LIQUIDATION VALUES AND THE CREDIBILITY OF FINANCIAL CONTRACT RENEGOTIATION: EVIDENCE FROM U.S. AIRLINES*

EFRAIM BENMELECH AND NITTAI K. BERGMAN

How do liquidation values affect financial contract renegotiation? While the "incomplete-contracting" theory of financial contracting predicts that liquidation values determine the allocation of bargaining power between creditors and debtors, there is little empirical evidence on financial contract renegotiations and the role asset values play in such bargaining. This paper attempts to fill this gap. We develop an incomplete-contracting model of financial contract renegotiation and estimate it using data on the airline industry in the United States. We find that airlines successfully renegotiate their lease obligations downward when their financial position is sufficiently poor and when the liquidation value of their fleet is low. Our results show that strategic renegotiation is common in the airline industry. Moreover, the results emphasize the importance of the incomplete contracting perspective to real-world financial contract renegotiation.

I. INTRODUCTION

The control rights that financial contracts provide over firms' underlying assets play a fundamental role in the incomplete-contracting literature. In particular, debt contracts provide creditors the right to possess assets when firms default on promised payments (see, e.g., Aghion and Bolton [1992]; Shleifer and Vishny [1992]; Hart and Moore [1994, 1998]; and Bolton and Scharfstein [1996]). This threat of asset liquidation motivates debtors to avoid default. Thus, in the incomplete-contracting literature, asset liquidation values play a key role in the *ex post* determination of debt payments. When liquidation values are low, debtors' bargaining position improves vis-à-vis creditors, and all else equal, debt payments should decrease.

*We thank Douglas Baird, Lucian Bebchuk, Andrea Eisfeldt, Mark Garmaise, Robert Gertner, Simon Gervais, Oliver Hart, Gustavo Manso, Stewart Myers, Antoinette Schoar, Andrei Shleifer, Jeremy Stein, George Triantis, Bilge Yilmaz, and seminar participants at the 2007 American Law and Economics Association meeting, 2008 AFA meeting in New Orleans, Columbia University, Dartmouth, Harvard Law School, Harvard Economics Department, Harvard-MIT organizational economics seminar, Interdisciplinary Center of Herzliya, MIT Sloan, NBER Corporate Finance meeting, NYU-Stern, Stanford GSB, Texas Finance Festival, the Federal Reserve Bank of Philadelphia, and the University of Virginia, Edward Glaeser (the editor), and two anonymous referees for constructive and helpful comments. We also thank Robert Grundy and Phil Shewring from Airclaims Inc. Alex Bayers provided excellent research assistance. All errors are our own.
effi_benmelech@harvard.edu, *nbergman@mit.edu*.

The Quarterly Journal of Economics, November 2008

But how do liquidation values affect financial contract renegotiation in practice? Although previous research has analyzed some of the implications of the incomplete contracts approach for financial contracting,[1] there is little empirical evidence analyzing the ability of firms to renegotiate their financial liabilities and the role asset values play in such renegotiations. This paper attempts to fill this gap by documenting empirically the conditions under which airlines renegotiate aircraft leases in the United States. Our goal is to understand the factors that enable airlines to extract concessions in renegotiation, and to estimate the magnitude of the concessions that airlines obtain. We find that publicly traded airlines often renegotiate their lease contracts. Furthermore, we show that aircraft lease renegotiations take place when liquidation values are low and airlines' financial condition is poor.

Aircraft leases are a natural environment for testing renegotiation-based models. While the incomplete-contracts literature focuses on debt contracts and assumes that creditors have the right to seize an asset if the debtor defaults, the automatic stay provision of the U.S. bankruptcy code protects debtors from foreclosures and repossessions. In contrast to creditors, in bankruptcy lessors are not subject to the automatic stay provision. Thus, matching the stylized assumption in the literature, lessors have the ability to relatively swiftly take possession of their assets if a firm defaults on its lease payments.[2]

We begin our analysis by developing a simple theoretical model of contract renegotiation based on Hart and Moore (1994). To determine the credibility of firms' threat to renegotiate preexisting financial contracts, we model explicitly the renegotiation process between the firm and its liability holders as in Bergman and Callen (1991). Our model has two testable implications. First, firms will be able to credibly renegotiate their financial commitments only when their financial situation is sufficiently poor. Second, when a firm's financial position is sufficiently poor, and hence its renegotiation threat is credible, a reduction in the liquidation value of assets increases the concessions that the firm obtains in renegotiation. Therefore, the positive relation between liquidation values and post-renegotiation firm payments to creditors

1. See, for example, Strömberg (2000), Kaplan and Strömberg (2003), Benmelech, Garmaise, and Moskowitz (2005), Bergman and Nicolaievsky (2007), and Benmelech (2008).
2. See, for example, Pulvino (1998, 1999) and Eisfeldt and Rampini (2008).

predicted in Hart and Moore (1994, 1998) should be concentrated during times when firms are doing poorly.

As motivational evidence for our empirical analysis, we begin by providing a short case study that describes American Airlines' renegotiation of lease contracts subsequent to its acquisition of Trans World Airlines (TWA) in January 2001. We show that American substantially reduced lease payments on aircraft previously owned by TWA, and estimate the present value of the cost reductions due to lease renegotiation at 36%. Anecdotal evidence suggests that American could successfully renegotiate the lease payments because of TWA's dire financial position and because of American's credible threat to reject TWA's leases and return the aircraft to lessors.

Our empirical analysis examines renegotiation of leases among U.S. airlines. We collect data on all publicly traded, passenger carriers and construct a data set that includes information about contracted lease payments, actual lease payments, and fleet composition by aircraft type. In addition, we construct four different measures of the ease of overall redeployability of an airline's leased aircraft. Fleet redeployability serves as a proxy for the value of the outside option that lessors have when a lessee fails to make a promised payment, and hence as a proxy for liquidation values.

We then examine how an airline's financial condition combined with the redeployability of its fleet affects lease renegotiation. As the model predicts, lease payments are reduced during periods of poor financial performance. Our regression analysis suggests that during years in which cash flow from operations and cash balances fall short of interest expense, the average ratio of an airline's actual lease payment to its previous year's contracted lease payment is reduced by approximately 10 percentage points after controlling for changes in fleet size and its composition.

The results further show that, as predicted by our model, the ability to reduce payments during periods of poor financial performance—when renegotiation credibility is high—is particularly large when liquidation values are low. This effect is sizable. For example, during periods of poor financial performance, a one-standard-deviation decrease in the number-of-operators redeployability measure decreases an airline's lease payment by 20% compared to its contracted lease payments. Our evidence is thus supportive of the ability of firms to strategically renegotiate their obligations when firm performance is poor, insofar as firm payments are reduced when lessors' outside options deteriorate. In contrast, when an airline is not in financial distress and hence its renegotiation credibility is relatively low, we find that fleet redeployability is either unrelated or slightly negatively related to lease payments, depending on the specification.[3]

We proceed by studying airline bankruptcies. Consistent with our previous results, during bankruptcy, airlines are able to reduce lease payments substantially. Furthermore, the ability of bankrupt airlines to reduce their lease payments is greater when their fleets are less redeployable. For example, during periods of bankruptcy, a one-standard-deviation decrease in the number-of-operators redeployability measure decreases an airline's lease payment by 22% compared to its contracted lease payment.

We supplement our analysis by studying lease renegotiation out of bankruptcy. We find that, even out of bankruptcy, airlines in poor financial condition can reduce their lease payments and that lower fleet redeployability enables these airlines to extract greater concessions from their lessors. Finally, we use the attacks of 9/11 as an exogenous shock to airlines' cash flows and fleet liquidation values and find that contractual lease obligations were reduced by approximately 13 percentage points.

The rest of the paper is organized as follows. Section II analyzes a simple financial contract-renegotiation model. A case study that analyzes the acquisition of TWA by American Airlines in 2001 is presented in Section III. Section IV provides a description of our data sources and summary statistics. Section V describes the empirical analysis, and Section VI concludes.

II. The Model

In this section, we develop a simple model of financial contract renegotiation based on Hart and Moore (1994). Our main goals are to analyze the conditions under which a firm can credibly commit to renegotiate its liabilities with outside claimholders, and to analyze the payoffs to parties conditional on renegotiation occuring. We generate two intuitive predictions which are then tested in the data. To assess the credibility of renegotiation, we follow Bergman and Callen (1991) in explicitly modeling the renegotiation process

3. Acharya, Bharath, and Srinivasan (2007) show that creditor recovery rates diminish during times of industry distress and particularly so among industries with high asset-specificity as measured by the book value of industry machinery and equipment divided by the book value of assets.

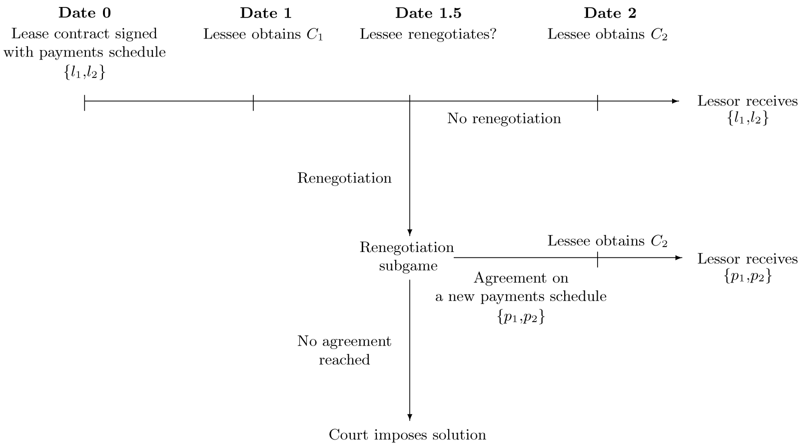

FIGURE I
Project Timeline and Assumptions

between the firm and its liability holders.[4] The project timeline and assumptions are shown in Figure I.

II.A. Setup

Consider a firm (the "Lessee") that has entered a contract to lease an asset for two periods from a Lessor. The contract stipulates that the Lessee will pay the Lessor l_1 at the end of period 1, and l_2 at the end of period 2. The Lessee will be using the asset to generate cash flow C_1 in period 1, and C_2 in period 2. These cash flows are not expropriable by the firm—an assumption that approximates the situation faced by large publicly traded firms in the United States. At the end of period 1, the market value of the asset if liquidated is L, while at the end of period 2, this value is 0. We assume that $L < C_2$, so that liquidation at $t = 1$ is inefficient.

The evolution of the game is as follows. At date 1.5 after having obtained C_1, the Lessee decides whether to abide by the contract and pay the contracted payments, or instead to trigger renegotiation with the Lessor.[5] To understand the credibility of the threat to renegotiate, we explicitly model the renegotiation

4. Our model is also related to Baird and Picker (1991) and Bebchuck and Chang (1992), who study bargaining between claimholders in bankruptcy. Similarly, Eraslan (2008) develops and structurally estimates a multilateral Chapter 11 bargaining game.

5. We assume that the Lessee cannot pay out a dividend until all lease obligations are fulfilled. Our main results are robust to this assumption.

process as a bargaining game in which the two parties engage in a series of alternating offers as in Rubinstein (1982). If during the bargaining process either party accepts an offer from its counterpart, bargaining ends and a new contract is signed with the agreed-upon repayment schedule. Bargaining, however, is costly in that the value of the second-period cash flow declines by an infinitesimal amount between each successive round of offers. This cost can be thought of as arising from a lack of optimal management, whether intentional or not, during the bargaining period.

If renegotiation is unsuccessful, in that the second-period cash flow has dwindled to 0 while neither party has agreed to an offer from its counterpart, a solution is imposed by a court. According to this, (i) the Lessor repossesses the asset and can therefore sell it for L, and (ii) the court orders the Lessee to pay the Lessor damages $D = \min\{C_1, l_1 + l_2 - L\}$.[6] This amount of damages guarantees that the Lessor obtains as payoff either the full promised payments, or the Lessee's entire date 1 cash balance as well as the value L of the assets.

Note that although cash flows cannot be expropriated, under certain conditions the Lessee will still be able to successfully renegotiate lease contracts and pay less than the original stipulated obligation. This stems from the Lessee's ability to credibly threaten the Lessor to forego future cash flows by accepting their loss during renegotiation, to the detriment of both parties.

II.B. Contract Renegotiation, Liquidation Values, and Cash Flows

In this section we solve for the subgame perfect equilibrium (SPE) of the game to analyze the conditions for contract renegotiation and the payoffs obtained therein. Because the game is one of complete information, the SPE of the subgame beginning after the Lessee decides to trigger renegotiation involves both parties immediately agreeing on a new repayment schedule. We show in a lemma in Appendix I that this involves a payoff of $1/2(C_2 - L)$ to the Lessee and $C_1 + 1/2(C_2 + L)$ to the Lessor. The following proposition, which is proved in Appendix I by simply comparing the Lessee's renegotiation payoffs to those from abiding by the contract, identifies when the Lessee will choose to trigger renegotiation.

6. In the event that the liquidation value, L, is greater than $l_1 + l_2$, damages are assumed to be 0.

PROPOSITION 1. The subgame perfect equilibrium of the game is characterized by the following two cases:

(a) If $C_1 + C_2 < l_1 + l_2$, the Lessee always renegotiates the contract.

(b) If $C_1 + C_2 \geq l_1 + l_2$ the Lessee renegotiates the contract when

$$C_1 + \frac{1}{2}(C_2 + L) < l_1 + l_2, \tag{1}$$

and otherwise abides by the original contract, raising capital at $t = 1$ if necessary. In all cases, if renegotiation occurs, payoffs to the parties are as in the lemma in Appendix I. If renegotiation does not occur, the Lessee obtains $(C_1 + C_2) - (l_1 + l_2)$ and the Lessor obtains $(l_1 + l_2)$.

The intuition behind inequality (1) in Proposition 1 is that the Lessee can credibly renegotiate the initial contract when C_1, C_2, and L are sufficiently small compared to the contractually specified payment $l_1 + l_2$. First, all else equal, when L or C_1 are small, the Lessee's effective bargaining position is high because the Lessor's outside option—to sell the repossessed asset for L and seize the period 1 cash flow C_1—is not very attractive. The Lessee can thus credibly commit to trigger renegotiation, knowing that the Lessor will accept a more favorable payment schedule. Similarly, the Lessee can credibly commit to renegotiate the lease contract only if C_2 is sufficiently low. This is because the Lessee's ability to obtain concessions in renegotiation stems from his willingness to accept the reduction of the firm's future earnings prospects during renegotiation, and in so doing, harm the firm's ability to repay the Lessor. However, if C_2 is too high, the Lessee's threat to accept future cash flow reduction is not credible, because in order to harm the firm's ability to repay the Lessor, a large fraction of the firm's future earnings prospects would need to be lost. The Lessee would thus prefer instead to simply pay the prespecified lease payments.[7]

Figure II displays the Lessee's renegotiation choice in (C_1, C_2) space. In area A, the firm is in financial distress $(C_1 + C_2 < l_1 + l_2)$, and hence, as stated in Proposition 1, can easily credibly renegotiate lease payments to obtain a positive payoff. In area B the firm

7. Less formally, when C_2 is high, the Lessee's threat to accept asset repossession and liquidation by the Lessor is not credible because the asset is needed to generate the high C_2 payoff in period 2. For a related intuition see Gromb (1995).

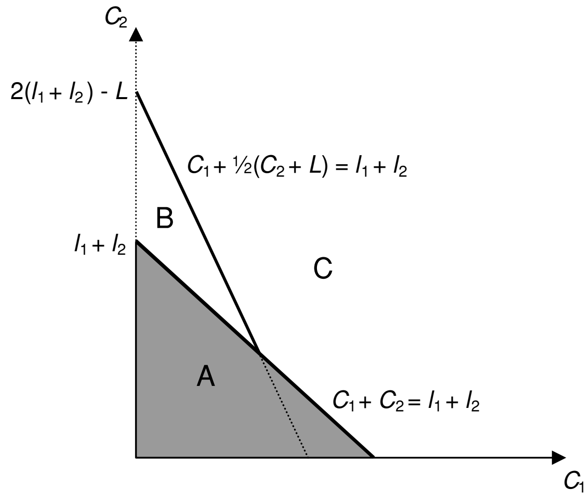

FIGURE II
Lessee's Renegotiation Choice in (C_1, C_2) Space

is not in financial distress and condition (1) holds. Thus, because C_1, C_2, and L are small enough compared to the initially specified contract payment, $l_1 + l_2$, the Lessee can credibly renegotiate a new, reduced payment schedule. Intuitively, although the firm is *not* in financial distress, its financial position is poor enough to allow the Lessee to credibly renegotiate lease payments. Finally, in area C, prespecified lease payments are relatively small compared to both the liquidation value, L, and current and future firm cash flows. Thus, in this area the Lessee cannot credibly trigger renegotiation and, instead, abides by the original signed contract.

The model generates two sets of predictions:

PREDICTION 1. All else equal, the credibility of contract renegotiation, and hence its likelihood, will decrease with the Lessee's current and future cash flow.

PREDICTION 2. Firms' ability to renegotiate down their lease payments when liquidation values are low will be concentrated during periods of relatively poor financial performance.

Both predictions are a direct result of Proposition 1. First, when C_1 and C_2 are relatively high, condition (1) will not hold and so the firm will not be able to credibly threaten to renegotiate its contracted lease payments. Thus, as Prediction 1 states, firms will be able to renegotiate financial contracts only when their financial condition is sufficiently poor. Prediction 2 states that firms will be able to renegotiate and lower their lease payments when the liquidation value of their assets, L, decreases but that this effect will be concentrated in times when firms' financial position is relatively poor. This is because only then can firms credibly renegotiate their payments, enabling changes in liquidation values to affect changes in the parties' payoffs.

III. The Acquisition of TWA by American Airlines: A Case Study

In this section, we briefly describe the acquisition of TWA by American Airlines (AA) in January 2001, and the lease renegotiation process that subsequently ensued. We argue that AA had the ability to credibly threaten to reject many of TWA's leases, and that the outcome of the lease renegotiation in this case is consistent with the model presented in Section II.

III.A. TWA's Financial Difficulties and AA's Purchase Plan

On January 10, 2001, TWA filed a Chapter 11 bankruptcy petition as part of a deal with AA. Under the deal, AA acquired almost all of TWA's assets by paying $625 million in cash and assuming obligations of TWA that exceeded $5 billion. The acquisition marked the end of more than a decade of financial difficulties for TWA, which included two previous Chapter 11 reorganizations.

AA purchased substantially all of TWA assets subject to section 363 of the Bankruptcy Code, which authorizes the sale of property of a debtor's estate under certain conditions. Baird and Rasmussen (2003) find that asset sales subject to section 363 of the Bankruptcy Code account for 56% of the large businesses that completed their Chapter 11 proceedings in 2002.

AA acquired a total of 173 aircraft from TWA, in addition to a new hub in St. Louis, key gates, maintenance facilities, and a 26% stake in the Worldspan computer-reservations system. One of the primary benefits of the TWA acquisition was the complementarity between the fleets of the two airlines.[8]

III.B. American Airlines' Threat to Reject TWA Leases

Although AA assumed most of TWA's obligations, it was not obligated by law to assume all lease contracts. According to section

8. There was a large overlap in aircraft type between AA and TWA. Out of its fleet of 191 aircraft, TWA operated 103 MD-80s, 27 Boeing 757s, and 16 Boeing 767s, whereas AA had a fleet of 726 aircraft, including 276 MD-80s, 102 Boeing 757s, and 79 Boeing 767s.

365 of the bankruptcy code, AA had the ability to reject TWA's aircraft leases, resulting in the leased aircraft being returned to the lessors and leaving the lessors with an action for damages. Furthermore, upon rejection, lessor's claim for damages would be against *TWA* cash flow. Consistent with Prediction 1 of the model, because TWA had not generated positive earnings for more than a decade, and by January 3, "TWA was down to its last $20 million in cash" (Carey 2001), AA's ability to threaten to reject the aircraft leases was deemed to be quite credible. Indeed, according to Buhler (2003, p. 7),

> The aircraft market conditions, and the disparity between American's credit and TWA's allowed American to approach the aircraft lessors and lenders with the choice of accepting American's purchase offers/deeply discounted lease rates, or taking the aircraft back in their then-current condition.... To my knowledge, all of the lenders and lessors agreed, resulting in new lease rates, in some cases 50 percent or more under TWA's.

Moreover, because TWA's fleet was quite large, rejecting TWA's leases could have flooded the aircraft market, thus forcing lessors to sell their repossessed aircraft at "fire sale" prices. Table I displays the top-ten operators of each of the main aircraft types in TWA's fleet as of 1/10/2001: MD-80, DC-9, Boeing 757, and Boeing 767. While all of these models are popular aircraft, AA was the top user of MD-80s in the world (276 aircraft representing 23.45% of the total number of MD-80s in the world), and the second largest user worldwide of both Boeing 757s (102 aircraft representing 10.81% of the total number of Boeing 757s), and Boeing 767s (70 aircraft representing 9.83% of the total number of Boeing 767s). Thus, AA was able to amplify the threat of fire sales by refusing to purchase the repossessed MD-80s, Boeing 757s, and Boeing 767s from TWA's lessors. The combination of limited demand for a large number of aircraft and TWA's low cash flows increased the bargaining position of AA vis-à-vis TWA's lessors during the lease renegotiation process.

III.C. Estimates of the Value of Lease Renegotiation

Eventually most of the DC-9s were rejected and the leases of the MD-80s, Boeing 757s, and Boeing 767s, were renegotiated. According to Buhler (2003, p. 7),

> When the American acquisition of the TWA assets closed in April 2001, American assumed most of TWA's leases and purchased a number of its aircraft. In TWA's case, the large number of aircraft created justifiable fears of a massive glut on the market if American's offers were refused.... The [TWA case]

TABLE I
MARKET FOR TWA'S AIRCRAFT AS OF 1/10/2001

	Top-ten operators of MD-80s				Top-ten operators of DC-9s		
Rank	Airline	Number of aircraft	% of total aircraft	Rank	Airline	Number of aircraft	% of total aircraft
1	American Airlines	276	23.45	1	Northwest Airlines	137	19.68
2	Delta Airlines	120	10.20	2	ABX Air	66	9.48
3	TWA Airlines	103	8.75	3	US Airways	46	6.61
4	Alitalia	89	7.56	4	AirTran Airways	35	5.03
5	SAS	68	5.78	5	TWA Airlines	30	4.31
6	Continental Airlines	66	5.61	6	US Navy	29	4.17
7	Aeromexico	41	3.48	7	Iberia	25	3.59
8	Iberia	37	3.14	8	Midwest Airlines	24	3.45
9	Spainair	35	2.97	9	US Air Force	23	3.30
10	Alaska Airlines	34	2.89	10	SAS	23	3.30
	Top-ten market share	869	73.83		Top-ten market share	438	62.93
	Total aircraft	1,177	100.00		Total aircraft	696	100.00
	Top-ten operators of B757s				Top-ten operators of B767s		
Rank	Airline	Number of aircraft	% of total aircraft	Rank	Airline	Number of aircraft	% of total aircraft
1	Delta Airlines	118	12.50	1	Delta Airlines	113	14.05
2	American Airlines	102	10.81	2	American Airlines	70	9.83
3	United Airlines	98	10.38	3	United Airlines	54	6.72
4	UPS Airlines	75	7.94	4	ANA	53	6.59
5	British Airways	52	5.51	5	Qantas	36	4.48
6	Northwest Airlines	48	5.08	6	Air Canada	32	3.98
7	Continental Airlines	41	3.34	7	UPS Airlines	30	3.73
8	US Airways	34	3.60	8	Japan Airlines	22	2.74
9	TWA Airlines	27	2.86	9	British Airways	21	2.61
10	Iberia	23	2.44	10	Canadian Airlines Int.	20	2.49
	Top-ten market share	618	65.47		Top-ten market share	460	52.71
	Total aircraft	944	100.00		Total aircraft	804	100.00

Notes. This table lists the ten largest operators for the main aircraft types operated by TWA as of 1/10/2001: MD-80, DC-9, B757, and B767. The table reports the number of aircraft per type, and the ratio between the number of aircraft per type that an airline operates and the total number of aircraft per type.

demonstrates one simple rule: the bargaining positions of the parties and the value of the subject matter dictate the result.

We continue by estimating the value of the renegotiation to AA. We obtain data on current and expected lease payments from the 10-Ks of AA and TWA. Because airlines are required to report their future lease obligations as specified by preexisting lease contracts, we can compare the expected lease expenses before the acquisition of TWA to the actual cost of the leases after the acquisition was completed. We begin by estimating the expected lease obligations of TWA as of 12/31/2000.

Using TWA's debt yields for different maturities as reported in TWA's 10-K to discount TWA's future lease commitments (between

9.7% and 14.7%), we calculate the present value of TWA's future lease commitments to be \$3,433 million (see Panel A of Table II). Because AA assumed leases on 78% of TWA's seat capacity, absent renegotiation, we would expect the present value of AA's lease expenses to increase by $0.78 \times 3,433 = \$2,677.6$ million. This was not the case.

Panel B of Table II calculates the present value of the *expected* lease payments of AA from 2001 and onward as of 12/31/2000, using a discount rate of 6.6% (corresponding to the average yield on AA's bonds during the year 2000). To estimate the increase in AA's present value of lease obligations during 2001, Panel C calculates the present value of AA's *actual* 2001 lease payment combined with the expected lease obligations from 2002 and onward as of 12/31/2000.[9] In calculating this value, we adjust the difference between AA's expected lease payments as of 12/31/2000 and the sum of the actual payments during 2001 and the expected lease payments as of 12/31/2001 for the number of AA's aircraft that were dismissed during 2001.[10] As can be seen from Panel C, while AA assumed TWA's leases with an estimated present value of \$2,677.6 million, the present value of AA's lease expense increased by only \$1,705.5 million. The difference, \$972.1 million, representing a cost reduction of 36.3%, is the estimate of the amount saved by AA due to successful lease renegotiation.[11]

Our estimate is consistent with Buhler's (2003) anecdotal evidence and suggests that, as our model predicts, AA was able to accept a favorable payment schedule given its credible threat to reject the leases due to TWA's low cash flow and the threat to flood the market with aircraft. The next sections provide a formal empirical analysis of these effects in the U.S. airline industry.

IV. Data and Summary Statistics

This section describes the data sources used in our empirical analysis and outlines summary statistics for both airline characteristics and measures of fleet redeployability.

9. We use a discount rate of 7.7% that corresponds to the average yield of AA's Enhanced Equipment Trust Certificates (EETCs) in 2001 prior to the 9/11 attacks. This rate reflects the increase in the risk of AA during 2001 that was not subject to the 9/11 industry shock.

10. AA dismissed about 3% of its seat capacity during 2001.

11. Note that the difference between the lease expenses of AA and TWA are not driven by the superior credit quality of AA because risk-adjusted discount rates are used in the present value calculations.

TABLE II
ESTIMATES OF THE SAVINGS FROM LEASE NEGOTIATIONS IN AMERICAN AIRLINES' ACQUISITION OF TWA

A. TWA's actual and expected lease payments for 2001 and onward discounted as of 12/31/2000

	2001	2002	2003	2004	2005 and after
Operating leases	$553	$538	$528	$518	$3,263

Present value of operating leases (at various rates b/w 9.7% and 14.7%) = $3,293
Present value of capital leases = (at various rates b/w 9.7% and 14.7%) = $139.5
Present value of total future lease payments (operating + capital) = $3,433

Fleet share taken by American (value weighted) = 0.78
Lease's value taken by American = 0.78*$3,433 = $2,677.6

B. American Airlines' expected lease payments for 2001 and onward as of 12/31/2000

	2001	2002	2003	2004	2005	2006 and after
Operating leases	$950	$898	$910	$893	$880	$11,268

Present value of operating leases (at 6.6%) = $11,442
Present value of capital leases (at 6.6%) = $1,364
Present value of total future lease payments (operating + capital) = $12,806

C. American Airlines' actual and expected lease payments for 2001 and onward as of 12/31/2000

	2001	2002	2003	2004	2005	2006	2007 and after
Operating leases	$1,188	$1,314	$1,256	$1,180	$1,119	$1,054	$11,622

Present value of operating leases (at 7.7%) = $12,481
Present value of capital leases = (at 7.7%) = $1,647
Present value of total future lease payments (operating + capital) = $14,128

During the year 2001, American Airlines dismissed 3% of its leased aircraft (value weighted)
Difference between expected lease payments = $14,127.8 − 0.97*$12,806.5 = $1,705.5
Amount American saved on TWA leases (adjusted for risk) = $2,677.6 − $1,705.5 = $972.1

Notes. This table summarizes the savings from lease renegotiation in the acquisition of TWA by American Airlines. Panel A presents TWA's actual and expected lease payments for 2001 and onward as of 12/31/2000. Panel B displays American Airlines' expected lease payments for 2001 and onward as of 12/31/2000. Panel C presents American Airlines' actual and expected lease payments for 2001 and onward as of 12/31/2000, and provides an estimate of the risk-adjusted savings from lease renegotiation on American Airlines's acquisition of TWA. Present values of capital leases are taken from airlines' financial reports.

IV.A. Airline Characteristics

To construct our sample, we collect data from a number of sources. We start with all publicly traded firms with a four-digit SIC code equal to 4512 (Scheduled Air Transportation) during the period 1995–2005. We then search for all annual reports of each of these firms as recorded in the online SEC-Edgar database. From each annual report, we collect the following information.

First, we construct an account of the composition of each airline's leased fleet. We record the number of aircraft that are leased by each airline *by aircraft type*. Second, from the income statement, we record the amount paid by each airline in the form of aircraft lease expenses.[12] Third, from each annual report, we collect information on future contracted lease payments owed by airlines. According to FAS regulation 13, a firm must report its preexisting lease commitments for each of the five years following the filing of an annual report, as well as the sum of future scheduled lease commitments from year six and on. We collect for each airline-year the schedule of future contracted lease payments owed by each airline. Finally, we use Thomson's SDC Platinum Restructuring database to identify airlines that are in Chapter 7 or Chapter 11 bankruptcy procedures. Our final sample consists of 212 airline-year observations, representing 25 airlines during the period 1995 to 2005.

Table III displays descriptive statistics for a selected set of variables. As the table demonstrates, annual lease payments are sizable, with the mean annual lease payment equaling \$250.4 million and the maximum annual lease payment exceeding \$1 billion. Annual lease payments represent, on average, 14.9% of an airline's assets with a standard deviation of 18.5%. The mean number of aircraft leased by airlines in our sample is 139, of which, on average, 7% were wide-bodied aircraft.[13] The maximum number of leased aircraft in our sample is 483 (Continental Airlines in 2005). The mean number of total seats in an airline's leased fleet is 20,472.1, while the average of airline profitability (operating income before depreciation divided by the book value of assets) is 9.13%.

12. In a few cases, firms do not report aircraft lease payments separately from other lease payments—such as those for ground facilities—and instead report the value of aggregate lease payments. Because we are interested in aircraft lease payments, the relevant data for these firms are coded as missing.

13. A wide-bodied aircraft is an aircraft with passenger seats divided by two lengthwise aisles such as a Boeing 747 or an Airbus 300.

TABLE III
AIRLINE CHARACTERISTICS

	Mean	25th percentile	Median	75th percentile	Standard deviation	Min	Max
Lease expenses ($m)	250.4	40.3	136.3	437.7	263.2	0.312	1,009.0
Lease expenses/assets	0.149	0.040	0.088	0.156	0.185	0.008	1.260
Actual/expected$_{-1}$ lease payments	1.051	0.851	1.057	1.194	0.293	0.458	2.809
ln(lease expenses/ lease expenses$_{-1}$)	0.091	−0.022	0.058	0.184	0.254	−0.907	1.309
Leased fleet (aircraft)	139	31	95	253	128	2	483
Leased fleet (seats)	20,472.1	2,851.2	7,676.6	37,712.7	22,654.5	60	80,042.9
Wide-body	0.070	0.00	0.000	0.078	0.166	0.000	1.000
Profitability (%)	9.13	3.17	10.41	16.97	17.55	−100.10	52.42
Cash flow if LowCash = 1 (%)	−13.10	−8.63	−1.53	0.96	31.41	−109.90	18.12

Notes. This table provides descriptive statistics of airline characteristics. Lease expenses are total aircraft lease expenses (in $million), Lease expenses/assets are total aircraft lease expenses divided by the book value of the assets, Actual/Expected$_{-1}$ lease payments is the ratio of an airline's actual lease expenses to its previous year's minimum expected lease payments, ln(Lease Expenses/Lease Expenses$_{-1}$) is the yearly change in lease payments, Leased fleet (aircraft) is the number of aircraft leased by the airline. Leased fleet (seats) is the total number of seats in the leased fleet. Wide-body is the fraction of wide-bodied aircraft leased by the airline. Profitability is operating income before depreciation divided by the book value of assets. Cash flow is income before extraordinary items + depreciation and amortization divided by assets, LowCash is a dummy variable that equals 1 for airlines in which cash flow from operations (income before extraordinary items + depreciation and amortization) plus cash balances are less than their interest expense, and 0 otherwise.

To measure the degree of lease contract concessions obtained by airlines, we construct three variables related to lease payments. Our first, and main, measure is the ratio of actual lease payments paid during year t to the minimum expected year t lease payment as contracted in year $t-1$ (Actual/Expected$_{-1}$). As described above, the denominator of this ratio is taken from the airlines' 10-K statements. Table III shows that the mean ratio of actual to minimum expected lease payment in the full sample is 1.05. On average, lease payments are greater than the previous year's minimum expected lease payment, indicating increased payments due to fleet growth. Our second measure is simply the rate of change of lease payments from year $t-1$ to year t. Table III shows that this average rate is 9.1%. The final measure we use to measure possible renegotiation of lease payments is simply the annual lease payments divided by the book value of assets.

As a measure of financial difficulties we define a variable LowCash that equals 1 for airlines in which cash flow from operations (income before extraordinary items + depreciation and amortization) plus cash balances are less than their interest expense, and 0 otherwise.[14] There are 25 airline-year observations

14. Asquith, Gertner, and Scharfstein (1994) use a similar methodology to identify firms in financial distress.

with LowCash = 1, representing 11.8% of our sample. Our results are qualitatively unchanged when proxying for financial difficulties using a dummy variable that equals 1 when cash flow from operations is negative.

IV.B. Redeployability Measures

Because of economies of scale in fleet operation, airlines tend to limit the number of aircraft types that they operate in order to reduce costs associated with pilot training, maintenance, and spare parts. We take advantage of this fact in developing our measures of redeployability by assuming that the potential secondary market buyers of any given type of aircraft are likely to be airlines already operating the same type of aircraft. According to Pulvino (1998), the market for used commercial aircraft is "extremely thin," with approximately twenty used commercial aircraft transactions per month worldwide. Likewise, Gavazza (2006) finds that between May 2002 and April 2003, 720 commercial aircraft were traded, representing 5.8% of the total stock of commercial aircraft. The thinness of the market for used aircraft reinforces the importance of the size of the set of potential buyers in determining aircraft redeployability.

Our approach to measuring redeployability is motivated by the industry equilibrium model of Shleifer and Vishny (1992), and is similar to the empirical approach developed in Benmelech (2008) for 19th century American railroads, and to Gavazza (2006) for U.S. aircraft. Benmelech (2008) exploits the diversity of track gauges in nineteenth century American railroads to identify potential buyers for railroad tracks and rolling stock. Gavazza (2006) uses the number of aircraft per type and the number of operators per type to proxy for asset liquidity.

We use the Ascend CASE database, which contains ownership and operating information about all commercial aircraft worldwide, to construct our measures of airline fleet redeployability. We begin by constructing three redeployability measures at the yearly level for each aircraft type, where aircraft type is defined using the broad-type category in the Ascend CASE database. To do so, we compute for every sample-year (1) the number of aircraft per type, (2) the number of operators per type, and (3) the number of operators who operate at least five aircraft per type. In calculating these three redeployability measures, we disregard airlines that are in bankruptcy (as defined in the SDC bankruptcy database), because their financial position most likely precludes them from serving as potential aircraft buyers. This process yields three redeployability measures for each aircraft type and each sample year.

To construct the redeployability measures for an entire fleet of an airline, we aggregate the aircraft-type redeployability measures across all leased aircraft in each airline's fleet. Specifically, we define the redeployability of an airline's leased fleet to be the weighted average of the redeployability index corresponding to each of the leased aircraft in the airline's fleet. We calculate in this manner three measures of fleet redeployability corresponding to each of the three measures of aircraft-type redeployability. The three measures are given by

$$\begin{aligned}
\text{Redeployability}_{i,t}^{\text{aircraft}} &= \sum_{a}^{A} \omega_{i,t,a}\left(\text{Redeployability}_{a,t}^{\text{aircraft}}\right)\\
\text{Redeployability}_{i,t}^{\text{operators}} &= \sum_{a}^{A} \omega_{i,t,a}\left(\text{Redeployability}_{a,t}^{\text{operators}}\right)\\
\text{Redeployability}_{i,t}^{\text{operators}>5} &= \sum_{a}^{A} \omega_{i,t,a}\left(\text{Redeployability}_{a,t}^{\text{operators}>5}\right),
\end{aligned}$$

where i represents an airline fleet, t represents a sample year, a denotes an aircraft type, and $\omega_{i,t,a}$ is defined as

$$\omega_{i,t,a} = \text{number}_{i,t,a} \times \text{seats}_a \Big/ \sum_{a}^{A} \text{number}_{i,t,a} \times \text{seats}_a.$$

Because we do not have data on aircraft market values, we use the number of seats in an aircraft model as a proxy for its size (and value) in our weighted-average calculations. Furthermore, in calculating the first redeployability measure, because we want to account for the *residual demand* for the aircraft in each fleet, we do not include each airline's own aircraft. Likewise, in our number-of-operators–based proxies we do not count the airline for which we calculate the measure.

The TWA case suggests that the fleets of large airlines are less sellable. Using the Ascend CASE database we therefore construct a fourth measure of redeployability as the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type. As before, to construct the fourth proxy at the airline-fleet level, we calculate the weighted average of the redeployability index corresponding to each of the leased aircraft in the airline's fleet:

$$\text{Fleet share}_{i,t} = \sum_{a}^{A} \omega_{i,t,a} \times (\text{number of aircraft}_{i,t,a}/\text{number of aircraft}_{a,t}),$$

where number of aircraft$_{t,a}$ is the number of worldwide aircraft of type a in year t.[15] Panel A of Table IV presents descriptive statistics for the redeployability proxies. As can be seen, the redeployability measure based on aircraft number has an average value of 1,217.2 with a median of 972.9. There are, on average, 152.7 potential buyers for an airline's leased aircraft but only 49.9 when operators with more than five aircraft of the same type are considered (the median number is 41.8). Moreover, on average, an airline in our sample operates 7.57% of the world's fleet of an aircraft type, with a median of 4.4%. Finally, as Panel B of Table IV shows, our redeployability measures are highly correlated.[16]

Table V lists examples of the leased aircraft and the corresponding redeployability measures of selected airlines in 2005. As Table V demonstrates, among the airlines in the table, Alaska Airlines had the most redeployable fleet, while AirTran had the least redeployable fleet in 2005. This is explained by the fact that Alaska Airlines leased some of the most widely used aircraft (31 B737-400, 5 B737-700, and 1 B737-800), while AirTran's leased fleet was dominated by 77 B717-200s, a low-redeployability aircraft with only 155 planes in active operation worldwide in 2005.

V. Empirical Analysis

In this section we analyze empirically the ability of airlines to renegotiate their contractual lease obligations. Our goal is to understand the factors that enable airlines to extract concessions in renegotiation by holding up their lessors, and to estimate the magnitude of the concessions that airlines obtain.

V.A. *Redeployability and Endogeneity*

One concern in using our redeployability measures as proxies for the strength of airlines' bargaining positions vis-à-vis their

15. Note that when the fleet-share redeployability measure is high, the fleet is less redeployable.

16. We include each of the redeployability measures separately in our regression analysis to avoid a multicollinearity problem.

TABLE IV
REDEPLOYABILITY MEASURES

A. Summary statistics

	Mean	25th percentile	Median	75th percentile	Standard deviation	Min	Max
Redeployability (number of aircraft)	1,217.2	642.8	972.9	1672.3	861.0	49.0	3,772.0
Redeployability (number of operators)	152.7	67.3	123.7	216.5	110.3	11.0	542.0
Redeployability (number of operators with more than 5 aircraft)	49.9	21.0	41.8	69.8	35.5	3.1	170.0
Redeployability (fleet share) (%)	7.57	2.33	4.40	7.39	9.71	0.20	58.33

B. Correlation matrix

	Redeployability (number of aircraft)	Redeployability (number of operators)	Redeployability (number of operators with more than 5 aircraft)	Redeployability (fleet share)
Redeployability (number of aircraft)	1.00	0.970 (0.00)	0.985 (0.00)	−0.473 (0.00)
Redeployability (number of operators)		1.00	0.980 (0.00)	−0.444 (0.00)
Redeployability (number of operators with more than 5 aircraft)			1.00	−0.450 (0.00)
Redeployability (fleet share)				1.00

Notes. Panel A provides descriptive statistics for the four redeployability measures used in the empirical analysis. Panel B displays correlations across the four redeployability measures (p-values in parentheses). Redeployability (number of aircraft) is the number of aircraft per type. Redeployability (number of operators) is the number of operators per type. Redeployability (number of operators with more than 5 aircraft) is the number of operators who operate at least 5 aircraft per type; Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type.

TABLE V
REDEPLOYABILITY OF LEASED FLEETS—SELECTED AIRLINES IN 2005

	Redeployability (number of aircraft)	Redeployability (number of operators)	Redeployability (number of operators with >5 aircraft)	Redeployability (fleet share) (%)	Leased aircraft fleet
AirTran	848.1	118.9	39.3	44.0	77 B717-200, 15 B737-700
Alaska	3,071.6	429.6	133.5	1.03	11 MD-80, 31 B737-400 5 737-700, 1 B737-800
American	694.6	111.0	31.1	14.3	24 A-300-600R, 203 MD-80 10 B737-800NG, 56 B-757-200 14 B767-200ER, 13 B767-300ER 4 Fokker-100
Delta	1,072	151.0	45.2	5.67	85 CRJ Regional, 57 MD-88 24 B737-200, 7 B737-300 44 757-200, 20 767-300 9 B767-300ER
JetBlue	1,103.4	150.8	59.8	6.75	25 A320-230, 6 EMB-190
United	1,230.5	180.7	59.1	4.00	55 A320-230, 22 A319 53 B737-300, 3 B737-500 10 B747-400, 53 B757-200 18 B767-300, 16 B777-200ER
U.S. Airways	1,547.5	233.4	74.6	6.41	5 A330-300, 13 A321 68 A320-230, 88 A319 18 EMB170, 23 CRJ200 7 CRJ Regional, 75 B737-300 40 B737-400, 44 757-200 10 B767-200, 6 Dash8-100 9 Dash8-200, 12 Dash8-300

Notes. This table provides values of redeployability measure for selected airlines in 2005 as well as a description of their leased aircraft fleet. Redeployability (number of aircraft) is the number of aircraft per type, Redeployability (number of operators) is the number of operators per type, Redeployability (number of operators with more than 5 aircraft) is the number of operators who operate at least 5 aircraft per type, Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type.

lessors is that the redeployability of an airline's aircraft is endogenous and driven by growth opportunities or profitability.

Although we control in our regressions for airline characteristics, and our identification strategy is based on within-airlines estimates using airline fixed effects, the endogeneity of the redeployability measures is ultimately an empirical question. We test the hypothesis that fleet redeployability is correlated with airline characteristics and report the results in Appendix II. We regress each of our four redeployability measures on airline characteristics: sales, profitability, fleet size as measured by the total number of seats in an airline's leased fleet, the fraction of wide-bodied aircraft leased by the airline, and a dummy variable that equals 1 for airlines in bankruptcy and 0 otherwise. All regressions include year and airline fixed effects, and standard errors are clustered by airline. As can be seen, none of the explanatory variables are statistically significant in explaining aircraft redeployability.[17] We do not include the market-to-book ratio as an explanatory variable in the regressions in Table VI because several airlines do not have publicly traded equity.[18]

The fact that our redeployability measures are not correlated with airline characteristics, such as size, profitability, bankruptcy, and market-to-book measures, alleviates concerns about the endogeneity of our redeployability measures and their correlation with future growth opportunities and financial performance. Furthermore, in our subsequent regression analysis we include airline characteristics and airline fixed effects to control for airline heterogeneity that potentially drives aircraft redeployability.

V.B. Financial Condition, Lease Renegotiation, and Aircraft Redeployability

Our model predicts that firms can credibly renegotiate scheduled payments only when their financial condition is relatively poor. We use years in which airlines' cash flow from operations plus cash balances are less than their interest expense as a proxy for periods in which their threat to renegotiate lease payments is credible (LowCash = 1). While renegotiation itself is

17. To alleviate a multicollinearity concern, we also include each of the regressors individually for each of the redeployability measures and find similar results (not reported).

18. In unreported regressions we included market-to-book for the subsample of airlines with data on equity prices and found no relation between market-to-book and the redeployability measures.

unobservable, we test the model's prediction by estimating the outcomes of contract renegotiation. To do so, we use the ratio of an airline's actual lease payments to its minimum expected lease payments calculated as of the previous year (Actual/Expected$_{-1}$) as our main dependent variable.

Because the ratio of an airline's actual lease payments to its previous year's minimum expected lease payments may increase (decrease) mechanically when airlines expand (reduce) their leased fleet size, we control in our regression analysis for the yearly change in the total number of seats in an airline's leased fleet.[19] In addition, we control for the total seats in the leased fleet, the square of the total seats in the leased fleet, and the composition of the fleet as captured by the fraction of wide-bodied aircraft in the fleet. We hypothesize that after controlling for fleet change, fleet composition, fleet size, and higher-order terms, changes in (Actual/Expected$_{-1}$) should be driven by contract renegotiation. To confirm this hypothesis, we conduct keyword searches of the financial reports of the airlines in our sample and find twenty cases in which airlines report that they have renegotiated aircraft leases. We find that the mean ratio of Actual/Expected$_{-1}$ for airlines that do not report lease renegotiation is 1.07, whereas that of airlines that do report lease renegotiation in their financial reports is 0.91 (t-statistic for an equal means test = 2.38). Furthermore, when we restrict our sample to airlines with LowCash = 1, the mean of Actual/Expected$_{-1}$ is 0.99 for airlines that do not report lease renegotiation, compared to 0.76 for airlines that do report lease renegotiation in their financial reports (t-statistic for an equal means test = 1.79). Thus, confirming our Actual/Expected$_{-1}$ renegotiation measure, airlines that report lease renegotiation pay in lease expenses an amount smaller than their (previous year's) contracted lease payments. Hence, we conclude that after controlling for a battery of fleet covariates that likely soak up changes in lease payments that may be unrelated to renegotiations, changes in our dependent variable capture contract renegotiations.

We run different specifications of the following baseline regression that includes an interaction term between each of the four measures of fleet redeployability and the LowCash dummy

19. As a robustness test we also scale Actual/Expected$_{-1}$ by the yearly change in seat size and find similar results.

variable:

$$
\begin{aligned}
(\text{Actual/Expected}_{-1})_{it} = {} & \alpha \times \text{LowCash}_{it} + \beta \times \text{Redeployability}_{it} \\
& + \gamma \times \text{Redeployability}_{it} \times \text{LowCash}_{it} \\
& + \mathbf{X}_{it}\lambda + \mathbf{y}_t\psi + \mathbf{a}_i\theta + \epsilon_{it},
\end{aligned} \tag{2}
$$

where $(\text{Actual/Expected}_{-1})_{it}$ is the ratio of an airline's actual lease expenses to its previous year's minimum expected lease payments; LowCash_{it} is a dummy variable indicating whether the sum of cash flow from operations and cash balances of airline i is less than its interest expense in year t; $\text{Redeployability}_{it}$ is one of our four measures of the redeployability of an airline's fleet; $\text{Redeployability}_{it} \times \text{LowCash}_{it}$ is an interaction term between LowCash and each of the four redeployability measures; $\mathbf{y}_t$ is a vector of year fixed effects; $\mathbf{a}_i$ is a vector of airline fixed effects; and $\mathbf{X}_{it}$ is a vector of control variables that include the natural logarithm of the airline's sales, the size of the airline's leased fleet as measured by the total number of passenger seats in the airline's leased aircraft, the square of size of the airline's leased fleet, the percentage change in the size of the airline's leased fleet, and the percent of wide-bodied aircraft in an airline's fleet. The first four columns in Table VI report the results of regression (2) for each of our four measures of redeployability, while the next four columns of Table VI report the results of the regressions that also include airline fixed effects. All regressions include robust standard errors that assume groupwise clustering at the airline level.

Consistent with Prediction 1, LowCash is associated with a drop in lease payments in three of the four redeployability measures (the coefficient using the fleet-share redeployability measure is negative but not statistically significant). The coefficients on the first four columns of Table VI indicate that during years of poor financial performance, the average ratio of an airline's actual lease payment to its minimum expected payment is reduced by approximately 10 percentage points.[20] Including airline fixed effects does not qualitatively change the results, although the statistical significance is reduced.

We test Prediction 2 of the model by employing an interaction term between $\text{Redeployability}_{it}$ and the LowCash variable. As

20. This economic effect is calculated at the sample mean of each redeployability measure.

TABLE VI
ACTUAL VS. EXPECTED LEASE EXPENSES, FINANCIAL DISTRESS, AND REDEPLOYABILITY

Dependent variable	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected
Sales	−0.015	−0.019	−0.018	−0.024	0.043	0.043	0.044	0.046	0.043	0.044	0.044
	(−0.59)	(−0.71)	(−0.68)	(−0.81)	(2.08)	(2.05)	(2.01)	(2.12)	(2.09)	(1.94)	(1.92)
Seats $\times 10^{-5}$	−1.212	−1.207	−1.192	−1.323	0.503	0.357	0.443	1.572	0.456	0.483	0.393
	(−1.74)	(−1.71)	(−1.71)	(−1.74)	(0.35)	(0.22)	(0.31)	(0.89)	(0.30)	(0.31)	(0.25)
Seats $\times 10^{-5}$ squared	1.121	1.134	1.103	1.330	0.118	0.267	0.225	−0.654	0.158	0.136	0.227
	(1.34)	(1.35)	(1.32)	(1.50)	(0.10)	(0.21)	(0.19)	(−0.50)	(0.13)	(0.11)	(0.18)
Seats change	0.147	0.158	0.155	0.177	0.274	0.278	0.271	0.244	0.273	0.264	0.264
	(0.86)	(0.92)	(0.89)	(1.07)	(1.47)	(1.56)	(1.50)	(1.56)	(1.43)	(1.54)	(1.51)
Wide-body share	0.035	0.045	0.048	0.097	−0.259	−0.238	−0.209	−0.145	−0.307	−0.215	−0.217
	(0.18)	(0.25)	(0.25)	(0.59)	(−0.56)	(−0.50)	(−0.44)	(−0.31)	(−0.77)	(−0.51)	(−0.50)
LowCash	−0.255	−0.243	−0.248	−0.100	−0.419	−0.437	−0.434	−0.171	−0.296	−0.284	−0.319
	(−2.56)	(−1.66)	(−2.13)	(−0.86)	(−2.12)	(−1.62)	(−2.05)	(−0.93)	(−1.70)	(−1.43)	(−1.80)
Redeployability	−0.00005				−0.00002				−2.52e-08 (a)		
(aircraft)	(−2.34)				(−0.26)				(−0.24)		
× LowCash	0.00013				0.00027				2.92e-07 (a)		
	(2.69)				(2.21)				(2.02)		

TABLE VI
(CONTINUED)

Dependent variable	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected
Redeployability		−0.0003				−0.0002				−5.09e-06 (a)	
(operators)		(−1.70)				(−0.34)				(−0.47)	
× LowCash		0.001				0.0021				0.00003 (a)	
		(1.55)				(1.88)				(1.70)	
Redeployability			−0.0011				−0.0001				−7.55e-06 (a)
(≥5 aircraft)			(−2.05)				(−0.51)				(−0.62)
× LowCash			0.003				0.0068				0.00004 (a)
			(2.03)				(2.18)				(2.16)
Redeployability				0.113				−0.583			
(fleet share)				(0.63)				(−0.58)			
× LowCash				0.648				2.541			
				(0.31)				(0.85)			
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.40	0.39	0.40	0.38	0.64	0.63	0.64	0.62	0.63	0.63	0.63
Observations	177	177	177	177	177	177	177	177	177	177	177

Notes. The dependent variable in the regressions is the ratio of an airline's actual lease expenses to its previous year's minimum expected lease payments—Actual/Expected$_{-1}$. Sales is the logarithm of annual airline sales. Seats is the total number of seats in the leased fleet. Seats squared is the square of the total number of seats in the leased fleet. Seats change is the annual change in Seats. Wide-body share is the fraction of wide-bodied aircraft leased by an airline. LowCash is a dummy variable that equals 1 for airlines in which cash flow from operations (income before extraordinary items + depreciation and amortization) plus cash balances are less than their interest expense, and 0 otherwise. Redeployability (aircraft) is the number of aircraft per type. Redeployability (operators) is the number of operators per type. Redeployability (≥5 aircraft) is the number of operators who operate at least 5 aircraft per type. Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type. Redeployability measures in the table's last three columns are calculated using only publicly traded airlines and by weighting each airline by its cash flow from operations plus cash balances. Regressions also include interactions between each of the Redeployability measures and LowCash. All regressions include an intercept (not reported) and year fixed effects; t-statistics are calculated using standard errors that are clustered by airline and reported in parentheses.

can be seen in Table VI, the coefficients on the noninteracted redeployability measures indicate either a negative relation between fleet redeployability and Actual/Expected$_{-1}$ or a relation that is not statistically different from 0. Thus, during years of relatively good financial performance (LowCash = 0), we find that airlines are *not* able to obtain concessions from their lessors and reduce their lease payments when the redeployability of their assets is low.[21]

However, consistent with Prediction 2 of the model, the results indicate that reduced fleet redeployability *is* associated with lower lease payments when an airline's financial position is relatively poor. As the interaction term between redeployability and LowCash indicates, both with and without airline fixed effects, in years of poor financial performance the relation between redeployability and Actual/Expected$_{-1}$ is now positive using three of our four measures of redeployability (number of aircraft, number of operators, and number of large operators). Put differently, when the threat to renegotiate is more credible, reductions in fleet redeployability measures are associated with reductions in actual lease payments. Using the airline fixed-effect specification, we find that when LowCash = 1, a one-standard-deviation decrease in the redeployability measures decreases an airline's lease payment by approximately 20 percentage points as compared to its minimum expected lease payment.[22] The interaction between the fourth redeployability measure, fleet share, and the LowCash dummy variable implies a similar positive relation between redeployability and Actual/Expected$_{-1}$ but this is not statistically significant.[23] In unreported results we repeat our analysis using as a dependent variable the ratio between actual year t lease payments and the year $t-2$ expected lease payments. We continue to

21. One possible explanation for the negative relation between redeployability and (Actual/Expected$_{-1}$) found in the specifications without airline fixed effects is that firms with highly redeployable fleets have lower lease expenses. Lessors understand that upon default it will be easier to redeploy the aircraft, and therefore charge lessees less up front. This argument is consistent with Benmelech and Bergman (2008), who find that debt tranches that are secured by more redeployable aircrafts have lower credit spreads.

22. Economic magnitudes throughout the paper take into account the total differential of both the level and the interaction term when appropriate. We also test for the statistical significance of the sum of the two coefficients and find that in the specifications that include firm fixed effects they are statistically significant.

23. The firm fixed effects capture (non-time-varying) unobserved differences in firms' ability to renegotiate with lessors. These include management's reputation for "toughness" in renegotiation, managerial quality, or the strength of the employee union in the firm.

find a positive and significant coefficient on the interaction term between redeployability and the LowCash dummy variable.

In the last three columns of Table VI, we weight airlines by their cash flow from operations plus cash balances when constructing the redeployability measures. Following Shleifer and Vishny (1992), this captures the notion that the financial condition of potential buyers is of importance in determining demand for assets.[24] Because accounting data are only available for publicly traded firms, this procedure has the drawback that it does not allow inclusion of private airlines when calculating the aircraft redeployability measures. Still, as can be seen from the last three columns of Table VI, conditional on LowCash = 1 we continue to find a positive relation between (weighted) fleet redeployability and Actual/Expected$_{-1}$ for three of the four redeployability measures.[25] Indeed, conditional on poor financial performance, the coefficients imply that a one-standard-deviation decrease in the redeployability measures reduces actual compared to expected lease payments by between 11.8 and 17.5 percentage points.

For robustness, we repeat our analysis using both lease payments scaled by assets, or changes in lease payments as dependent variables, and report the results in Table VII. In the first four columns of Table VII we use lease expenses scaled by assets as our dependent variable. We find that after controlling for airline fixed effects, there is no statistically significant relation between the level of lease payments and the LowCash dummy variable, or the redeployability measures. However, our main result holds: the interaction between redeployability and LowCash is positive and statistically significant at the 1% level in three of four cases. Thus, consistent with Prediction 2, conditional on poor financial performance—as proxied by LowCash = 1—reductions in fleet redeployability are associated with reductions in (scaled) lease payments. Indeed, a standard deviation reduction in fleet redeployability reduces the ratio of lease payments to assets by between 3.2 to 4.6 percentage points.

Likewise, in the last four columns of Table VII we use the one-year change in lease payments as our dependent variable. Because in these regressions our dependent variable is a rate of change we

24. Our original unweighted redeployability measures also follow this notion in that when calculating the redeployability measures we ignore airlines in bankruptcy as a source of potential demand for aircraft.

25. As above, the coefficient on fleet share is not statistically significant and, for brevity, is not reported in Table VI.

TABLE VII
LEASE EXPENSES, FINANCIAL DISTRESS, AND REDEPLOYABILITY

Dependent variable	Leases/ assets (1)	Leases/ assets (2)	Leases/ assets (3)	Leases/ assets (4)	Change (5)	Change (6)	Change (7)	Change (8)
Sales	0.011	0.011	0.012	0.008	0.040	0.040	0.040	0.034
	(1.10)	(1.11)	(1.12)	(0.80)	(2.13)	(2.04)	(2.07)	(1.61)
Seats $\times 10^{-5}$	1.293	1.242	1.270	0.790	−0.770	−0.721	−0.736	−0.914
	(2.07)	(1.84)	(1.95)	(1.18)	(−2.55)	(−2.39)	(−2.46)	(−2.86)
Seats $\times 10^{-5}$ squared	−0.942	−0.895	−0.911	−0.567	0.572	0.503	0.525	0.810
	(−1.84)	(−1.63)	(−1.72)	(−1.05)	(1.77)	(1.57)	(1.65)	(2.30)
Seats change	0.037	0.038	0.040	0.046	0.385	0.383	0.389	0.378
	(0.87)	(0.87)	(0.83)	(1.07)	(3.15)	(3.14)	(3.16)	(3.31)
Wide-body share	−0.121	−0.106	−0.098	−0.047	0.013	0.004	0.017	0.048
	(−1.25)	(−0.91)	(−0.84)	(−0.54)	(0.22)	(0.06)	(0.27)	(1.05)
LowCash	−0.020	−0.030	−0.012	0.085	−0.208	−0.214	−0.204	−0.184
	(−1.00)	(−1.34)	(−0.55)	(1.83)	(−3.00)	(−2.08)	(−2.55)	(−1.79)
Redeployability	6.57e-06				−0.00004			
(aircraft)	(0.22)				(−1.55)			
× LowCash	0.00005				0.0001			
	(4.14)				(2.77)			
Redeployability		−0.00005				−0.0003		
(operators)		(−0.23)				(−2.13)		
× LowCash		0.0004				0.001		
		(3.30)				(1.68)		

TABLE VII
(CONTINUED)

Dependent variable	Leases/ assets (1)	Leases/ assets (2)	Leases/ assets (3)	Leases/ assets (4)	Change (5)	Change (6)	Change (7)	Change (8)
Redeployability			−0.0001				−0.0009	
(≥5 aircraft)			(−0.15)				(−1.78)	
× LowCash			0.001				0.002	
			(2.77)				(2.28)	
Redeployability				0.289				0.313
(fleet share)				(3.33)				(1.48)
× LowCash				−0.991				2.777
				(−1.15)				(1.19)
Firm fixed effects	Yes	Yes	Yes	Yes	No	No	No	No
Adjusted R^2	0.94	0.94	0.94	0.94	0.35	0.36	0.36	0.36
Observations	184	184	184	184	184	184	184	184

Notes. The dependent variable in the regressions is either the ratio of lease payments to the book value of assets (columns (1)–(4)), or the yearly change in lease payments—Change (columns (5)–(8)). Sales is the logarithm of annual airline sales. Seats is the total number of seats in the leased fleet. Seats squared is the square of the total number of seats in the leased fleet. Seats change is the annual change in Seats. Wide-body share is the fraction of wide-bodied aircraft leased by an airline. LowCash is a dummy variable that equals 1 for airlines in which cash flow from operations (income before extraordinary items + depreciation and amortization) plus cash balances are less than their interest expense, and 0 otherwise. Redeployability (aircraft) is the number of aircraft per type. Redeployability (operators) is the number of operators per type. Redeployability (≥5 aircraft) is the number of operators who operate at least 5 aircraft per type, Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type. Regressions also include interactions between each of the Redeployability measures and LowCash. All regressions include an intercept (not reported) and year fixed effects; t-statistics are calculated using standard errors that are clustered by airline and reported in parenthesis.

do not include airline fixed effects. Consistent with Predictions 1 and 2, we find a robust negative relation between the LowCash dummy variable and the yearly change in lease payments for three of the four redeployability measures. During years when LowCash equals 1, the yearly change in lease payments is reduced by between 10.8 and 11.4 percentage points as compared to years when LowCash is zero. Importantly, consistent with Prediction 2, we find that the interaction between redeployability and LowCash is positive and statistically significant for three out of the four redeployability measures. Therefore, when airlines are doing poorly, reductions in fleet redeployability are associated with reductions in lease payments. A one-standard-deviation reduction in the redeployability measures reduces the change in lease payments by between 3.5 and 4 percentage points.

V.C. Lease Renegotiation in Bankruptcy

We continue our analysis by studying airline bankruptcies. We use years in which an airline is in bankruptcy as a proxy for periods in which airlines can credibly renegotiate their lease payments. While there is a limited number of airline bankruptcies in our sample,[26] given the importance of airline bankruptcies, and because some of the airlines who file for Chapter 11 are among the largest in the industry, we devote a subsection for lease renegotiation in bankruptcy. Furthermore, we hypothesize that because a lessee's threat to reject its leases and return aircraft to lessors is more credible during bankruptcy, the effect of redeployability on the ability to obtain concessions from lessors in lease renegotiation will be stronger than that found in the previous section.

Table VIII presents the results of running the following regression for each of the four redeployability measures:

$$\begin{aligned}(\text{Actual/Expected}_{-1})_{it} = {} & \alpha \times \text{Bankruptcy}_{it} + \beta \times \text{Redeployability}_{it} \\ & + \gamma \times \text{Seats}_{it} \times \text{Bankruptcy}_{it} \\ & + \sigma \times \text{Redeployability}_{it} \times \text{Bankruptcy}_{it} \\ & + \mathbf{X}_{it}\lambda + \mathbf{y}_t\psi + \mathbf{a}_i\theta + \epsilon_{it}, \end{aligned} \tag{3}$$

26. We include both bankruptcies of U.S. Airways (2002–2003 and 2004–2005), and the bankruptcies of ATA, Comair Delta Airlines, Mair, Northwest, and United Airlines. We were not able to obtain data for the second bankruptcy of TWA (1995), and for the bankruptcies of Hawaiian Airlines and Tower. We do not include the third bankruptcy of TWA because it was acquired by American Airlines.

TABLE VIII
ACTUAL VS. EXPECTED LEASE EXPENSES, BANKRUPTCY, AND REDEPLOYABILITY

Dependent variable	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected
Sales	−0.056	−0.052	−0.053	−0.102	0.019	0.027	0.023	−0.005
	(−2.09)	(−1.98)	(−2.01)	(−3.03)	(0.61)	(0.87)	(0.75)	(−0.16)
Seats $\times 10^{-5}$	−0.547	−0.640	−0.586	−0.002	0.066	−0.048	−0.118	0.678
	(−0.78)	(−0.93)	(−0.84)	(−0.00)	(0.04)	(−0.03)	(−0.07)	(0.35)
Seats $\times 10^{-5}$ squared	0.539	0.641	0.570	0.092	0.465	0.594	0.627	0.106
	(0.69)	(0.82)	(0.73)	(0.12)	(0.35)	(0.42)	(0.46)	(0.07)
Seats change	0.171	0.174	0.175	0.183	0.248	0.256	0.256	0.240
	(1.40)	(1.39)	(1.40)	(1.52)	(1.38)	(1.47)	(1.47)	(1.49)
Wide-body share	0.088	0.089	0.090	0.110	−0.171	−0.152	−0.122	−0.065
	(0.54)	(0.56)	(0.56)	(0.78)	(−0.35)	(−0.30)	(−0.25)	(−0.12)
Profitability	0.160	0.168	0.162	0.256	0.087	0.085	0.088	0.078
	(1.29)	(1.33)	(1.31)	(2.04)	(0.50)	(0.48)	(0.53)	(0.42)
Bankruptcy	−0.252	−0.194	−0.212	1.113	−0.277	−0.257	−0.271	0.643
	(−0.76)	(−0.51)	(−0.63)	(3.46)	(−1.49)	(−1.33)	(−1.46)	(3.39)
Seats $\times 10^{-5}$	−0.002	−0.0024	−0.0025	−0.004	−0.001	−0.0009	−0.001	−0.002
× bankruptcy	(−2.67)	(−2.23)	(−2.58)	(−3.76)	(−1.17)	(−0.98)	(−1.23)	(−2.82)
Redeployability	−0.00002				−0.00006			
(aircraft)	(−1.35)				(−0.49)			
× bankruptcy	0.0005				0.00036			
	(2.35)				(2.02)			
Redeployability		−0.0002				−0.0004		
(operators)		(−0.89)				(−0.50)		
× bankruptcy		0.003				0.0024		
		(1.75)				(1.73)		

TABLE VIII
(CONTINUED)

Dependent variable	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected
Redeployability			−0.0006				−0.002	
(≥ 5 aircraft)			(−1.15)				(−0.80)	
× bankruptcy			0.010				0.009	
			(2.17)				(2.00)	
Redeployability				0.058				−0.267
(fleet share)				(0.45)				(−0.27)
× bankruptcy				−5.189				−3.070
				(−4.75)				(−2.60)
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Adjusted R^2	0.44	0.43	0.44	0.47	0.62	0.62	0.62	0.63
Observations	177	177	177	177	177	177	177	177

Notes. The dependent variable in the regressions is the ratio of an airline's actual lease expenses to its previous year's minimum expected lease payments—Actual/Expected$_{-1}$. Sales is the logarithm of annual airline sales. Seats is the total number of seats in the leased fleet. Seats squared is the square of the total number of seats in the leased fleet. Seats change is the annual change in Seats. Wide-body share is the fraction of wide-bodied aircraft leased by an airline. Profitability is operating income before depreciation divided by the book value of assets. Bankruptcy is a dummy variable taking on the value of 1 in those years in which an airline is under the protection of Chapter 11, and 0 otherwise. Redeployability (aircraft) is the number of aircraft per type. Redeployability (operators) is the number of operators per type. Redeployability (≥5 aircraft) is the number of operators who operate at least 5 aircraft per type. Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type. Regressions also include interactions between Fleet and Bankruptcy, and between each of the Redeployability measures and Bankruptcy. All regressions include an intercept (not reported) and year fixed effects; t-statistics are calculated using standard errors that are clustered by airline and reported in parenthesis.

where Bankruptcy is a dummy variable taking on the value of 1 in those years in which an airline is under the protection of Chapter 11, and 0 otherwise. Seats_{it} is the total number of seats in an airline's leased fleet, $\text{Seats}_{it} \times \text{Bankruptcy}_{it}$ is an interaction term between Bankruptcy and Seats_{it}, and the rest of the variables are identical to those in regression (2). Consistent with our model, during bankruptcy, the relation between redeployability and $\text{Actual/Expected}_{-1}$ is positive using all four measures of redeployability. Also, as hypothesized, consistent with a more credible threat of lease rejection, the effect of reduced fleet redeployability is generally stronger in bankruptcy than in periods when LowCash = 1. In the specifications without airline fixed effects, we find that in bankruptcy, a one-standard-deviation decrease in the fleet redeployability measures decreases an airline's lease payments by between 30 and 49 percentage points below its contractual lease payment. In the specifications that include airline fixed effects, this effect is between 22.1 percentage points (number-of-operators redeployability measure) and 32.4 percentage points (fleet-share redeployability measure). The fleet-share measure captures an airline's threat to reject leases on a massive scale—a threat that is most credible in bankruptcy. Thus, as opposed to when using the LowCash variable, when proxying for poor financial performance using the bankruptcy dummy variable, fleet share is statistically significant.

Finally, in Table VIII we also include the interaction between fleet size and the Bankruptcy_{it} variable to capture the possibility that airlines with large fleets can extract concessions by threatening their lessors with massive liquidation as in the case of TWA's acquisition. We find support for this hypothesis in that the coefficient on this interaction variable is negative in all eight specifications, and is statistically significant in five of them.

V.D. Lease Renegotiation out of Bankruptcy

We now test whether our results are driven solely by the ability of firms to renegotiate while in bankruptcy, by including only those airline-years in which airlines are outside of bankruptcy. The results are presented in the first four columns of Table IX.

Our results continue to hold when focusing only on airlines out of bankruptcy: First, as in Table VI, the LowCash dummy variable is negatively related to $\text{Actual/Expected}_{-1}$ in three of the four redeployability measures. Second, and more important, among airlines with LowCash = 1, there is a positive relation

TABLE IX
OUT OF BANKRUPTCY RENEGOTIATION AND LARGE CONCESSIONS

Dependent variable	Actual/ expected (1)	Actual/ expected (2)	Actual/ expected (3)	Actual/ expected (4)	[Actual/ expected] ≥ 1 (5)	[Actual/ expected] ≥ 1 (6)	[Actual/ expected] ≥ 1 (7)	[Actual expected] ≥ 1 (8)
Sales	−0.074	−0.093	−0.068	−0.093	−0.034	−0.025	−0.028	−0.080
	(−0.49)	(−0.62)	(−0.48)	(−0.69)	(−0.81)	(−0.58)	(−0.65)	(−1.72)
Seats $\times 10^{-5}$	1.121	1.090	0.875	2.041	−3.694	−3.676	−3.696	−3.364
	(0.56)	(0.51)	(0.45)	(0.79)	(−2.36)	(−2.36)	(−2.35)	(−2.10)
Seats $\times 10^{-5}$ squared	−0.611	−0.591	−0.436	−1.289	4.120	4.041	4.073	4.070
	(−0.42)	(−0.38)	(−0.31)	(−0.67)	(2.06)	(2.04)	(2.04)	(2.03)
Seats change	0.267	0.271	0.268	0.251	0.151	0.170	0.177	0.152
	(1.56)	(1.66)	(1.61)	(1.60)	(0.84)	(0.96)	(1.01)	(0.76)
Wide-body share	0.029	0.070	0.090	0.009	−0.618	−0.650	−0.597	−0.405
	(0.06)	(0.14)	(0.18)	(0.02)	(−1.32)	(−1.37)	(−1.28)	(−0.94)
LowCash	−0.488	−0.507	−0.478	−0.190	−0.695[a]	−0.654[a]	−0.632[a]	−0.030[a]
	(−3.42)	(−2.14)	(−2.88)	(−1.18)	(−3.00)	(−2.77)	(−2.91)	(−0.17)
Redeployability (aircraft)	−0.000017				−0.0001			
	(−0.15)				(−1.99)			
$\times$ LowCash	0.00025				0.0004			
	(3.30)				(2.07)			
Redeployability (operators)		−0.00016				−0.001		
		(−0.22)				(−2.21)		
$\times$ LowCash		0.002				0.0025		
		(2.34)				(1.90)		

TABLE IX
(CONTINUED)

Dependent variable	Actual/ expected (1)	Actual/ expected (2)	Actual/ expected (3)	Actual/ expected (4)	[Actual/ expected] ≥ 1 (5)	[Actual/ expected] ≥ 1 (6)	[Actual/ expected] ≥ 1 (7)	[Actual expected] ≥ 1 (8)
Redeployability			−0.001				−0.003	
(≥5 aircraft)			(−0.55)				(−1.97)	
× LowCash			0.006				0.007	
			(2.87)				(1.93)	
Redeployability				−0.491				1.640
(fleet share)				(−0.50)				(2.45)
× LowCash				0.404				−5.385
				(0.10)				(−2.45)
Firm fixed effects	Yes	Yes	Yes	Yes No	No	No	No	
Adjusted R^2	0.62	0.62	0.62	0.62	0.43[b]	0.43[b]	0.43[b]	0.45[b]
Estimation method	OLS	OLS	OLS	OLS	probit	probit	probit	probit
Observations	166	166	166	166	177	177	177	177

Notes. The dependent variable in the regressions is either the ratio of an airline's actual lease expenses to its previous year's minimum expected lease payments—Actual/Expected$_{-1}$ (columns (1)–(4)), or a dummy variable taking on a value of 1 when Actual/Expected$_{-1}$ is greater than one–(columns (5)–(8)). Seats is the total number of seats in the leased fleet. Seats squared is the square of the total number of seats in the leased fleet. Seats change is the annual change in Seats. Wide-body share is the fraction of wide-bodied aircraft leased by the airline. LowCash is a dummy variable that equals 1 for airlines in which cash flow from operations (income before extraordinary items + depreciation and amortization) plus cash balances are less than their interest expense, and 0 otherwise. Redeployability (aircraft) is the number of aircraft per type. Redeployability (operators) is the number of operators per type. Redeployability (≥5 aircraft) is the number of operators who operate at least 5 aircraft per type. Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type. Regressions also include interactions between each of the Redeployability measures and LowCash. All regressions include an intercept (not reported) and year fixed effects; t-statistics (z-statistics for the probit regressions) are calculated using standard errors that are clustered by airline and reported in parentheses. The Table also reports R^2.

[a] dy/dx is for discrete change of dummy variable from 0 to 1.

[b] pseudo R^2.

between redeployability and the amount of actual compared to expected lease payments in three of the four redeployability measures. Thus, we find that, even outside of bankruptcy, airlines can renegotiate with their lessors and cut their lease rates when their fleets are less redeployable and their financial condition is sufficiently poor.

V.E. Large Concessions

As an additional test of our model, we proxy for renegotiation using a dummy variable that takes on a value of 0 when Actual/Expected$_{-1}$ is less than 1 and equals 1 otherwise. A 0 value of the dummy variable represents cases in which airlines paid an amount smaller than their minimum contracted lease payment.[27] We repeat the analysis in regression (2) using a probit model with this dummy variable as a dependent variable.[28]

The last four columns of Table IX present the results. As can be seen, our results are unchanged: Consistent with Prediction 1, in three of the four specifications airlines in poor financial condition are more likely to obtain concessions, as evidenced by a higher probability of having a ratio of Actual/Expected$_{-1}$ which is less than 1. Consistent with Prediction 2, conditional on LowCash $= 1$, reductions in all of the four redeployability measures are associated with a greater likelihood that an airline's lease payments are smaller than its minimum contracted lease payments. The coefficients indicate that a standard-deviation reduction in the redeployability measures increases the likelihood of lease renegotiation by between 14.2 and 36.4 percentage points, representing an increase of between 23.9% and 61.1% relative to the unconditional mean event of large concessions.

V.F. 9/11 and Lease Renegotiations

Finally, we document the effect of the September 11, 2001, attacks on airline lease renegotiation. The 9/11 attacks shook the American airline industry drastically and affected both cash flows and liquidation values in the industry. Average profitability of airlines in our sample was 13.31% in the period 1994–2000, and only 4.77% in the period 2001–2005 (t-statistic for an equal means

27. In unreported results, we repeat this exercise with a 0.9 cutoff threshold for Actual/Expected$_{-1}$ and obtain similar results.

28. We do not include airline fixed effects in the probit specification given the incidental parameters problem a fixed effects probit introduces (Wooldridge 2002). We find similar results using a linear probability model with airline fixed effects.

test = 3.86). Similarly, liquidation values of aircraft declined sharply after 9/11:

> Prices for used jets are down as much as 40% since 2000, their lowest level in at least 15 years. . . . The soft market for airplanes gives bankrupt airlines tremendous leverage when it comes to renegotiating their leases.[29]

We examine the implications of the 9/11 attacks for lease renegotiations. The attacks were an exogenous shock to the airline industry that affected both airline cash flows and liquidation values. Because we cannot separate the effects of the exogenous 9/11 shock on liquidation values and cash flows, we repeat the analysis in regression (2) using (Actual/Expected$_{-1}$) as our dependent variable and include a dummy variable that equals 1 for the years 2001–2005 (Post-9/11), and 0 otherwise. As Table X demonstrates, the coefficients on the Post-9/11 dummy variable suggest that contractual lease obligations were reduced by approximately 13.0 percentage points (t-statistics between -1.96 and -3.02). Furthermore, all our results hold after controlling for the Post-9/11 dummy. Thus, the exogenous shock of the 9/11 attacks that affected both cash flows and liquidation values had a large impact on lease contract renegotiations.

VI. Conclusion

In this paper we analyze theoretically and empirically firms' ability to renegotiate financial obligations from an incomplete-contracting perspective. We provide a simple model showing that firms will be able to credibly renegotiate for better terms only when their financial position is relatively poor, that firms' ability to reduce their prespecified commitments will increase when the liquidation values of their assets decrease, but, importantly, that this effect will be concentrated in those times when renegotiation is credible. We proceed by analyzing lease renegotiation in a sample of publicly traded U.S. airlines. Our empirical results indicate that, consistent with the model, airlines in relatively poor financial position are able to renegotiate and reduce their lease payments with lessors. Furthermore, using measures of fleet redeployability as a proxy for the liquidation value lessors would obtain upon the default of an aircraft lease, we show that when airlines are in poor financial condition, lower fleet redeployability

29. Kahn (2003).

TABLE X
ACTUAL VS. EXPECTED LEASE EXPENSES AND 9/11 SHOCK

Dependent variable	Actual/ expected	Actual/ expected	Actual/ expected	Actual/ expected
Sales	0.043	0.043	0.044	0.046
	(2.92)	(2.84)	(2.89)	(2.27)
Seats $\times 10^{-5}$	0.503	0.357	0.443	1.572
	(0.36)	(0.21)	(0.31)	(0.96)
Seats $\times 10^{-5}$ squared	0.118	0.267	0.225	−0.654
	(0.13)	(0.24)	(0.24)	(−0.54)
Seats change	0.274	0.278	0.271	0.244
	(1.59)	(1.63)	(1.59)	(1.60)
Wide-body share	−0.259	−0.238	−0.209	−0.145
	(−0.57)	(−0.48)	(−0.45)	(−0.31)
Post-9/11	−0.130	−0.129	−0.133	−0.132
	(−2.49)	(−1.96)	(−2.41)	(−3.02)
LowCash	−0.419	−0.437	−0.434	−0.171
	(−1.61)	(−1.70)	(−1.65)	(−0.89)
Redeployability	−0.000025			
(aircraft)	(−0.34)			
× LowCash	0.0003			
	(2.17)			
Redeployability		−0.0002		
(operators)		(−0.41)		
× LowCash		0.0021		
		(2.27)		
Redeployability			−0.001	
(≥5 aircraft)			(−0.53)	
× LowCash			0.007	
			(2.18)	
Redeployability				−0.583
(fleet share)				(−0.91)
× LowCash				2.541
				(0.74)
Firm fixed effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.64	0.63	0.64	0.62
Observations	177	177	177	177

Notes. The dependent variable in the regressions is the ratio of an airline's actual lease expenses to its previous year's minimum expected lease payments—Actual/Expected$_{-1}$. Sales is the logarithm of annual airline sales. Seats is the total number of seats in the leased fleet. Seats squared is the square of the total number of seats in the leased fleet. Seats change is the annual change in Seats. Wide-body share is the fraction of wide-bodied aircraft leased by an airline. Post-9/11 is a dummy variable taking on the value of 1 for each year following and including year 2000, and 0 otherwise. LowCash is a dummy variable that equals 1 for airlines in which cash flow from operations (income before extraordinary items + depreciation and amortization) plus cash balances are less than their interest expense, and 0 otherwise. Redeployability (aircraft) is the number of aircraft per type. Redeployability (operators) is the number of operators per type. Redeployability (≥5 aircraft) is the number of operators who operate at least 5 aircraft per type. Redeployability (fleet share) is the ratio between the number of leased aircraft per type that an airline has and the total number of aircraft per type. Regressions also include interactions between each of the Redeployability measures and LowCash. All regressions include an intercept (not reported) and year fixed effects; t-statistics are calculated using standard errors that are clustered by airline and reported in parenthesis.

increases their ability to reduce lease payments. Our evidence supports the incomplete contracting literature in that the ability of firms to renegotiate their financial commitments depends heavily on their bargaining position vis-à-vis liability holders. This bargaining position is determined, in turn, by both the credibility of threats made during renegotiation and by the outside option of the bargaining parties.

APPENDIX I

Proof. In this Appendix we solve for the SPE of the subgame beginning after the Lessee has decided to trigger renegotiation. In doing so, we need only consider the case when $C_1 + L < l_1 + l_2$. When this inequality does not hold, the Lessee clearly never triggers renegotiation because the Lessor can obtain *full* repayment through the court-imposed solution. We prove the following lemma.

LEMMA. Assuming that $C_1 + L < l_1 + l_2$, then in the SPE of the subgame that begins after the Lessee triggers renegotiation, the Lessee immediately offers the Lessor a new schedule of payments (p_1, p_2) with $p_1 + p_2 = C_1 + 1/2(C_2 + L)$ and $p_1 \leq C_1$. The Lessor accepts the offer, so that payoffs to the parties are as follows: The Lessee obtains $1/2(C_2 - L)$, and the Lessor obtains $C_1 + 1/2(C_2 + L)$.

Proof. The lemma is a particular example of a standard result in alternating-offers games (see, e.g., Rubenstein [1982]), which shows that under certain conditions, the axiomatic Nash bargaining solution coincides with the subgame perfect equilibrium of the alternating-offer game. The proof is by backward induction. First, suppose that the value of the second-period cash flow has deteriorated to a level below L. In this case, the only offer that the Lessor will accept is one in which the Lessee liquidates the firm and pays out all proceeds, along with C_1, to the Lessor, for a total payment of $C_1 + L$. This is because of the fact that the Lessor can guarantee $C_1 + L$ by refusing all offers and waiting for the court-imposed solution, while the Lessee cannot offer more than this amount because of the deterioration of the second-period cash flow.[30]

By backward induction, to solve for the SPE, we can consider a revised game in which the subgame following the point in which

30. Because $C_1 + L$ is assumed to be less than $l_1 + l_2$, the lessee obtains $C_1 + L$ under the court-imposed solution.

second-period cash flow equals L is replaced with a terminal node having a payoff of $C_1 + L$ to the Lessor and a payoff of zero to the Lessee. Consider, therefore, the game in which after a rejection by either party, period 2 cash flow is reduced by $(1/N) * (C_2 - L)$ (with N large) so that after N rejected offers, period 2 cash flow equals L and parties receive their terminal payoffs of $C_1 + L$ and 0. Assume that, without loss of generality, the Lessor makes the final offer prior to second-period cash flow deteriorating to L and that N is even. Finally, for convenience, we number the N rounds of alternating offers in *reverse* order with round N referring to the round in which the first offer is made, and round 1 referring to the round in which the last offer is made, that is, prior to second-period cash flow deteriorating to L. Because the Lessee is not allowed to pay dividends until all lease obligations are fulfilled, we can analyze repayment schedules (p_1, p_2) based on their sum $(p_1 + p_2)$. It should also be noted that because cash flows obtained by the firm are not expropriable, at $t = 2$ the Lessee will never be able to renegotiate lease payments.

In the last round of the alternating offer process (round 1), second-period cash flow equals $L + (1/N) * (C_2 - L)$. The Lessor's optimal repayment-schedule offer has $p_1 + p_2 = C_1 + L + (1/N) * (C_2 - L)$, which leaves 0 for the Lessee. It is optimal because the Lessee is indifferent between accepting this offer and refusing it, because if he refuses, cash flow will deteriorate to L and he will obtain a terminal payoff of 0 anyway. Without loss of generality we assume that the Lessee accepts the offer. In round 2, in which it is the Lessee's turn to make an offer, second-period cash flow equals $L + (2/N) * (C_2 - L)$. To induce the lessor to accept a round 2 offer, the lessee must offer the lessor a payment schedule (p_1, p_2) with $p_1 + p_2 \geq C_1 + L + (1/N) * (C_2 - L)$, as this is what the Lessor can guarantee by refusing the round 2 offer and proceeding to round 1. The Lessee therefore offers $p_1 + p_2 = C_1 + L + (1/N) * (C_2 - L)$ leaving $(1/N) * (C_2 - L)$ for himself, and the Lessor accepts. The backward induction solution continues to unravel in a similar manner; in round i, the party making the offer—be it Lessor or Lessee—offers to his counterpart the amount that the counterpart will obtain in round $i - 1$ and keeps the remaining surplus to himself. Because in each round no rents are left on the table, every period the offerer will increase his payoff by $(1/N) * (C_2 - L)$, whereas the offeree will see no change in his payoff as compared to the previous round. By induction, therefore, at every even-numbered round i, the SPE has the Lessee offering the Lessor a repayment schedule of $p_1 + p_2 = C_1 + L + (i/2N) * (C_2 - L)$, and the Lessor accepting. Thus, at round N (the first round), the Lessor offers the Lessee a payment schedule with a total payment of $C_1 + L + 1/2(C_2 - L)$. Payoffs to the parties are as in Lemma 1. ■

Next, we prove Proposition 1 in Section II.

Proof. If the lessee is in financial distress in that $(C_1 + C_2) < (l_1 + l_2)$, he will obviously choose to renegotiate and obtain a strictly positive payoff rather than abide by the original contract and obtain a payoff of zero. In contrast, when the Lessee is not in financial distress, he will trigger renegotiation when his payoff from doing so, $1/2(C_2 - L)$, is greater than his payoff from abiding by the contract $(C_1 + C_2) - (l_1 - l_2)$. This can be rearranged to yield equation (1) of Proposition 1. If renegotiation does not occur and $C_1 < l_1$, the only way to pay l_1 at t = 1 is by raising additional capital against t = 2 cash flow. This is feasible, however, because case (b) of the proposition has $C_1 + C_2 > l_1 + l_2$. ■

APPENDIX II. REDEPLOYABILITY AND AIRLINE CHARACTERISTICS

Dependent variable	Redeployability (no. of aircraft)	Redeployability (no. of operators)	Redeployability (no. of operators ≥5 aircraft)	Redeployability (fleet share)
Sales	20.80	−2.21	0.233	0.013
	(0.59)	(−0.51)	(0.15)	(1.33)
Seats × 10^{-5}	−854.51	−199.88	−41.90	0.400
	(−0.85)	(−1.27)	(−0.93)	(1.65)
Wide-body	383.85	72.04	26.64	0.012
	(0.48)	(0.57)	(0.66)	(0.07)
Profitability	−43.74	−0.067	−3.67	0.002
	(−0.11)	(−0.00)	(−0.25)	(0.05)
Bankruptcy	−101.70	−21.56	−3.29	0.011
	(−0.51)	(−0.70)	(−0.33)	(0.48)
Firm fixed effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.89	0.88	0.89	0.77
Observations	213	213	213	213

Notes. This table regresses fleet redeployability measures on airline characteristics. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type, Redeployability (≥5 aircraft) is the number of operators who operate at least 5 aircraft per type. Sales is the logarithm of annual airline sales. Seats is the total number of seats in the aircraft leased by the airline. Wide-body is the fraction of wide-bodied aircraft leased by the airline. Profitability is operating income before depreciation divided by the book value of assets. Bankruptcy is a dummy variable taking on the value of 1 in those years in which an airline is under the protection of Chapter 11, and 0 otherwise. All regressions include an intercept (not reported) as well as year fixed effects; t-statistics are calculated using standard errors that are clustered by airline and reported in parenthesis.

HARVARD UNIVERSITY AND NBER
MIT SLOAN SCHOOL OF MANAGEMENT

REFERENCES

Acharya, Viral, Sreedhar Bharath, and Anand Srinivasan, "Does Industry-wide Distress Affect Defaulted Firms?—Evidence from Creditor Recoveries," *Journal of Financial Economics*, 85 (2007), 787–821.

Aghion, Philippe, and Patrick Bolton, "An Incomplete Contracts Approach to Financial Contracting," *Review of Economic Studies*, 59 (1992), 473–494.

Asquith, Paul, Robert Gertner, and David Scharfstein, "Anatomy of Financial Distress: An Examination of Junk-Bond Issuers," *Quarterly Journal of Economics*, 109 (1994), 625–658.

Baird, Douglas, G., and Randal C., Picker, "A Simple Noncooperative Bargaining Model of Corporate Reorganizations," *Journal of Legal Studies*, 20 (1991), 311–349.

Baird, Douglas, G., and Robert K. Rasmussen, "Reply Chapter 11 at Twilight," *Stanford Law Review*, 56 (2003), 673–699.

Bebchuck, Lucian A., and Howard F. Chang, "Bargaining and the Division of Value in Corporate Reorganizations," *Journal of Law, Economics, and Organizations*, 8 (1992), 253–279.

Benmelech, Efraim, "Asset Salability and Debt Maturity: Evidence from 19th Century American Railroads," *Review of Financial Studies,* forthcoming, 2008.

Benmelech, Efraim, and Nittai K. Bergman "Collateral Pricing," *Journal of Financial Economics*, forthcoming, 2008.

Benmelech, Efraim, Mark J. Garmaise, and Tobias J. Moskowitz, "Do Liquidation Values Affect Financial Contracts? Evidence from Commercial Loan Contracts and Zoning Regulation," *Quarterly Journal of Economics*, 120 (2005), 1121–1154.

Bergman, Nittai K., and Daniel Nicolaievsky, "Investor Protection and the Coasian View," *Journal of Financial Economics*, 84 (2007), 738–771.

Bergman, Yaacov Z., and Jeffery L. Callen, "Opportunistic Underinvestment in Debt Renegotiation and Capital Structure," *Journal of Financial Economics*, 29 (1991), 137–171.

Bolton, Patrick, and David Scharfstein, "Optimal Debt Structure with Multiple Creditors," *Journal of Political Economy*, 104 (1996), 1–26.

Buhler, Gregory W., "Airline Bankruptcies and Workouts: Lessons Learned," Schnader Harrison Segal & Lewis LLP, April 2003.

Carey, Susan, "American Airlines' TWA Financing Plan Is Approved, Although Rivals Cry Foul," *Wall Street Journal*, January 29, 2001, A3.

Eisfeldt, Andrea, and Adriano Rampini, "Leasing, Ability to Repossess, and Debt Capacity," *Review of Financial Studies*, forthcoming, 2008.

Eraslan, K. K. Hülya, "Corporate Bankruptcy Reorganizations: Estimates from a Bargaining Model," *International Economic Review*, 49 (2008), 659–681.

Gavazza, Alessandro, "Asset Liquidity, Boundaries of the Firm and Financial Contracts: Evidence from Aircraft Leases," Working Paper, Yale University, 2006.

Gromb, Denis, "Renegotiation in Debt Contracts," Working Paper, Université Libre de Bruxelles, 1995.

Hart, Oliver, *Firms, Contracts, and Financial Structure* (Oxford: Oxford University Press, 1995).

Hart, Oliver, and John Moore, "A Theory of Debt Based on the Inalienability of Human Capital," *Quarterly Journal of Economics*, 109 (1994), 841–879.

——, "Default and Renegotiation: A Dynamic Model of Debt," *Quarterly Journal of Economics*, 113 (1998), 1–41.

Kahn, Jeremy, "The Great Airline Leasing Disaster," *Fortune*, January 20, 2003.

Kaplan, Steven N., and Per Strömberg, "Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts," *Review of Economic Studies*, 70 (2003), 281–315.

Pulvino, Todd C., "Do Fire-Sales Exist? An Empirical Investigation of Commercial Aircraft Transactions," *Journal of Finance*, 53 (1998), 939–978.

——, “Effects of Bankruptcy Court Protection on Asset Sales,” *Journal of Financial Economics*, 52 (1999), 151–86.
Rubinstein, Ariel, “Perfect Equilibrium in a Bargaining Model,” *Econometrica*, 50 (1982), 97–110.
Shleifer, Andrei, and Robert W. Vishny, “Liquidation Values and Debt Capacity: A Market Equilibrium Approach,” *Journal of Finance*, 47 (1992), 143–166.
Strömberg, Per, “Conflicts of Interests and Market Illiquidity in Bankruptcy Auctions: Theory and Tests,” *Journal of Finance*, 55 (2000), 2641–2692.
Wooldridge, Jeffrey M., *Econometric Analysis of Cross Section and Panel Data* (Cambridge, MA, and London: MIT Press, 2002).