppliers of regional jets. The dispute was initiated in 1996, when Canada challenged the legitimacy of the Brazilian PROEX programme under the WTO subsidy agreement. The PROEX programme is a government export promotion scheme that provides interest rate subsidies to foreign consumers that purchase Brazilian goods, in this case the Embraer's regional jets. In 1999, the WTO ruled that Canada and Brazil both provided government support that amounted to export subsidies to their domestic regional jet producers. The WTO asked both parties to change their export subsidy programmes to comply with Article 3 of the WTO subsidy agreement. Canada has abided by the ruling, but the amended Brazilian export-financing scheme still violates WTO rules. As a result, the WTO approved Canadian sanctions on Brazilian imports amounting to $233.5 million per year over six years (WTO, 2000b).

A WTO inquiry into EU financing of the A-380 might be more complicated, because the government support is not in the form of an export subsidy and thus is not directly prohibited by the WTO subsidy agreement. However, other forms of government support can be challenged by the WTO. The WTO rules require that governments only extend loans to projects under conditions that are in line with the practices of private investors in a country. That is, the development financing and its terms must be governed by the commercial viability of the project. US officials contend that since the repayment of the loan for the A-380 project is based on per-plane sales, Airbus does not have any financial liability to the European government if it does sell a sufficient number of A-380s. The EU

[11] See WTO (2000a) for details.

government then bears all commercial risk of the project. This form of government subsidy can be illegal under WTO rules if it is targeted to a specific industry or firm (i.e. specific subsidies as defined by Article 2 of the WTO subsidy agreement). The US believes that EU support for the A-380 falls into this category.

The commercial viability of the A-380 project plays a central role in this dispute. Industry experts disagree in their predictions about the commercial success of the A-380. Ever since the failed EU–US cooperation on the superjumbo, Boeing has claimed that the market for such aircraft is very limited and that the A-380 will create overcapacity, airline losses, and not cover the $12 billion development costs (*The Economist*, 2000). Instead, the Boeing has offered a stretch version of the Boeing 747 to satisfy the limited market that the A-380 intends to capture. Boeing's view has been supported by some industry observers (Brelis, 2001). Yet, many others claim that the Airbus A-380 is exactly what the market needs. Perhaps the airline responses are the most telling: Airbus has received promises for over 60 orders for the A-380 by April 2001, though at discounts up to 35 per cent off the list price. In contrast, Boeing failed to receive any orders for the stretch version of 747 by March 2001, so it cancelled the project. Given that the final outcome of the trade dispute is still uncertain and that the new aircraft do not enter the market until 2006, it is important to evaluate the impact that the A-380 entry might have on other aircraft, in particular Boeing planes.

b. The Impact of the A-380 Entry on Other Wide-body Aircraft

In this section, I evaluate the implications that the entry of the A-380 will have on the market share and price of other wide-body aircraft. Recent work by Irwin and Pavcnik (2001) uses detailed product-level data on annual aircraft prices, sales, and aircraft characteristics from 1969 through 1998 to estimate a structural model of demand and supply in the wide-body aircraft market. On the demand side, the model accounts for product differentiation, strong market segmentation between narrow- and wide-body aircraft, and market segmentation between medium-range and long-range wide-body planes.[12] The consumer choice model yields a market share of an aircraft as a function of its characteristics and price, and the price and characteristics of competing planes. The demand estimation also provides estimates of own- and cross-price elasticities used in the simulations. On the supply side, the model assumes that firms compete in prices, and it allows for multi-product firms.[13] A firm's profit-maximising behaviour yields an equilibrium

[12] They estimate a discrete choice, differentiated products demand system using methodology from Berry (1994).

[13] In the original work, the model is also estimated assuming that firms compete in quantities. During the 1990s, the two assumptions yield increasingly similar findings.

pricing relationship, where a product's price is a function of a product's marginal cost and a markup that the firm can charge over marginal cost.[14] The empirical work provides structural estimates of demand and supply parameters. Irwin and Pavcnik (2001) use this estimated structural model to simulate the effects that the A-380 entry will have on the market share and pricing of other wide-body planes. In this section, I summarise the main findings.

Table 3 presents a summary of simulation results.[15] Column 1 of the table shows the average prices and the market share held by Boeing and Airbus before the A-380 entry. These data correspond to the market equilibrium in 1998, the last year of data available in Irwin and Pavcnik (2001). Other columns depict the market equilibrium after the A-380 entry (i.e. prices and market shares), when the A-380 is sold at list price, at a 20 per cent discount, and at a 30 per cent discount. These discounts are in line with the initial price discounts of up to 35 per cent off the $235 million list price reported in the press. The top part of the table shows average equilibrium prices of long-range and medium-range wide-body aircraft sold by Boeing and Airbus under different A-380 pricing scenarios. The middle part of the table reports the simulated market share of long-range and medium-range wide-body aircraft in the total aircraft market (wide-body and narrow-body combined). The bottom part of the table reports the market share of Airbus and Boeing within medium-range and long-range wide-body market segment. All columns also report the percentage change in the respective variables relative to the no A-380 entry case.

Prior to the A-380 entry (column 1), long-range Boeing aircraft (747, 777, and MD-11) sell on average for $118.7 million, and they account for 18 per cent of the overall aircraft market and 75 per cent of the long-range wide-body market segment. The existing long-range Airbus planes (A-330 and A-340) are sold on average at $109 million and account for six per cent of the overall market and 25 per cent of the long-range wide-body market segment. Narrow-body planes, the outside good in the simulations, account for 69 per cent of the overall market.[16] When the A-380 is sold at a 20 per cent discount, the A-380 gains 2.2 per cent of the overall annual market (which translates into 17 aircraft), and 8.9 per cent of the market within the long-range market segment. The comparison of the results across various pricing options for the A-380 reveals the importance of price discounts in securing a higher market share for the A-380. While Airbus is only able to sell about four A-380s per year at the list price (corresponding to 0.6 per

[14] The markup depends on own- and cross-price elasticities of products.

[15] Although simulations yield equilibrium market share and price for each existing aircraft, Table 3 aggregates the predictions over Boeing and Airbus aircraft for the sake of brevity. See Irwin and Pavcnik (2001) for aircraft-specific predictions.

[16] Narrow-body aircraft is an imperfect substitute for wide-body aircraft. Without the inclusion of the outside good in the model, a simultaneous increase in prices of all wide-body aircraft would not change the total demand for the wide-body aircraft.

TABLE 3
The Effect of A-380 Entry on Existing Wide-body Aircraft

	No Entry	*List Price*		*20% Discount*		*30% Discount*	
	Actual	*Simulated*	*% Change*	*Simulated*	*% Change*	*Simulated*	*% Change*
Price (million 1995 $)							
Long Range							
Boeing Aircraft	118.7	118.1	−0.5	116.5	−1.9	114.7	−3.5
Airbus Aircraft	109.2	109.1	−0.2	108.6	−0.6	108.2	−1.0
Medium Range							
Boeing Aircraft	75.3	75.2	−0.2	74.9	−0.6	74.5	−1.1
Airbus Aircraft	75.0	75.0	−0.1	74.9	−0.2	74.7	−0.4
Market Share							
Long Range							
A-380		0.006		0.022		0.043	
Boeing Aircraft	0.1764	0.1760	−0.2	0.1744	−1.1	0.1718	−2.6
Airbus Aircraft	0.0597	0.0587	−1.6	0.0558	−6.3	0.0527	−11.6
Medium Range							
Boeing Aircraft	0.0596	0.0594	−0.3	0.0589	−1.3	0.0581	−2.5
Airbus Aircraft	0.0178	0.0177	−0.6	0.0173	−2.3	0.0170	−4.3
Outside good	0.6865	0.6826	−0.6	0.6711	−2.2	0.6576	−4.2
Market Share within each Wide-body Market Segment							
Long Range							
A-380		0.023		0.089		0.160	
Boeing Aircraft	0.747	0.732	−2.0	0.690	−7.6	0.643	−14.0
Airbus Aircraft	0.253	0.244	−3.4	0.221	−12.5	0.197	−21.9
Medium Range							
Boeing Aircraft	0.771	0.7709	0.1	0.7722	0.2	0.7737	0.4
Airbus Aircraft	0.230	0.229	−0.2	0.228	−0.7	0.226	−1.4
Total Effect							
Number of A-380 sold		4.4		17.6		33.7	
Decline in sales of LR aircraft		1.1		4.5		9.0	
Decline in sales of MR aircraft		0.2		0.9		1.8	
Decline in sales of outside good		3.1		12.1		22.8	

Notes:
The table is adopted from Irwin and Pavcnik (2001). The reported percentage changes are relative to the base of no A-380 entry reported in column 1. The outside good consists of all narrow-body planes.

cent market share in the overall market), the annual sales of the A-380 increase to 34 planes at a 30 per cent discount (4.3 per cent market share). Although the large initial price discounts might be a good strategy for Airbus to secure sufficient initial orders to exploit its learning curve, Airbus might not be able to continue to sell the plane at the reported discounts in the future if it wants to recoup its development costs.

Let us focus on the simulation when the A-380 is sold at a 20 per cent discount to highlight some other results. First, due to strong market segmentation between the medium-range and the long-range wide-body market, the A-380 entry affects the long-range Boeing products such as the 747 much more than the medium-range aircraft such as the 767. Boeing's long-range aircraft lower their prices by approximately two per cent to protect their market share after the A-380 entry, while the price of Boeing's medium-range plane declines by only 0.6 per cent. This reflects that the A-380 is a much closer substitute in demand for aircraft such as the 747 than the 767. The bottom part of the table shows that the entry of the A-380 translates into the total annual loss of 4.5 sales by the existing long-range varieties and a total annual loss of one sale by the existing medium-range wide body varieties.[17]

Second, the simulations in Table 3 illustrate the risk that multi-product firms such as Airbus face when introducing new models. If a multi-product firm offers products that are relatively close substitutes, the firm needs to consider the effect that the introduction of a product will have on its existing sales. For example, when Airbus introduces the A-380, the entry not only reduces the market share of Boeing's products, but might also undercut the sales of Airbus's other long-range wide-bodies. Table 3 indicates that the A-380 entry substantially undercuts the demand for Airbus's existing long-range wide bodies, the A-330 and the A-340. While the market share of Boeing's long-range wide-body planes declines on average by 1.1 per cent, the Airbus's long-range wide-body aircraft experience on average a 6.3 per cent drop in their market share in the overall aircraft market. Nevertheless, the overall market share of Airbus still increases at Boeing's expense, especially in the long-range wide-body market that has been dominated by the 747. Industry sources indicate that the Boeing 747 accounts for a substantial portion of Boeing's profits. Hence, the subsidised entry of the A-380 may have a significant negative impact on the US producer and lead to future conflicts in US–EU trade relations.

Finally, the question obviously arises whether Airbus can sell enough A-380s at relatively high prices to recoup its development and production costs. Let us consider the predictions of simulations, where Airbus sells the A-380 at a 30 per cent discount off its $230 million list price. Without additional growth in demand, this yields 34 annual sales, amounting to 680 planes sold and $110 billion in revenues over the next 20 years (ignoring discounting). These figures suggest that the A-380 will likely cover its development costs (estimated to be $12 billion), and that Airbus might be able to repay government loans. However, the estimates fall short of Airbus's forecast that the airlines will demand 1,500 superjumbos over the next 20 years, yielding around $345 billion in revenues. In fact, the

[17] The large overall decline of sales of the outside good (narrow-body aircraft) is due to the fact that this segment accounts for 68 per cent of the overall market.

simulated number of total sales is closer to Boeing's predictions that market will only demand around 700 superjumbos overall. According to Boeing, these sales are insufficient for the project to eventually become profitable.

5. CONCLUSIONS

This paper overviews the trade dispute between the US and the EU in the aircraft industry triggered by the 2006 market entry of the Airbus superjumbo, the A-380. The dispute provides an interesting case study.

To begin with, the EU and US trade officials disagree whether the bilateral 1992 US–EU agreement on trade in civil aircraft or the multilateral 1994 WTO subsidy agreement should be used to evaluate the legitimacy of the EU financing of the A-380. While the financing appears legitimate under the 1992 agreement, it might be questionable under the WTO subsidy rules. However, at this point, it is unclear how the dispute will be resolved. The two sides have been exchanging threats of retaliatory actions. For example, the European Commission has threatened to contest Boeing's contracts with NASA and the US Defense Department, if the US pursues the Airbus A-380 financing with the WTO. If this government-funded research and development lowers Boeing's cost of producing commercial aircraft, these contracts constitute indirect support under the 1992 agreement. The EU claims that this indirect support amounted to 7.5 per cent of Boeing's annual sales in 1998 (Agence France Presse, 2001). This violates Article 5 of the 1992 agreement, which limits such support to four per cent of the Boeing's annual sales.

The costs of an escalated trade conflict would be substantial. Both producers rely heavily on each other's markets for consumers. According to the data published by the Airline Monitor, the US-based airlines still account for 40 per cent of Boeing's active fleet, but 20 per cent of Boeing's active fleet is in the European market. Similarly, although Airbus still sells most of its aircraft to Europe (33 per cent of its active fleet resides there), it has become more dependent on US airlines for sales over time (16 per cent of its active fleet is in the US). This reliance on foreign markets might divert a trade conflict as it has deterred US producers from filing countervailing-duty petitions in the past. Further, the retaliatory costs are even bigger when one considers that Airbus and Boeing rely on subcontractors in the rival country for parts and components. *The Economist* suggests that the two industries account for 100,000 jobs in the rival territory and spend about $5 billion per year buying parts, components, and services from each other (*The Economist*, 2000). Trade officials are aware of these costs and are hesitant to make the first move. For example, after voicing retaliatory threats in April 2001, a spokesman for the European Commission concluded that 'certainly we won't be the ones to cast the first stone' (Geitner, 2001).

Given that the final outcome of the dispute is still uncertain and that the new aircraft will enter the market only in 2006, this paper also considers the impact that the A-380 might have on other wide-body planes. The simulations suggest that the entry will be harmful for Boeing, but that it will actually reduce the market share of the existing Airbus products by more. This indicates that the presence of multi-product firms makes it more challenging for companies to successfully introduce a new aircraft without hurting their existing product line. Moreover, our simulations imply that during the next 20 years, Airbus will receive substantially fewer orders for the A-380 than originally anticipated. The estimates suggest that while the A-380 project is likely to cover its development costs, it is less likely to actually earn profits.

Finally, a significant amount of information on product characteristics, sales, prices, combined with strong assumptions on firm conduct and demand are required to estimate the demand and supply parameters that can be used to evaluate the implications of various trade policy options aimed at promoting the domestic aircraft firms. While the aircraft industry consists of only two major players, many of its other characteristics such as multi-product firms, market segmentation, and large dynamic economies of scale complicate trade policy analysis. Thus, although the Brazilian, Canadian, EU, and US governments continue to promote their domestic producers with both direct and indirect means, Krugman's (1987) caution about the usefulness of strategic trade policy to increase national welfare is well warranted in this case.

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