How Labor–Management Disputes Influence Commercial Aircraft Manufacturing

The Cost of Upstream Strikes

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Abstract

Modern management practices stress the importance of removing buffer stocks and reducing parts inventories in pursuit of lean manufacturing. These techniques can increase exposure to upstream disruptions. We examine the impact of a major IAM aerospace strike on productivity downstream at an aircraft manufacturing plant primarily represented by the non-striking UAW. This event seeded a split both between the unions and within the UAW local, with long-term repercussions. Mass layoffs began downstream 26 days after the upstream strike. Downstream assembly costs increased by 47% during the strike and remained elevated for months.

The propagation of shocks underlies much of macroeconomics. On a micro-level the propagation of shocks across firms in a supply chain depends on both the technology of production and a series of management choices. The result determines the extent to which the parties to a labor dispute impose production externalities on other firms. Using detailed production data from within a major company, we examine the impact of a major IAM (International Association of Machinists & Aerospace Workers) aerospace strike at a parts plant on productivity downstream at an aircraft manufacturing plant primarily represented by the non-striking UAW (United Automobile, Aerospace and Agricultural Implement Workers). This event seeded a split both between the unions and within the UAW local, with long-term repercussions. More immediately, for months the downstream plant suffered higher production costs.

In examining what happens when a strike impacts an upstream supply plant, we first ask how quickly the shock propagates downstream, which depends on the degree of parts specialization and excess capacity among alternative suppliers with the requisite skills. The problem is worse in aerospace with highly specialized and customized parts, stringent quality demands and long backlogs. The ability to substitute to other suppliers is also limited in this industry by the FAA requirement that suppliers also be certified by the FAA. These factors combine to increase exposure to upstream labor disputes. The speed of propagation also depends on the level of intermediate-good inventories, which is endogenous to expected shocks. The smaller the parts inventory, the faster the dominos fall. We then examine the costs imposed downstream, both from disrupted work-flow and in this case, from destabilized labor relations. While our focus here is on downstream impacts, suppliers further upstream will also feel the impact as the supply-chain backs-up.

It is useful to think about risk propagation in terms of insurance. Consider a downstream manufacturer of a final product who contracts with an upstream supplier for a part. If the part is a commodity and transactions costs are small, then the downstream firm faces no idiosyncratic risk

from the supplier. By definition, any commodity supplier is easily replaced. In this case, the existence of a competitive undifferentiated supplier market fully insures downstream parties against the failure of any one supplier. The situation becomes more interesting with parts that require relationship specific investments. These customized parts cannot be procured in the market without transactions costs, time, and specialized investments.

Specialization creates exposure to idiosyncratic risk which the downstream firm can manage in a variety of ways. Sole sourcing is common for specialized aerospace parts. By paying an insurance premium represented by the cost of duplicating the transactions costs, the fixed-costs, and the lost economies of scale of part production, the downstream firm can dual or multiple source. In a classic case of supply chain disruption, a fire in 2000 snarled production at a Philips chip plant that supplied both Ericsson and its rival Nokia. Ericsson had previously decided to simplify its supply chain and sole source major components. In the aftermath of the supplier fire, Ericsson lost substantial profits and market share. In contrast, Nokia had developed alternative supplies which allowed it to weather the supply disruption better than did Ericsson (Tang 2006).

Alternatively, the firm can self-insure. One method of doing this is to invest in holding buffer stocks of the part, or of work in process. This form of insurance is exactly what the widely adopted technique of just in time production, JIT, seeks to strip away. JIT is commonly thought of as benefiting the firm by reducing costs by systematically reducing excess buffer stocks of parts and work in process. On a deeper level it forces continuous improvement by stressing the production and supply process to pro-actively uncover weaknesses. These are substantial and important benefits. However, this is essentially an inward focused appraisal, often with little regard for external supply risks. A balanced evaluation requires not just counting cost savings, but also asking what happens when the system is disrupted. By stripping away buffer stocks, JIT reduces insurance against upstream supply shocks and exposes the firm to greater risk. The 2012 earthquake in Japan disrupted downstream manufacturers around the world who in many cases had no alternative source of supply. The 1997 UPS strike similarly cut off many firms from their suppliers. In each case downstream firms that had most diligently stripped out buffer stocks were left exposed. JIT trades off this increased risk exposure in return for static and dynamic cost reduction.

An alternative method is to attempt to reduce the risk by managing it directly. Vertical integration brings the supply risk inside the firm. The terms of the tradeoff depend on the downstream firm's relative expertise in managing the upstream function, and whether this outweighs the loss of market discipline on the supply function brought inside the downstream firm.

The extent of vertical integration is also affected by considerations of US labor law, which treats the internal and external supplier cases distinctly differently. Free markets offer no special protection to a unionized supplier. Bring that supply plant inside the firm and the law restricts shutting down the plant or reallocating work because of anti-union sentiment, a recent issue at Boeing.

More generally, the law sets few limits on collateral damage imposed on firms upstream or downstream of a struck firm. Unions such as the Teamsters, in the transportation and logistics industries, have been instrumental in extending this leverage. A rarely invoked Taft-Hartley provision allows the President to seek to have the courts enjoin a strike that affects an entire industry or a substantial part thereof, and that imperils the national health or safety. This was last used (for first time in 24 years) in the West Coast ports dispute of 2002, and previously in aircraft engine, coal, and steel disputes that were seen to threaten the nation's economy or security. With these rare exceptions, ripple effects are implicitly accepted as part of strike leverage. However, they have not been well measured at the micro-level.

The Commercial Aircraft Manufacturing Industry

Vertical integration in the aircraft industry peaked before the Air Mail Act of 1934 forced the breakup of aviation holding companies which had formerly combined airlines with the manufacturers of aircraft and their engines. Aircraft manufacturers typically outsource a set of discrete components that require distinctive specialized skills: engines, avionics, communications, environmental controls, brakes and landing gear chief among them. They also sometimes outsource some fuselage, wing, and empennage (tail section) fabrication. For example, Dehavilland of Canada initially built the DC-9's wings and Northrop has built major portions of the 747 fuselage. In the past decade, the two largest makers of commercial aircraft, Boeing and Airbus, have each pursued a policy of disintermediation which would leave a greater share not just of manufacturing, but also of some component design in the hands of suppliers. At Boeing this policy reached an ill-fated peak with the 787. Less well known, Airbus followed a similar policy with its Power 8 program to spin off some component plants to independent suppliers.

This increase in outsourcing has been driven by attempts to reduce costs, share risks, engage supplier expertise, win orders with implicit offsets, avoid high labor costs and union leverage, collect subsidies, and induce more competition in the supply chain.

Companies that have had to bet the company on a multi-billion investment in a new aircraft have also been attracted by the prospect of sharing and shifting some of this investment risk onto suppliers. Outsourcing is sometimes seen as a way of shedding and diversifying risk. However, the simplest model of diversification that made the idea of risk-sharing attractive is a mirage. Diversification only works if risks are uncorrelated, as in parallel production of independent products. Aircraft only fly with all their major parts. This has the risk characteristics of serial, not parallel production, in the sense that one broken link grounds the plane. By increasing outsourcing to plants not under their direct management, both Boeing and Airbus have now systematically increased their exposure to the weakest-link in their supply chains.

Those links sometimes break. Parts shortages in this industry have led to cascade failures that have immobilized entire plants and reshaped the industry. Douglas Aircraft would attribute its (forced) merger into McDonnell-Douglas to a parts shortage. As the Vietnam War began to build, military demand for aviation parts increased. In 1966, Douglas fell behind delivering early model DC-9s. As costs and delays spiraled out of control, Douglas was pushed by its creditors into a merger with McDonnell. McDonnell-Douglas would later claim in court that the main cause of delays in the early years of DC-9 production were supply shortages exacerbated by the Vietnam War buildup - factors that were disputed at court [Eastern Airlines, Inc. v. McDonnell-Douglas Corporation (532 F.2d 957)].

Previous work has shown that even transient and less dramatic parts shortages adversely and significantly affect aircraft production costs (Kleiner, Nickelburg, and Pilarski 2011). Parts shortages disrupt the flow of production. Planes produced out of sequence or planes delivered later than their peers have higher costs. (Leonard and Pilarski 2012).

Aerospace unions have long understood how to use this supply chain leverage. In 1971, the aerospace bargaining round took place under wage and price controls that sought to cap wage increases and which effectively limited union leverage in the US (Budd 1994, Shabecoff 1972). The UAW under Leonard Woodcock's leadership crafted a creative strategy that would starve Douglas without engaging in a US strike. Planes don't go far without wings, and the wings for the DC-10 were produced by McDonnell Douglas' plant in Malton, Canada - beyond the reach of US Executive Orders. The Malton UAW local 1967 obliged with a strike. As wingless DC-10 fuselages began to stack up, McDonnell Douglas laid off 1,500 at its Long Beach final assembly plant. (Wright 1971).

McDonnell-Douglas became more forthcoming in collective bargaining, offering terms the US UAW accepted. Malton however slipped the leash, refusing to settle on the prior automotive pattern. 30,000 Long Beach UAW workers were threatened with layoffs (New York Times, December 11, 1971). Threatening the Canadian local with loss of strike benefits, Woodcock then forced Malton to settle in order to preserve UAW jobs downstream. Highly specialized parts and production limit the ability to flexibly source, even within a single firm.

The Douglas Aircraft Case

The Douglas Long Beach plant was among the largest in the country, by itself accounting in 1968 for about 2% of the value of U.S. export goods, and about 1% of U.S. durable goods revenue. The plant's major commercial products were the DC-9 and later the DC-10. We focus here on detailed company production records of the DC-9 between 1965 and 1976. These are corporate records of labor hours required for final assembly, as recorded by the Douglas Division of McDonnell-Douglas for the first 836 DC-9s assembled in Long Beach, California. DC-9 production continued after this period but records shifted to a different system I do not have access to.

The Douglas Aircraft division had dual unions. In 1975 Long Beach employed about 12,000 workers represented by UAW Local 148, and 155 flight-line workers represented by IAM District 720. Major sub-assemblies and parts for the DC-9 were produced upstream at Douglas' Torrance parts plant, which was represented by IAM District 720. District 720 also represented Douglas workers at its Santa Monica plant which also fed parts to Long Beach (The Machinist, March 13, 1975). I will use Torrance to refer to both upstream plants. This dual-union relationship was an historical residue from the competition between the UAW, a CIO union, and the IAM, an AFL union, to organize aircraft workers during the 1940's and 50's.

Relations between the unions swung between cooperation and conflict (Erickson 1993). The two unions engaged in intense jurisdictional disputes over aircraft industry workers during the 1930s and 1940s. Recognition by both unions of their joint interests progressed from a No Raid Agreement in 1948-1955, to Joint Negotiations in 1952-1956, and to the creation of a Joint Planning and Coordinating Committee in 1956 (Levinson 1966). Relations then soured. In 1968, the UAW cancelled its Mutual Assistance Pact with the IAM (Flint, 1968). At the time, the UAW was attempting to win over IAM represented workers at McDonnell Douglas' St. Louis plant. A 1971 UAW-IAM Agreement foundered over tensions that the IAM settled for a lower wage at Boeing after the UAW had set the Aerospace pattern at McDonnell Douglas (Wright, December 6, 1971). Another attempt between the unions to kiss and make-up, would not survive the 1974 bargaining round, whose aftermath we examine here.

With the industry in cyclical decline after the oil shock, the unions were still fighting to obtain back-pay due from the 1971 round. Tensions were exacerbated by McDonnell Douglas's long delay in making this payment even after losing a court challenge (The Machinist, April 4, 1974). As the aerospace industry approached its 1974 collective bargaining round, labor unrest grew in this plant during 1973 and 1974, generating a backlog of 2,300 unresolved union grievances by September, 1974 [Solidarity, September 1974]. Stoking this and provoking the U.A.W. leadership, McDonnell-Douglas had withheld wage increases previously agreed to, even after the U.A.W. prevailed in court against administrative challenges under Nixon era wage and price controls [Solidarity, December, 1972; May, 1974].

Table 1 gives the time-line for the labor disruption we study here. This time-line marks not only a growing split between McDonnell Douglas and its unions, but between the unions as well.

Douglas imposed lock-outs at the end of 1974 and terminated its expired collective-bargaining contracts. On February 10, 1975, IAM Local 720 began a strike at McDonnell Douglas, which shut down the Torrance parts plant. One week later, the UAW voted not to strike and accepted management's terms (The Machinist, March 6 and 27, 1975; New York Times, February 18, 1975). This meant that UAW represented workers at Long Beach would be crossing picket lines manned by IAM Long Beach workers – clouding future relations between the unions. Unlinking McDonnell Douglas's negotiations with the two unions would not, however, sever the production links which made final assembly in Long Beach dependent on Torrance built parts. As the Malton experience had already shown, independent negotiations increase the number of opportunities at which leverage could be exerted on the specialized supply chain.

Results

Long Beach was perhaps not the most efficiently managed operation, but they were not in the habit of keeping excess wings and sub-assemblies sitting around. Within 26 days of the upstream Torrance strike, Douglas announced mass layoffs at Long Beach, a plant with about 12,000 workers at the time. On March 7 the first 1,000 layoffs were announced (The New York Times, March 7, 1975). One week later, Douglas laid off an additional 6,000 Long Beach workers. This was followed on March 27 by an additional 2,000 layoffs (The New York Times, March 28, 1975). At this point, three quarters of the workers had been laid off because of the upstream strike. Production stalled in a plant where 99% of the workforce was not on strike, and where the dominant union, the UAW, was not respecting IAM picket lines.

In the last three quarters of 1974 before the strike, and again after the strike in the last quarter of 1975 and the beginning of 1976, Long Beach was delivering DC-9s at the rate of 12 per quarter. Given the long and complex supply chain, aircraft manufacturers plan these rates well in advance, often years in advance. Table 2 shows monthly output and unit cost in the months before and after the strike. Output is for all DC-9s. To limit confounds from a changing mix of planes, I construct a cost index that refers to labor hours used in Long Beach final assembly of only DC-9 Series 30 models. When the IAM and UAW contracts expired on September 15, 1974, both unions kept working on a day to day basis under the terms of the expired contracts. This mutual pause at the precipice is reflected in the output rates. Long Beach continued to deliver 4 planes per month in October, increasing to 5 in November. After Douglas laid off its workforce over Thanksgiving, depriving them of 2 days' vacation pay, December production fell to 3 planes. By itself this might only reflect inter-temporal substitution – speeding up one December delivery into November. Douglas then increased the pressure, locking out employees over their Christmas and New Years breaks and depriving them of 6 additional days of vacation pay. This tactic bore fruit, but perhaps not of the expected type. Only two planes were delivered in January. Given the immense carrying costs of capital in this industry, this is a financially punishing trickle of output. January's drop in production to half its planned rate cannot be attributed to a February upstream strike yet to occur. Rather, it reflects a disgruntled workforce engaged in an in-plant slow-down in Long Beach. That Long Beach did not lack for parts at that point can be seen in the fact that once the UAW voted on February 17 not to join the IAM in strike, Long Beach quickly began clearing the backlog, delivering five planes in February, four of them after the 17th.

With the UAW under a new contract, but the IAM still on strike, it was only a matter of time before the specialized parts pipeline ran dry. Three planes were delivered in March. The full impact of the upstream strike was felt in April, when Long Beach could produce only one plane. Both sides felt the pain. The company could not long survive at these rates, and the Machinists union strike

fund had run dry (The Machinist, April 3, 1975). The IAM strike was settled on April 16, largely on McDonnell-Douglas' terms. Only 1 plane was delivered in April. Output fluctuated in the following months, quickly restored to 4 in May, falling to 2 in June, then 4, 3, and 6 in the following months. The steady and predictable output rate of the prior few years had been disrupted.

Unit assembly costs also deteriorated, but followed a more complex time path. These costs are a less discrete and so more sensitive indicator of what is taking place within the plant. The effects of labor disputes at Douglas predate the IAM strike and persist long after the strike was formally settled. While ill-will, saber-rattling, and poor morale can easily extend beyond the formal strike dates, some of the patterns are surprising. It wouldn't have been surprising to see labor slow down as a way of sending a message to management as the collective-bargaining contract neared expiration. Nor would it be surprising to see management try to stockpile extra production as a possible strike neared. In some cases, workers cooperate with this effort, stockpiling extra income through over-time in anticipation of a possible strike. At Long Beach as contract negotiations were underway in August 1974, costs were among the lowest on record, and production rates held steady.

Pressure built after the contracts expired. In an escalating series of steps, management terminated the expired contracts, unilaterally imposed contract changes, laid off workers over Thanksgiving, ceased collecting union dues through payroll deductions, and imposed a lockout in December. Labor relations became polarized and Long Beach assembly costs progressively rose. Unit assembly costs for Series 30 DC-9s increased by 17% in September as the collective bargaining contracts expired. All cost comparisons are with August 1974 levels before contract expiration. Costs remained elevated by 23% and 25% in the next two months before leaping again to 39% in December following the Thanksgiving layoffs.

The worst of the immediate cost impact was felt in February as the IAM went out on strike and as the UAW voted to accept a new contract and not to strike. At this point it cost 29% more to assemble a Series 30 DC-9 than it had during the first 8 months of 1974 before the contract expired, and 47% more than the minimum cost month, August 1974. Through March and April, unit assembly costs remained elevated by 44% even as output dwindled as the parts pipeline ran dry. These are punishing cost increases after years of riding down the learning curve of cost reductions. It had been nearly 5 years since back in March, 1969 that it had cost Douglas so much to assemble a DC-9.

Following the IAM settlement in mid-April, Long Beach costs recovered only slightly, remaining 35 to 39% above their August 1974 level in May, June and July of 1975. In a normal production span any plane coming off the line by August 1975, if not before, would have entered final assembly after the strike was settled. Assembly costs did not fall. Employees were not pleased with the resolution of their labor disputes. After a costly strike, the IAM settled on management terms. In Long Beach, UAW represented workers were reported to be surprised and disappointed when they discovered the terms of their new contract. (The Valley News, May 9, 1975). Local 148 had one of the most active internal democracies of any US union, with multiple organized political parties. In the aftermath of the 1975 strike, elections for local leadership threw out the incumbent United party, replacing it with leaders seen as more aggressive. Unit labor costs in Long Beach deteriorated further in the last months of 1975.

DC-9 assembly costs would not regain their former lows through the end of 1976, the last month observed in our data set. This is a persistent scar. How much is attributable to the souring and polarizing of relations after the labor disputes of 1974-1975 is not easily discerned. An historian might be more comfortable than an economist saying each plane has its own story. Costs for all DC-9 models jumped in August, as the newly stretched Series 50 starting coming off the line. The mix also shifted to include more freighter versions, which typically had higher assembly costs. The

available evidence points to a prolonged increase in assembly costs in the aftermath of the 1975 IAM strike.

Conclusion

Customization creates opportunities for hold-up, a theory unions have been willing to put to the proof. In the Douglas case, we see evidence of substantial cost increases and production disruptions downstream from a struck plant.

The bitter residue from this strike not only disrupted production at Douglas Aircraft. It also drove a wedge between the IAM and the UAW, chilling their attempts to forge a common front in Aerospace. Less obviously, the events of 1975 contributed to greater fragmentation within the UAW, both to internal splits within Local 148, and between local factions within Local 148 and the UAW's leadership in the Western Region and the International (Kleiner and Pilarski, 2001). Over many years the 1975 strike contributed to increasing internal polarization between rival union factions, and between management and workers, with costly in-plant slow-downs that would later end with Local 148 being put into receivership.

A strike is only the most obvious manifestation of labor unrest. The production record at Long Beach allows a more nuanced view of the costs of labor disputes short of a strike. Costs increased as the workforce withheld effort in response to a series of acts that tend to attract less attention than strikes. Costs increased when the collective bargaining contract expired without a new agreement in place. They increased again after management terminated the expired contract and briefly locked out workers. Management was clearly willing to raise the stakes. They won in the sense of eventually getting contracts largely on their terms, but this came at the price of assembly costs that would remain persistently elevated. The strike did not delimit the labor dispute, either temporally or geographically.

Tables

Table 1: Timeline

9/15/1974	Douglas Aircraft Co. (DAC) contracts with UAW and IAM expire. Workers remain on the job.
10/14/1974	UAW 148 votes to authorize strike at Long Beach (LB).
11/28/1974	DAC imposes 2 day Thanksgiving layoff.
12/13/1974	DAC terminates contract and imposes changes.
12/23/1974	DAC begins one week lock-out.
2/10/1975	IAM 720 strike begins at McDonnell Douglas.
2/17/1975	UAW votes not to strike alongside IAM, accepts management terms.
3/7/1975	DAC announces 1,000 furloughs at LB due to parts shortage.
3/14/1975	DAC lays off an additional 6,000 at LB.
3/27/1975	DAC announces 2,000 more furloughs at LB.
4/16/1975	IAM 720 strike end at McDonnell Douglas.

Table 2: DC-9 Output and Assembly Cost Index Before and After the 1974 Bargaining Round

Date	Cost Index	Output
1974m1	1.18	5
1974m2	1.13	5
1974m3	1.16	4
1974m4	1.14	4
1974m5	1.07	3
1974m6	1.20	5
1974m7	1.19	4
1974m8	1.00	4
1974m9	1.17	4
1974m10	1.23	4
1974m11	1.25	5
1974m12	1.39	3
1975m1	1.37	2
1975m2	1.47	5
1975m3	1.44	3
1975m4	1.44	1
1975m5	1.37	4
1975m6	1.39	2
1975m7	1.35	4
1975m8	1.89	3
1975m9	1.67	6
1975m10	1.54	3
1975m11	1.75	5
1975m12	1.74	4

Note: Output is of all DC-9s. The Cost Index is for labor hours for final assembly of Series 30 DC-9s.

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