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The Influence on Resale Prices of Labor Management Disputes in Aircraft Manufacturing

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Introduction

The prospect of being 40,000 feet off the ground in an aircraft manufactured by disgruntled or replacement workers may be unsettling to some, whether or not the quality of the aircraft has actually been affected. Quality campaigns have long played a significant role both in attempts to align employee and management interests, and in consumer marketing. Consumers may respond to a variety of quality concerns, including those triggered by labor unrest or strikes. We analyze the influence of labor-management disputes on the perceived quality of commercial jet aircraft reflected in resale prices.

Background

Strikes impose significant costs on both labor and management. Direct costs that have been measured in aircraft manufacturing generally include lost productivity and revenue (Kleiner, Leonard, and Pilarski, 2002). To raise safety concerns about the product or service during a strike is common in health-care, but rare in manufacturing (Gruber and Kleiner, 2012). In part, this may be because once provoked, the fear is more difficult to assuage and delimit in manufacturing than in services where output produced by replacement workers is easier to identify. It is obvious when a hospital seeks to continue providing services during a strike. The scope for spillover outside the period of a strike is potentially greater in manufacturing where safety concerns can persist among passengers who are not in a position to know the date their aircraft was produced until they are boarding, if ever. Although unleashing reputational damage that can outlive a strike is a double-edged sword, this has not precluded use of the tactic. Bob Berghoff, at the time leader of UAW Local 148 at Douglas Aircraft, said during a prolonged

1986 labor dispute "We do not believe that any sane customer would knowingly accept a plane without normal inspectors and flight-ramp workers on the line" (Associated Press, 1986).

Set against the fear that statement sought to provoke is an extensive set of quality control measures implemented by at least three independent parties. In addition to the manufacturer's own quality control, quality standards for process and product are imposed by regulation and enforced by government inspectors under the Federal Aviation Administration and European Aviation Safety Administration. A third set of eyes is provided by customers who can also monitor production quality in the plant. As one experienced firm offering this service states "The early detection, documentation and rectification of production defects enhances reliability in later operation and ultimately adds to the value retention of the aircraft. Experience shows that it is sensible to supplement the manufacturer's own quality control system by an independent service which is tailored to the quality requirements of the particular aircraft buyer or future operator concerned." (Lufthansa Technik, 2013). As this statement suggests, aircraft purchasers have quality concerns that go beyond the safety and airworthiness rules enforced by government regulation, and these concerns may affect resale prices.

Although few in number, studies in other industries have shown that labor-management disputes can affect both product quality and the resale or residual values. How far these results might generalize is not yet known. The two most compelling studies of the impact of labor disputes on product quality are by Krueger and Mas (2004), and by Mas (2008). Krueger and Mas find that a long, contentious strike and the hiring of replacement workers at Bridgestone/Firestone's Decatur plant in the mid-1990s contributed to the production of defective tires, particularly around the time concessions were demanded and in the especially charged environment when replacement workers and returning strikers worked side by side. To

discover a significant effect of the size estimated by Krueger and Mas requires a large sample for statistical power. Isolated consumers would have difficulty uncovering this source of quality variation. Mas's investigation of the resale prices of construction equipment is closest to ours. Using data on the resale prices of Caterpillar tractors, Mas finds that resale market participants significantly discounted machines produced in Caterpillar factories affected by contract disputes by about five percent. Equipment produced in facilities undergoing unrest was also resold more often and received worse appraisal reports. Evidence that labor disputes affect quality extends beyond manufacturing productivity. In a related paper, Mas reports evidence from the public service sector showing that police officers dissatisfied with labor arbitration decisions perform worse. In the months after New Jersey police officers lost in arbitration, arrest rates and average sentence length declined and crime reports rose relative to when they won. Earlier work in industrial relations also was concerned with the impact of labor relations on product quality. Surveying manufacturing plant managers, Cooke (1992) reports that among unionized firms, those with jointly administered employee participation programs achieved significantly greater improvements in product quality than did those with more traditional, adversarial collective bargaining relationships.

Product quality is a product of skill, effort, and the firm's ability to monitor employee performance. Poorly motivated or disgruntled workers may reduce effort in ways that are difficult to monitor. Firms that continue to produce during strikes typically must rely on less skilled and less experienced replacement workers. Labor management disputes might affect resale values either by reducing product quality, or by preying upon the fear of reduced quality. Some sense of the possible magnitude of fear can be gained from the analysis of the extreme case of fatal crashes.

Commercial aircraft manufacturing is distinctive both in the degree of public attention drawn by any unexpected encounter of its products with terrain, and by the extent of regulation. The former helps drive demand for the latter. Consumer demand for safety contributes to strict government, manufacturer, and airline safety standards. The channels through which labor disputes might affect resale prices go through both quality control mechanisms and passenger perceptions. The manufacturers and operators of commercial aircraft in most of the world have admirable safety records, but the rare fatalities draw pervasive and intense publicity. The front page of the New York Times during a one year period beginning October 1988 featured 138 stories per thousand US deaths in commercial aviation. This is orders of magnitude greater than coverage of fatalities from cancer (.04 per thousand), homicides (1.7 per thousand) or automobiles (.08 per thousand), all of which account for a greater number of deaths (Barnett, 1990).

If there were little financial impact of these extreme and extremely well publicized events on the airframe makers, then one might expect air travelers to impose lesser penalties for lesser quality concerns. Note, airlines might still discount aircraft with high maintenance costs not visible to passengers. Results from event studies of the impact of crashes on manufacturers focus on two accidents which originally raised concerns of manufacturing or design defects: a Chicago DC-10 crash claiming 271 lives in 1979, the worst domestic U.S. airline accident, and a Sioux City DC-10 crash in 1989 (Barnett and LoFaso, 1983; Chalk, 1986; Karels, 1989; Barnett, Menighetti, and Prete, 1990). The market capitalization of the DC-10's manufacturer, McDonnell Douglas, fell by about 10 percent in the first four days after the 1979 accident, and by an additional 10 percent when the FAA took the unprecedented step of suspending the DC-10 series aircraft's type certificate, and so grounding the entire DC-10 fleet. Most of this loss in

market value was recovered as evidence surfaced that the crash was due to improper airline maintenance. (Chalk 1986, Karels, 1989). Reviewing this literature, Rose (1992) finds that “Responses to the 1979 DC-10 crash are not representative of the impact of other accidents”, and that Chalk’s (1987) attempt to generalize using a broader sample of 19 accidents is likely skewed by the extreme impact of the 1979 crash and subsequent decertification. Manufacturers carry full liability insurance, so a decline in their equity value would reflect increased premiums and decreased future demand. In their examination of airlines, Borenstein and Zimmerman (1988) find insignificant demand effects in the regulated period, and weakly significant reductions after airline deregulation.

Less dramatically, airlines are also affected by aircraft reliability, durability, and maintenance costs, all of which should factor into resale prices. If planes produced during labor disputes suffer from quality problems requiring extra maintenance that surface over time but are not apparent on delivery, this should reduce their resale value- the basis for our empirical test.

Data

Aircraft resale prices are collected by Avitas, Inc., and are viewed as reliable by clients who pay for this data and view it as the “Blue Book” for used aircraft. Avitas collects this data from a variety of sources and thinks it is representative of the market. The Avitas data does sometimes serve as a basis for establishing loan collateral by financial institutions.

All prices refer to an aircraft together with the requisite number of engines. Spare parts included in such deals are not separately accounted. Buyers typically have access to a variety of quality information; including FAA (or their foreign counterparts) records of required maintenance and incident history, engine and aircraft cycle time and hours, and FAA

airworthiness directives. Avitas does not adjust transaction prices for aircraft quality. The initial sales prices of commercial aircraft are trade secrets - discounted from list and not often disclosed. Initial sales prices are estimated by Avitas from transaction data and other sources using proprietary methods. These estimates are highly correlated with data from actual resale transactions of aircraft less than a year old. Avitas does not factor production during a labor dispute into its estimate of initial sales price so, by construction, the impact of labor disputes cannot be capitalized into initial sales prices used here.

For the models studied here, Avitas has data on 1731 single-aisle and 448 twin aisle resale transactions. Prices have been adjusted for inflation using estimates provided by the Royal Bank of Scotland, who uses proprietary inflation data based on the estimates from a few leading aircraft appraisers.

Aircraft resold multiple times may appear in the data more than once. The data includes observed prices of aircraft produced by Airbus, Boeing, BAe, Douglas (including McDonnell-Douglas), Lockheed, and Fokker.

Model

By definition, the depreciation rate of an asset gives today's value as a function of an initial value and elapsed time.

$$(1) \quad V_t = V_0 * D^t$$

Rearranging terms and taking logarithms yields the standard depreciation formula,

$$(2) \quad \ln(V_t/V_0) = t \ln(D)$$

Where D is 1 minus the annual depreciation rate, and t is elapsed time. Measuring from the date of initial sales, t is age. We stratify by age and whether the aircraft is single or twin aisle. The empirical question is whether aircraft manufactured during labor disputes depreciate more than others.

Labor-Management Dispute Timing

Labor-Management disputes could affect quality both before and after the formal period of the dispute. Commercial aircraft take months to assemble, so some aircraft delivered after the end of a dispute will have been in process during the dispute. Strikes usually occur after a period of smoldering discontent. If this affects quality, some aircraft delivered before the beginning of a strike will also be affected. Ill will can also survive the formal end of a strike, possibly having an adverse effect on quality even after a strike ends. To capture these cases, we employ a three months window before and after the formal period of a strike or labor dispute. Narrowing this window down to the strike dates does not materially affect the results.

Both strikes and a slowdown are included here. The strikes are the IAM strikes at Boeing in 1965 (19 days), 1977 (45 days), 1989 (48 days), 1995 (69 days), 2005 (28 days) and 2008 (58 days); the UAW strike at McDonnell-Douglas in 1975 (93 days), and the UAW Slowdown at Douglas in 1986 and 1987 (296 days).

Results

Aircraft resale prices are not affected by labor-management disputes at the time of manufacture. We can estimate aircraft depreciation rates with some precision. Table 1 presents an analysis of variance of aircraft depreciation by strike status and the age for the plane. Due to financial agreements with lenders rather than the final purchaser of the planes that was the case

for many transactions less than one year old we deleted those observations. In Table One we show the F-statistics developed from regressions where we take out the model specific means in depreciation rates. We find that for all planes that were older than one year the F-value from the Anova was .22 in row one. Using the same procedure for planes older than one year, but less than 10 years old the F-value was .08, and for those planes older than 10 years, the F-value was .90. In none of these cases was the F-value from the Anova statistically significant. The estimates fail to reject the hypothesis that depreciation rates are the same whether or not a plane is produced during a labor dispute. The rate at which resale prices decline does not differ significantly for planes built during strikes.

The data for the planes in our sample includes both strikes and labor slow-downs such as work-to-rule. Results are similar in both cases. We also narrowed the potential labor disruption period from a three month window before and after the formal strike period down to the period on strike and again find similar results. Overall, our estimates are consistent in showing no significant evidence that labor-management disputes affect the resale value of commercial aircraft.

Conclusion

Aircraft are manufactured with unusual attention to quality control. The pride in their product common in this industry limits the potential for Lordstown style disgruntled employee sabotage documented in the auto industry (Cimini, Behrmann and Johnson, 1993). A loose bolt that rattles inside an automobile's door frame is of a different magnitude than one that threatens the integrity of an aircraft. On top of the incentives to build quality in, aircraft are manufactured under multiple overlapping levels of quality control: by the manufacturer, by the buyer, and by

the FAA. This oversight extends from design, to parts, to assembly, to maintenance. Both the market incentives and the extensive regulatory oversight limit the scope for labor disputes to affect quality.

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Table 1

Analysis of Variance of the Influence of Strikes on the Depreciation of Commercial Air Craft*

	F statistic for all planes more than one year old	F-statistic for planes greater than 1 but less than 10 years old	F-statistic for planes greater than 10 years old
Single and Twin Aisle Planes, N=1,028	.22	.08	.90

Estimated from a regression of the residual value of the plane on strike activity with type of plane and the model number of the plane

*statistically significant at the 5% level