Journal of Financial Economics 91 (2009) 339–360

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Collateral pricing ☆

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ARTICLE INFO

Article history:
Received 15 March 2007
Received in revised form
18 February 2008
Accepted 3 March 2008
Available online 30 November 2008

JEL classification:
G24
G32
G33

Keywords:
Collateral
Redeployability
Liquidation
Collateralized debt obligations
Airlines

ABSTRACT

We examine how collateral affects the cost of debt capital. Using a novel data set of secured debt issued by U.S. airlines, we construct industry-specific measures of collateral redeployability. We show that debt tranches that are secured by more redeployable collateral exhibit lower credit spreads, higher credit ratings, and higher loan-to-value ratios—an effect which our estimates show to be economically sizeable. Our results suggest that the ability to pledge collateral, and in particular redeployable collateral, lowers the cost of external financing and increases debt capacity.

1. Introduction

Collateral is of central importance in the theory and practice of corporate finance. In particular, collateral allows the creditor to recover, at least partially, a loan made to a debtor. The ability to seize and sell collateral when a debtor fails to make a promised payment reduces the creditor's expected losses upon default. All else equal, therefore, if a firm pledges collateral when issuing bonds or taking a loan, the price at which it obtains credit should be lower.

There is an extensive theoretical literature showing that collateral can be used to alleviate financial frictions stemming from moral hazard and adverse selection effects (Aghion and Bolton, 1992; Johnson and Stulz, 1985; Hart and Moore, 1994, 1998; Hart, 1995). The presence of collateral in a loan, therefore, may be correlated with unobserved firm characteristics which have a first order impact on loan rates. For example, previous theories focusing on moral hazard argue that firms with greater default risk pledge collateral as a mechanism to increase pledgeable income (see, e.g., Berger and Udell, 1990; Eisfeldt and Rampini, 2009; Rampini and Viswanathan, 2008; Tirole, 2005). Consistent with these theories, empirical evidence shows that creditors require firms with poor repayment histories or firms with greater default risk to secure their loans with collateral (see, e.g., Hester, 1979; Berger and Udell, 1995; Jimenez, Salas, and Saurina, 2006).

The selection effect, in which riskier firms are more likely to be required to pledge collateral, makes it difficult to analyze the impact of collateral on loan rates by

☆ We thank Paul Asquith, George Baker, Amiyatosh Purnanandam, Adriano Rampini, Jeremy Stein, Amir Sufi, seminar participants at the 2008 AFA meetings in New Orleans, Harvard University, University of Illinois, and the University of Michigan's 15th Mitsui Life Symposium and an anonymous referee for very constructive and helpful comments. We also thank Robert Grundy and Phil Shewring from Aircraims Inc. Alex Bayers provided excellent research assistance. All errors are our own.

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doi:10.1016/j.jfineco.2008.03.003

examining the extensive margin of collateral use—i.e., whether a loan has collateral or not. Indeed, a number of past studies find a *positive* relation between loan rates and the existence of collateral, consistent with a moral hazard induced selection effect in which collateral is required of high default-risk firms (see, e.g., Berger and Udell, 1990; John, Lynch, and Puri, 2003; Knox, 2005). Testing the effect of collateral on loan rates by analyzing its extensive margin suffers, therefore, from endogeneity and selection bias.

In this paper, we study collateral pricing by examining the *intensive margin* of collateral use—i.e., variation in the value of collateral to lenders. Using a novel data set of secured debt tranches issued by U.S. airlines, we construct measures of collateral redeployability as a proxy for creditors' expected value of collateral upon default. We show that asset redeployability is negatively related to credit spreads, and positively related to credit ratings and loan-to-value ratios in an economically significant manner. Thus, focusing on a particular industry and examining the intensive, rather than the extensive, margin of collateral values reveals a negative impact of collateral on the price and amount of debt, and enables us to estimate the magnitude of this effect.

Airlines in the U.S. issue tranches of collateralized debt obligations (CDOs) which take a variety of formats known as equipment trust certificates (ETCs), enhanced equipment trust certificates (EETCs), and pass through certificates (PTCs). Pledging aircraft from an airline's fleet as collateral, these debt instruments served as the main source of external financing for U.S. airlines during the 1994–2005 period. We construct a sample of aircraft tranche issues from SDC Platinum and then use filing prospectuses to obtain the serial number of all aircraft that were pledged as collateral. Matching aircraft serial numbers to the Ascend CASE airline database—a database containing information on all commercial aircraft worldwide—we obtain detailed information about aircraft characteristics such as aircraft type, engines, noise level, and age. As a result, for each of the debt tranches in our sample we can identify precisely its underlying collateral.

Using the Ascend CASE database, we also construct measures of aircraft redeployability to proxy for the expected value of collateral to creditors upon default. Our proxies for aircraft redeployability are motivated by Shleifer and Vishny's (1992) industry equilibrium model. We use three measures of aircraft redeployability: (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. Our measures of aircraft redeployability are proxies for the ease at which creditors will be able to liquidate their positions, and hence capture the value to creditors of the collateral backing each secured tranche. We then examine the relation between our measures of collateral redeployability and credit spreads controlling for airline and tranche characteristics.

One concern about the effect of collateral values on credit spreads is a selection effect along the intensive margin similar in spirit to that shown in previous literature. If higher default-risk firms are required not only to pledge collateral, but also to pledge collateral of *greater* redeployability, increases in our redeployability measures would, in part, proxy for increases in airline default risk. We test for selection in collateral quality by regressing our redeployability measures on proxies for airline risk, and find that they are not correlated with aircraft redeployability. Thus, a selection bias in which higher default-risk firms are required to pledge collateral of greater redeployability is not supported by the data.

Using our proxies for aircraft redeployability, we find that more redeployable collateral is associated with lower credit spreads. After controlling for tranche and airline characteristics and both year and airline fixed effects, an increase from the 25th percentile to the 75th percentile in our redeployability measures is associated with a decrease in the spread that is between 58.0 and 64.2 basis points, representing a decrease of between 29.2 and 32.3 percentage points relative to the mean spread. In interpreting the magnitude of our results, it is important to note that we are estimating the effect of collateral redeployability on spreads at the time of the credit issue. The value of collateral is, therefore, priced based on the *expected* probability of liquidation value calculated as of the issue date. Hence, to the extent that a firm's financial position deteriorates and liquidation probabilities increase post issue—a description accurate for many of the airlines in our sample—we are underestimating the average life-time impact of collateral on credit spreads. Moreover, we provide qualified support for the hypothesis that the ability to pledge redeployable collateral is more valuable during industry downturns.

Next, we analyze the relation between the redeployability of collateral and credit ratings, loan-to-value ratios, and tranche maturity. We find that more redeployable collateral is associated with better credit ratings and higher loan-to-value ratios. We do not find a statistically significant relation between collateral redeployability and tranche maturity. Our results provide insight into the role that asset redeployability plays in the determination of credit spreads, credit ratings, and debt capacity of secured debt, and in particular of CDOs.

The rest of the paper is organized as follows. Section 2 provides the theoretical framework for the analysis. Section 3 provides the institutional details on the market for ETCs and enhanced equipment trust certificates. Section 4 describes our data and the aircraft redeployability measures. Section 5 presents the empirical analysis of the relation between collateral redeployability and different facets of CDOs. Section 6 concludes.

2. Collateral and debt financing—implications for the airline industry

Most of the theory on the role of collateral in secured lending has focused either on situations where borrowers exhibit moral hazard or on situations of adverse selection, with borrowers enjoying private information about project quality. The nature of the financial friction in these models yields differential theoretical predictions. When the financial friction is one of adverse selection and asymmetric information, high quality firms are predicted

to employ collateral when borrowing, while firms of low quality are predicted to borrow using unsecured debt. For example, in Bester (1985), lenders offer different loan contracts with variable collateral requirements where the interest rate is decreasing in the value of the collateral. The optimal contract in Bester (1985) is such that risky borrowers pay a high interest rate but are not required to put down any collateral, while safer borrowers put down some collateral and pay a lower interest rate. Collateral is thus used as a signaling device by high quality borrowers to differentiate themselves from low quality ones. Such signaling is made possible because higher quality firms find it less costly to pledge collateral, since the probability of them defaulting and losing their collateral is smaller. Similarly, Besanko and Thakor (1987a, b), Chan and Kanatas (1985), and Chan and Thakor (1987) all analyze the role of collateral in the presence of information asymmetry and deliver similar predictions to those in Bester (1985) that lower-risk borrowers pledge more collateral.

In contrast to the predictions relying on adverse selection and hidden information, models that are based on moral hazard predict that *lower* quality firms are required to use collateral when raising capital, while higher quality firms are able to borrow without it (see, e.g., Berger and Udell, 1990; Boot, Thakor, and Udell, 1991). In essence, collateral is used to increase borrowers' pledgeable income and hence, helps in obtaining external finance and reducing its price (see, e.g., Tirole, 2005; Qian and Strahan, 2007).

According to John, Lynch, and Puri (2003) and Tirole (2005) the empirical evidence suggests that, consistent with the moral hazard models, low quality borrowers are those more likely to post collateral (see, e.g., Berger and Udell, 1990; Booth, 1992). For example, Hester (1979) finds that bank analysts classified loans with collateral to be riskier, while Jimenez, Salas, and Saurina (2006) find that creditors often require firms with poor repayment histories or firms which, ex post, were more likely to default, to pledge collateral. Furthermore, Harhoff and Korting (1998) find that the use of collateral is more likely among firms which are in financial distress at the time of the loan issue. These results explain the empirical finding of a positive relation between the use of collateral and debt yields (Berger and Udell, 1990, 1995). The selection effect, whereby low quality firms are required to post collateral, leads to a positive bias in estimates of the effect of collateral on the price of loans. John, Lynch, and Puri (2003) also find that the yield on collateralized debt is higher than on unsecured debt after controlling for credit rating.[1] Their results are interesting given that they control for the borrower risk in their regressions. To explain these results John, Lynch, and Puri (2003) develop a model that shows that agency problems affect the value of collateralized assets, so that if credit ratings fail to fully reflect the impact of agency problems on credit quality, then secured debt will have higher yields than unsecured debt controlling for credit rating.

Collateral redeployability plays an important role in alleviating moral hazard problems and increasing pledgeable income. In particular, more redeployable collateral—i.e., comprised of assets that have better alternative uses—helps in reducing the costs of external finance because assets can be sold for a higher price in the event of default (Tirole, 2005). However, since an increase in the liquidation value of an asset may also raise the optimal debt level, the net effect of liquidation value on promised debt yields is analytically ambiguous. Harris and Raviv (1990) show in numeric results that, controlling for the debt level of the firm, higher liquidation values are associated with lower promised yields, since creditors can expect a higher payment in the case of default.

The airline industry is a natural candidate for analyzing the relation between collateral and debt financing. During the period 1990–2005, secured debt became the primary source for external finance of aircraft by airlines in the U.S.[2] Since secured debt is used by virtually all airlines in the U.S., risk-based selection is less likely to explain collateral use in the airline industry. Moreover, our sample represents secured debt issues by large publicly traded airlines that include the 10 largest scheduled passenger carriers in the U.S. (out of which five are among the 10 largest passenger carriers in the world as of 2005), as well as the largest air courier company in the world (FedEx). During our sample period 1990–2005, the airlines in our sample account on average for 97.2% of the book value of all publicly traded airlines in the U.S. airline industry. We argue that given their scale and publicity, concerns about asymmetric information and adverse selection are not likely to play a major role. Finally, as shown below, by devising asset-specific measures of collateral characteristics in the airline industry and using them to analyze the intensive, rather than extensive, margin of collateral use, we alleviate the standard selection bias that imposes a positive relation between collateral and loan rates.

Another advantage of using airline debt tranches is that they are typically bankruptcy-remote and subject to Section 1110 of the Bankruptcy Code. Bankruptcy remoteness and Section 1110 insulate creditors from the bankruptcy of the issuing airline by relieving creditors from automatic stay provisions, allowing them to seize and foreclose collateral. These special features of secured debt in the airline industry reinforce the importance of collateral value for debt financing.

The following two predictions emerge from the relation between the cost of borrowing and the liquidation value of the collateral in studying the intensive margin of collateral in tranches of secured debt issued by airlines.

Prediction 1. Credit spreads decrease in collateral liquidation values, all else equal.

[1] Likewise, Knox (2005) finds that the effects of collateral on a firm's cost of capital is positive, after controlling for borrower characteristics.

[2] According to Morrell (2001), as of 2000, secured debt accounts for 20% of aircraft finance, while equity and unsecured debt account for about 15%.

Prediction 2. Tranche credit ratings improve in collateral liquidation values, all else equal.

The value of collateral affects other facets of debt contracts in addition to credit spreads. Both the transactions cost approach and the incomplete contracts approach emphasize the role that collateral value plays in financial contracting. The next two predictions about debt capacity and debt maturity follow from this literature. According to Williamson (1988), Shleifer and Vishny (1992), Harris and Raviv (1990), and Hart and Moore (1994), the total debt capacity the lender is willing to supply is increasing in collateral redeployability. We therefore have:

Prediction 3. Loan-to-value ratios increase in collateral liquidation values, all else equal.

Moreover, Hart and Moore (1994) show that asset redeployability increases the durability of the asset and serves as better collateral for long-term debt. Similarly, Berglöf and von Thadden (1994) predict that firms with fungible assets should be financed with long-term debt.[3] Thus, Prediction 4 states that:

Prediction 4. Tranche maturity increases in collateral liquidation values, all else equal.

Both Predictions 3 and 4 stem from the 'bargaining approach' to financial contracting.[4] The driving force in this approach is the right to foreclose on the debtor's assets in the case of default. If the debtor fails to make a promised repayment, the creditor can seize his assets and liquidate the assets for their market value. The threat to liquidate thus induces the debtor to repay. It is the liquidation value of the assets, therefore, that determines the allocation of bargaining power between the creditor and the debtor and the credibility of the liquidation threat. While in this paper we focus on implications of collateral redeployability to ex ante tranche characteristics, airlines often renegotiate the terms of the tranches ex post. For example, Benmelech and Bergman (2008) provide evidence that airlines can successfully renegotiate their lease obligations downward when their financial position is sufficiently poor and when the liquidation value of their fleet is poor. Thus, while asset redeployability is important for the initial contract, it may also affect the ex post determination of contract renegotiation.[5]

Before presenting our empirical analysis, we describe the airline secured debt market in the next section.

3. The airline ETC market

3.1. Historical development

ETCs first evolved during the 19th century in the American railroad industry by using railroad rolling stock as collateral.[6] Unlike mortgage liens, the legal title for the rolling stock underlying ETCs was vested with a trustee rather than the railroad. The trustee would lease the rolling stock back to the railroad while selling the ETCs to investors, using the lease payments to pay principal and interest on the certificates. The railroad did not own the equipment until the certificates were fully repaid, and if the railroad defaulted, the trustee could easily foreclose and repossess the rolling stock as the holder of the legal title.

The first form of ETCs dates back to the financing of several locomotives of the Baltimore and Susquehanna Railroad in 1839. In 1890, the total dollar value of equipment certificates of all steam railways in the U.S. was $49.0 million representing 1.11% of total funded debt by railroads. In 1924 the total dollar value of equipment certificates of all steam railways in the U.S. was $1,057.0 million representing 8.55% of total funded debt by railroads (Street, 1959). By 1955, equipment certificates accounted for 26.01% of total debt in the railroad industry with a total value of $2,589.0 million.

Airline ETC financing developed from the railroad equipment certificates. According to Littlejohns and McGairl (1998), the Bankruptcy Code began to treat aircraft financing favorably in 1957, but it was not until 1979 that Congress amended the Bankruptcy Code and introduced Section 1110 protection which provides creditors relief from the automatic stay. On October 22, 1994, the Bankruptcy Code was amended, and the rights of creditors under Section 1110 were strengthened.[7] The changes in the Bankruptcy Code increased the protection that Section 1110 provided to secured creditors and reduced the potential threat of legal challenge to secured aircraft.

This legal innovation affected the practice of secured lending in the airline industry. The market for ETCs expanded and new financial innovations such as enhanced equipment trust certificates (EETCs) soon became the leading source of external financing of aircraft. The ammendments to Section 1110 led Moody's to revise its ratings criteria such that securities that were issued after the enactment date received a rating up to two notches above issuing airlines' senior unsecured rating.

3.2. ETC and EETCs

In a traditional ETC a trustee issues ETCs to investors and uses the proceeds to buy the aircraft which is then leased to the airline. The collateral of ETCs typically include only one or two aircraft. For example, on August 24, 1990, American Airlines issued an ETC (1990 Equipment Trust Certificates, Series P) with a final maturity on March 4, 2014. The certificates were issued to finance approximately 77% of the equipment cost of one Boeing 757-223 (serial number 24,583) passenger aircraft, including engines (Rolls-Royce RB211-535E4B). The proceeds

[3] See Benmelech (2009) for a discussion of the relation between liquidation values and debt maturity.

[4] See Hart (1995) for a survey of the literature.

[5] Of course, the threat of contract renegotiation also feeds into ex ante debt contract terms, such as debt pricing.

[6] This section draws heavily from Littlejohns and McGairl (1998) and Morrell (2001).

[7] See Littlejohns and McGairl (1998, pp. 72–73).

from the ETC issue were $35.5 million, with a serial interest rate of 10.36% and a credit rating of A (S&P) and A1 (Moody's).

Economies of scale in issuance costs led airlines with large financing needs to the development of PTCs, which pool a number of ETCs into a single security that is backed by a pool of aircraft rather than one. The added security in the form of diversification over a pool of aircraft led to a substantial number of PTC issues in the early 1990s. However, the poor earnings of airlines during the 1990s led to downgrades of many ETCs and PTCs to below investment grade, and subsequently to a narrowed investor base and poor liquidity. The next development was a modified version of the ETC—the enhanced equipment trust certificate. EETC securitization enhances the creditworthiness of traditional ETCs as follows. First, the issuer of the EETC is bankruptcy-remote. Second, EETCs typically have several tranches with different seniority. Third, a liquidity facility ensures the continued payment of interest on the certificates for a predetermined period following a default. The basic structure of an EETC contains several tranches of senior, mezzanine, and subordinated certificates, with different loan-to-value ratios, cross-collateralization of aircraft, ratings, and maturities.

Table 1 presents the characteristics of three EETC issues that are in our sample. There are three tranches in each of the EETCs in Table 1. For each tranche we report the issue size (in $ millions), yield, spreads (in basis points), final maturity date, Moody's and S&P tranche-specific credit rating, cumulative loan-to-value, and collateral description. Cumulative loan-to-value is defined as the ratio between the sum of the principal amount of that tranche and all tranches senior to it, divided by an appraisal of the value of the assets serving as collateral. For example, the cumulative loan-to-value ratio of tranche 1-B of the FedEx 1998-1 issue, which is a mezzanine tranche, includes the sum of the loans of both the senior tranche (1-A) and the mezzanine tranche (1-B). Likewise, the cumulative loan-to-value ratio of tranche 1-C of the FedEx 1998-1 issue (0.688), which is a subordinated tranche, includes the sum of the loan amounts of the senior tranche (1-A), the mezzanine tranche (1-B), and the subordinated tranche (1-C).

In the first EETC in the table (FedEx 1998-1), the most senior tranche (1-A) has a credit rating of Aa2/AAA, a cumulative loan-to-value ratio of 38.7%, and a credit spread of 125 basis points over the corresponding treasury. The least senior tranche in the FedEx 1998-1 issue (1-C) has a lower credit rating ((Baa1/BBB+), a higher cumulative loan-to-value ratio (68.8%), and a credit spread of 155 basis points. All three tranches of FedEx 1998-1 are secured by the same pool of assets—five McDonnell Douglas MD-11F and eight Airbus A300F4-605R. Similarly, the most senior tranche (G) in the second EETC in the table (NWA 1999-3) has a credit rating of Aaa/AAA, a cumulative loan-to-value ratio of 44.1%, and a credit spread of 170 basis points, while the mezzanine tranche in the NWA 1999-3 issue (B) has a lower credit rating (Baa2/BBB), a higher cumulative loan-to-value ratio (61.4%), and a credit spread of 325 basis points. As before, all the three tranches of NWA 1999-3 are secured by the same pool of aircraft—14 BAE Avro RJ85. Finally, the third EETC in Table 1 has two senior tranches (G-1 and G-2) and one junior tranche (C). The three tranches of Delta 2002-1 sum-up together to $1,125.9 million, and are secured by 32 Boeing aircraft, consisting of 17 Boeing 737-832 aircraft, one Boeing 757-232 aircraft, eight Boeing 767-332ER aircraft, and six Boeing 767-432ER aircraft.

4. Data and summary statistics

This section describes our data, and provides summary statistics on airline characteristics, tranche characteristics,

Table 1
Selected EETC transactions.
This table displays the characteristics of three EETC issues by FedEx, Northwest Airlines, and Delta Airlines. Tranche is the name of each individual tranche (presented by seniority). Issue size is the dollar value (in $ millions) of the tranche. Yield is the yield of the tranche at the time of issue. Spread is credit spread (in basis points) over its corresponding treasury yield. Maturity is the number of years until the final payment. Moody's tranche rating and S&P tranche rating are the ratings of the tranche assigned by either Moody's or S&P. LTV is the tranche cumulative loan-to-value ratio defined as the ratio between the sum of the principal amount of that tranche and all tranches senior to it, divided by an appraisal of the value of the assets serving as collateral. Collateral provides a description of the aircraft serving as tranche collateral.

EETC	Tranche	Issue size	Yield (%)	Spread (bp)	Maturity	Moody's rating	S&P rating	LTV	Collateral
FedEx 1998-1	1-A	458.1	6.720	125	1/2022	Aa2	AAA	0.387	5 MD-11F 8 A300F4-605R
FedEx 1998-1	1-B	178.6	6.845	138	1/2019	A1	AA–	0.532	5 MD-11F 8 A300F4-605R
FedEx 1998-1	1-C	196.8	7.020	155	1/2016	Baa1	BBB+	0.688	5 MD-11F 8 A300F4-605R
NWA 1999-3	G	150.2	7.935	170	6/2019	Aaa	AAA	0.441	14 BAE Avro RJ85
NWA 1999-3	B	58.6	9.485	325	6/2015	Baa2	BBB	0.614	14 BAE Avro RJ85
NWA 1999-3	C	30.5	9.152	300	6/2010	Baa3	BBB–	0.691	14 BAE Avro RJ85
Delta 2002-1	G-1	586.9	6.718	153	1/2023	Aaa	AAA	0.519	17 B737-832 1 B757-232 8 B767-332ER 6 B767-432ER
Delta 2002-1	G-2	370.3	6.417	123	7/2012	Aaa	AAA	0.519	17 B737-832 1 B757-232 8 B767-332ER 6 B767-432ER
Delta 2002-1	C	168.7	7.779	325	1/2012	Baa2	A–	0.611	17 B737-832 1 B757-232 8 B767-332ER 6 B767-432ER

Table 2
Equipment trust certificates issuance.

This table displays the distribution of nominal values of 246 equipment trust certificates (ETCs), pass-through certificates (PTCs), and enhanced equipment trust certificates (EETCs) that were issued in the U.S. public markets between 1990 and 2005 and are included in our sample. Number of issues per airline are provided in parentheses for different sample periods.

Airline	1990–1993	1994–1997	1998–2001	2002–2005	**1990–2005**
Alaska Airlines	$98.9				**$98.9**
	(4)				**(4)**
America West		$93.8	$1,079.9		**$1,173.7**
		(4)	(9)		**(13)**
American Airlines	$668.9	$65.9	$3,792.4	$871.9	**$5,399.1**
	(23)	(1)	(14)	(2)	**(40)**
Atlas Air			$543.5		**$543.5**
			(4)		**(4)**
Continental Airlines		$2,287.7	$5,338.0	$1,575.5	**$9,201.2**
		(19)	(29)	(7)	**(55)**
Delta Air Lines	$1,105.5	$79.6	$2,748	$1,125.9	**$5,059.0**
	(10)	(2)	(8)	(3)	**(23)**
Federal Express	541.9	$1,615.7	$1,183.6		**$3,341.2**
	(6)	(14)	(7)		**(27)**
JetBlue Airways				$929.3	**$929.3**
				(6)	**(6)**
Southwest Airlines	$168.0	$610.4	614.3		**$1,392.7**
	(3)	(9)	(3)		**(15)**
United Air Lines	$724.3	$610.6	$3,622.5		**$4,957.4**
	(12)	(3)	(12)		**(27)**
U.S. Airways	$168.6	$263.0	$2,947.3		**$3,378.9**
	(3)	(3)	(10)		**(16)**
Northwest Airlines			$1,872.8	$749.1	**$2,621.9**
			(12)	(4)	**(16)**
Total	**$3,476.1**	**$5,626.7**	**$23,742.3**	**$5,251.7**	**$38,096.8**
	(61)	**(56)**	**(108)**	**(22)**	**(246)**

the aircraft used as collateral, and aircraft redeployability measures.

4.1. Sample construction

Using SDC Platinum, we identify all secured bonds, ETCs, PTCs, and enhanced equipment trust certificates issues by firms with four-digit SIC codes 4512 (Scheduled Air Transportation), 4513 (Air Courier Services), and 4522 (Nonscheduled Air Transport) that were issued between January 1990 and December 2005. This results in 426 debt tranches out of which 191 are private placements and 235 are issued in U.S. public markets. We collect all relevant data from SDC Platinum such as seniority, size, and credit spread over the corresponding treasury at time of issue. The aggregate nominal value of the private placements and public issues are $19.8 billion and $32.1, respectively, totaling $51.9 billion.

We continue by collecting the filing prospectus from EDGAR Plus (R) and from Compact Disclosure for each publicly traded tranche identified by SDC. Since there are no publicly available prospectuses for private placements, we collect data from *Airfinance Journal*, an industry periodical, for the private deals. For each public tranche, we obtain the serial number of all aircraft that were pledged as collateral from the filing prospectus, while for private tranches we obtain the aircraft model type serving as collateral from *Airfinance Journal*. We are able to find full information about the aircraft collateral securing the bonds for 198 public tranches and 48 private tranches. To obtain data on aircraft model type for the public tranches, we match each aircraft serial number obtained from filing prospectuses to the Ascend CASE airline database, which contains ownership information, operating information, and information on aircraft characteristics for every commercial aircraft in the world. For each of the 246 tranches, we can thus identify the full portfolio of aircraft serving as collateral.

4.2. Tranche and airline characteristics

Table 2 describes the sample of secured tranches used in the paper, by issuing airline. There are 246 individual tranches with an aggregate nominal value of $38,096.8 million that were issued by 12 American airlines.[8] During the period 1990–1993, 61 tranches with an aggregate book value of $3,476.1 million were issued by seven airlines as compared to 108 tranches with an aggregate book value of $23,742.3 that were issued by 10 airlines between 1998 and 2001. Our sample includes the 10 largest scheduled passenger airlines in the U.S. (out of which five are among the 10 largest passenger carriers in the world as of 2005), as well as the largest air courier company in the world (FedEx).

[8] Some of the tranche level variables are not available for all the tranches.

Table 3
Summary statistics.

This table provides descriptive statistics for the variables used in the empirical analysis. Panel A displays tranche characteristics. Panel B provides airlines characteristics. Tranche size is the dollar value (in $ millions) of the tranche. Number of aircraft is the number of aircraft serving as collateral. Spread is credit spread (in basis points) over its corresponding treasury yield. Loan-to-value is the ratio between the cumulative book value of the loan and the appraised value of the aircraft used as collateral for the loan. S&P tranche rating and Moody's tranche rating are the ratings of the tranche assigned by either S&P or Moody's. Maturity is the number of years until the final payment. Seniority is the tranche seniority (1 = most senior). Call provision is a dummy variable that equals to one if the tranche is callable. Private is a dummy variable that equals to one for private placement tranches. Size is the book value of the airline assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Profitability is defined as operating income over assets. Leverage is defined as total debt divided by total assets. S&P airline credit rating is the airline long-term credit rating.

	Mean	25th Percentile	Median	75th Percentile	Standard deviation	Min	Max
Panel A: Tranche characteristics							
Tranche size ($m)	154.87	47.6	112.5	194.5	148.5	0.7	1,319.6
Number of aircraft	16.2	4.0	13.0	21.0	11.9	1.0	46.0
Spread	198.8	135.0	182.0	238.0	107.5	40.0	909.4
Loan-to-value	0.616	0.490	0.600	0.780	0.149	0.329	0.890
S&P tranche rating	N/A	A	BBB+	AA+	N/A	B+	AAA
Moody's tranche rating	N/A	A3	Baa2	Aa3	N/A	B1	Aaa
Maturity	15.4	10.3	16.3	20.6	6.1	1.7	25.0
Seniority	1.50	1.00	1.00	2.00	0.80	1.00	4.00
Call provision	0.14	0.00	0.00	0.00	0.35	0.00	1.00
Private	0.17	0.00	0.00	0.00	0.38	0.00	1.00
Panel B: Airlines characteristics							
Size ($m)	10,024.4	5,793.1	8.768.8	10,877.4	6,800.9	1,211.6	32,841.0
Market-to-book	1.19	1.02	1.15	1.22	0.27	0.86	2.51
Profitability (%)	11.7	8.97	12.68	14.26	7.21	−7.26	46.17
Leverage	0.39	0.32	0.39	0.44	0.11	0.13	0.67
S&P airline credit rating	N/A	BB+	BB−	BBB	N/A	B−	A

Panel A of Table 3 provides summary statistics for the 246 tranches in our sample. The mean tranche size is $154.87 million. The largest tranche in our sample was issued in May 2001 by American Airlines with a nominal value of $1,319.6 million and a collateral pool of 46 aircraft. Each tranche in our sample has, on average, 16.2 aircraft serving as collateral.[9] The average credit spread is 198.8 basis points. While the majority of tranches incorporate fixed-coupon payments, a few tranches were issued as floating-rate debt with the spread quoted over the corresponding Libor rate. For these tranches, we use Bloomberg asset swap calculator (ASW) to calculate the equivalent fixed rate yield as well as the corresponding credit spread at the issue date. The average cumulative loan-to-value ratio is 0.616 and the maximum is 0.890 where higher values of cumulative loan-to-value typically correspond to subordinated tranches. The median S&P tranche credit rating is BBB+, with a sample-wide minimum rating of B+, and maximum rating of AAA. The median Moody's credit rating is Baa2, with a sample-wide minimum rating of B1, and maximum rating of Aaa. There are at most four different layers of tranche seniority within an issue, and 14% of the tranches have call provisions. Further, private placements account for 17% of tranche issues. Finally, tranches in our sample have an average maturity of 15.4 years with a maximum of 25 years.

Panel B of Table 3 provides summary statistics for the issuing airlines. The size, measured as the book value of assets, of the average airline in our sample is approximately $10 billion. The average airline market-to-book ratio is 1.19,[10] while their average profitability and leverage are 11.7% and 39%, respectively.[11] Finally, the median airline has a credit rating of BB−, with a sample-wide minimum rating of B−, and a maximum rating of A, reflecting the industry downturns during the early and mid-1990s and the period that followed September 2001. As would be expected, credit ratings of debt collateralized by aircraft are far superior to those of issuing airlines as a whole.

4.3. Redeployability measures

We measure the redeployability of aircrafts by exploiting aircraft model heterogeneity. 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 (2009) for 19th century American railroads, and

[9] As Table 1 demonstrates, the same aircraft can be used as collateral for more than one tranche in an EETC issue.

[10] Market-to-book is calculated as the market value of equity [Compustat Annual Items 24*25] + book value of assets [Compustat Annual *Item*6] minus the book value of equity [Compustat Annual Item 60] all over the book value of assets [Compustat Annual Item 6].

[11] Profitability is defined as [Compustat Annual Item 13] over assets [Compustat Annual Item 6], and leverage is defined as [Compustat Annual Items 9 + 34 + 84] divided by total assets [Compustat Annual Item 6].

Table 4
Aircraft type.
This table lists the 22 different aircraft types represented in our sample. For every aircraft type we list the number of aircraft and percentage of total aircraft in our sample. The table also reports the time-series (1990–2005) mean of the three redeployability measures for every aircraft type. Redeployability (# of aircraft) is the number of aircraft per type; Redeployability (# of operators) is the number of operators per type; Redeployability (# of operators with more than 5 aircraft) is the number of operators who operate at least five aircraft per type.

Aircraft type	Number	Percent	(time-series mean) # of aircraft	(time-series mean) # of operators	(time-series mean) # operators with >5 aircraft
Airbus A300	25	2.30	278.9	53.1	17.8
Airbus A310	12	1.10	161.7	44.9	10.6
Airbus A319	144	13.26	188.7	36.3	8.9
Airbus A320	89	8.20	621.1	83.2	34.1
Airbus A321	10	0.92	116.6	31.0	9.1
Airbus A330	9	0.83	117.5	30.7	9.1
BAE SYSTEMS RJ Avroliner	14	1.29	44.1	6.0	2.1
BAE SYSTEMS Jetstream 31/S3	2	0.18	180.9	64.0	8.5
Boeing (McDonnell-Douglas) MD-11	24	2.21	130.4	26.6	9.8
Boeing (McDonnell-Douglas) MD-80	49	4.51	997.7	67.3	28.3
Boeing 737 (CFMI)	58	5.34	1502.3	162.9	66.0
Boeing 737 (NG)	222	20.44	686.1	143.3	28.7
Boeing 747	21	1.93	760.8	91.4	36.3
Boeing 757	141	12.98	688.0	80.0	26.2
Boeing 767	80	7.37	617.6	83.5	30.1
Boeing 777	56	5.16	185.8	25.8	9.9
Bombardier Dash 8	2	0.18	389.4	69.0	18.9
Embraer EMB-120	9	0.83	31.2	5.0	1.3
Embraer ERJ-135	8	0.74	19.3	6.7	0.7
Embraer ERJ-145	98	9.02	205.7	20.1	7.2
Lockheed L-1011 TriStar	11	1.01	73.8	28.5	4.4
Saab 340	2	0.18	274.0	40.1	12.5
Total	1,086	100.00	–	–	–

Benmelech and Bergman (2008) and Gavazza (2006) for airlines.

In order to reduce costs associated with operating different aircraft types, airlines tend to operate a limited number of aircraft models. Therefore, potential secondary market buyers of any given type of aircraft are prone to be airlines already operating the same type of aircraft. The notion that the number of potential buyers and the 'popularity' of an aircraft model are important determinants of the redeployability of aircraft is supported by industry participants and analysts. According to Littlejohns and McGairl (1998), the ease of remarketing an aircraft is an important determinant of expected collateral value and that, "[a]n aircraft with a large number in current use across a wide array of users will obviously be easier to resell or re-lease than an aircraft of limited production and usage."[12] Similarly, the prospectus supplement of PTCs issued by Federal Express describe the factors that affect the marketability of an aircraft:

> Marketability of Aircraft. It is impossible to predict the resale value for any Aircraft to be sold upon the exercise of the Indenture Trustee's remedies under the related Indenture. The market for aircraft, whether new or used, is and will be affected by many factors including, among other things, the supply of similarly equipped aircraft of the same make and model, the demand for such aircraft by air carriers and the cost and availability of financing to potential purchasers of such aircraft.[13]

Table 4 provides a breakdown of all aircraft in our sample, by aircraft type. Our sample includes 1,086 individual aircraft serving as collateral, representing 22 different aircraft types. The most prevalent type of collateral aircraft in our sample is the Boeing 737 (NG) (222 aircraft), followed by the Airbus A319 (144 aircraft), and Boeing 757 (141 aircraft). The least popular aircraft in our sample are BAE Jetstream 31/S3, Saab 340, and Bombardier Dash 8, with two aircraft each. While Boeing 737 (CFMI) is the most popular aircraft in the world, it is underrepresented in the pool of aircraft used as a collateral for these deals. The reason for this underrepresentation is that the sample in our paper does not cover the whole market for used aircraft, but rather the sample of aircraft that were used as collateral by major U.S. airlines during the period 1990–2005.

Using the Ascend CASE database, we construct three redeployability measures using the same method as in Benmelech and Bergman (2008). We begin by constructing redeployability measures at the yearly level for each aircraft type, where aircraft type is defined using the

[12] Littlejohns and McGairl (1998, p. 81).

[13] Source: Federal Express Corp. Prospectus Supplement, November 26, 1993.

aircraft-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 measures, we disregard airlines who are in bankruptcy using the SDC bankruptcy database, as their financial position most likely precludes them from serving as potential aircraft buyers.[14] This process yields three redeployability measures for each aircraft-type and each sample-year. The last three columns in Table 4 report the time-series mean of each of the three redeployability series during the period 1990–2005. The aircraft type with the largest number of operators that were not subject to Chapter 7 or Chapter 11 of the Bankruptcy Code is the Boeing 737 (CFMI). This aircraft was operated by an average of 162.9 operators, of which 66 had more than five such aircraft. The aircraft type with the smallest number of operators in our sample is the Embraer EMB-120 with an average of only 31.2 aircraft, five operators, and 1.3 operators with more than five aircraft.

To construct the redeployability measures for a portfolio of aircraft serving as collateral for a particular tranche, we simply aggregate the aircraft-type redeployability measures across all aircraft in the portfolio. Specifically, we define the redeployability of the collateral-portfolio to be the weighted average of the redeployability index corresponding to each of the aircraft in the portfolio. In calculating the first redeployability measure, since 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 subtract the airline for which we calculate the measure. 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

$$Redeployability_{i,t}^{aircraft} = \sum_{s}^{S} \omega_{i,t,s}(Redeployability_{s,t}^{aircraft}),$$

$$Redeployability_{i,t}^{operators} = \sum_{s}^{S} \omega_{i,t,s}(Redeployability_{s,t}^{operators}),$$

$$Redeployability_{i,t}^{operators>5} = \sum_{s}^{S} \omega_{i,t,s}(Redeployability_{s,t}^{operators>5}),$$

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

$$\omega_{i,t,s} = number_{i,t,s} \times seats_s \Big/ \sum_{s}^{S} number_{i,t,s} \times seats_s.$$

We use the number of seats in an aircraft model as a proxy for its size (and value) in our weighted average calculations. We use the number of seats since we have appraised values of aircrafts for only about 60% of the aircraft in our sample. Also, according to Littlejohns and McGairl (1998): "(T)he exact appraisal value of aircraft involved in a securitization is not vital because the rating agencies recognize that the value will change from the outset of the deal. They do, however, take into consideration whether the secondary market is at a cyclical high or low." In contrast to current appraised aircraft value, our aircraft-type-based measures serve to capture the long-term redeployability of an aircraft, while placing less weight on current market conditions and prices.

Panel A of Table 5 provides descriptive statistics for our three redeployability measures. As can be seen, the redeployability measure based on number of aircraft has an average value of 958.6 aircraft operated by airlines that are not subject to Chapter 7 or Chapter 11 of the Bankruptcy Code. Furthermore, on average, there are 118.7 potential non-bankrupt buyers for aircraft serving as collateral for secured tranche issues. When we measure redeployability using potential buyers with at least five aircraft, there are only 40.2 potential buyers on average (median of 27). Panel B of Table 5 lists examples of tranches, their collateral, and the corresponding redeployability measures. Northwestern NWA-1999 tranches G, B, and C have the least redeployable aircraft pool in our sample. Secured by 14 BAE SYSTEMS RJ85 Avroliner aircraft, there were only 72 aircrafts of this type on the issue date, with only three solvent operators with more than five aircraft. In contrast, the collateral of Southwest 1996 A1 and A2 tranches is among the most redeployable pools in our sample—secured by six Boeing 737-300 aircraft that have 112 potential buyers that operate more than five aircraft. Panel B also shows that the pool of aircraft that is used as collateral for ETCs, PTCs, or EETCs often includes multiple aircraft types. The Delta 2000-1 tranches A2, B, and C are secured by 20 Boeing 737-832, 18 Boeing 757-232, and six B767-332ER, resulting in 63 potential buyers that operate more than five aircraft.

5. Empirical analysis

This section presents the empirical analysis of the relation between aircraft redeployability and credit spread and tranche rating, as well as cumulative loan-to-value ratios and tranche maturity. Our theoretical predictions stem from the observation that, all else equal, when debt is secured by collateral with greater expected liquidation values, creditors bear less downside risk in the event of default. Rather than relying only on the promised payments by the firm to generate a return on their original investment, creditors can sell the collateralized assets and redeploy them elsewhere to a different user. Hence, redeployability should be negatively related to tranche credit spreads, positively related to tranche credit ratings, and should be associated with higher debt capacity and longer-term debt.

To test redeployability's impact on credit characteristics, and establish its economic significance, we relate our three measures of tranche-collateral redeployability to the tranche credit spread, to the tranche S&P and Moody's credit rating, as well as to cumulative loan-to-value ratios and tranche maturity. Because all of the tranches in our

[14] As robustness we run all regressions using redeployability measures that do not exclude bankrupt airlines. The results are qualitatively unchanged.

Table 5
Redeployability measures.

This table provides descriptive statistics for the redeployability measures used in the empirical analysis. Panel A displays the characteristics of the Redeployability measures. Redeployability (# of aircraft) is the number of aircraft per type; Redeployability (# of operators) is the number of operators per type; Redeployability (# of operators with more than 5 aircraft) is the number of operators who operate at least five aircraft per type. Panel B presents examples of specific tranches, the collateral used to secure the tranches, and the redeployability measures values for each of the tranches.

	Mean	25th Percentile	Median	75th Percentile	Standard deviation	Min	Max
Panel A: Summary statistics							
Redeployability (# of aircraft)	958.6	365.0	661.7	1,624.1	793.8	72.0	3,485.0
Redeployability (# of operators)	118.7	53.2	73.6	185.8	90.7	7.0	421.0
Redeployability (# of operators with >5 aircraft)	40.2	17.6	27.0	63.0	30.0	2.0	131.0

EETC	Tranche	Issue size	Spread (bp)	# of aircraft	# of operators	# of operators with >5 aircraft	Collateral
Panel B: Examples of tranche redeployability							
Delta 2000-1	A1	341.1	148	1657.2	185.8	63.0	20 B737-832 18 B757-232 6 B767-332ER
Delta 2000-1	A2	738.1	170	1657.2	185.8	63.0	20 B737-832 18 B757-232 6 B767-332ER
Delta 2000-1	B	182.5	205	1657.2	185.8	63.0	20 B737-832 18 B757-232 6 B767-332ER
Delta 2000-1	C	238.3	188	1657.2	185.8	63.0	20 B737-832 18 B757-232 6 B767-332ER
NWA 1999-3	G	150.2	170	72.0	7.0	3.0	14 BAE RJ85
NWA 1999-3	B	58.0	325	72.0	7.0	3.0	14 BAE RJ85
NWA 1999-3	C	31.9	300	72.0	7.0	3.0	14 BAE RJ85
Southwest 1996	A1	113.1	72	2646.0	302.0	112.0	6 B737-300
Southwest 1996	A2	33.1	85	2646.0	302.0	112.0	6 B737-300

sample employ aircraft as collateral, our tests rely on examining the effect of the intensive margin rather than the extensive margin of collateral use. Put differently, we are analyzing the effect of variation in collateral redeployability levels on tranche characteristics, rather than the effect of having collateral at all on these characteristics. By doing so, we alleviate the selection bias that is present in a number of previous studies which utilize variation in the extensive margin to analyze the effect of collateral on loan prices (see, e.g., Berger and Udell, 1990). As described above, these studies tend to find a positive relation between a debt issue employing collateral and its yield, a fact that is interpreted as suggesting that only relatively low-risk firms can borrow using non-collateralized loans. The selection bias involved in the collateralization decision tends, therefore, to mask the actual relation between collateral values and loan characteristics.

5.1. Airline risk and the endogeneity of the redeployability measures

One potential effect which would lead our results to underestimate the actual effect of collateral values on credit spreads is a selection effect similar in spirit to that shown in previous literature. If higher default-risk firms are required not only to pledge collateral, but also to pledge collateral of *greater* redeployability, increases in our redeployability measures would, in part, proxy for increases in airline default risk. It should be noted, however, that such a selection bias along the intensive margin will work against our finding support for the hypotheses in Section 2: if riskier airlines are required to post better collateral, increased collateral redeployability will have a more negative impact on credit spreads than that estimated by our regressions. Similarly, increased collateral redeployability will have a more positive effect on improved credit ratings, loan-to-value ratios, and debt maturities than that estimated in our regressions.

Although a selection bias along the intensive margin works against our finding support for the hypotheses, its existence is ultimately an empirical question. In Table A1 in the Appendix we test the hypothesis that aircraft redeployability is correlated with airline default risk. We regress each of our three tranche redeployability measures on variables that capture the financial status of an airline: size, profitability, leverage, interest coverage, and the S&P long-term credit rating. All regressions include year fixed effects and standard errors are clustered by airline. To alleviate a multicollinearity concern, we include each of the regressors individually in Panel A through Panel C of Table A1 for each of the redeployability measures. We also test a multivariate specification in which all the explanatory variables are included. As can be seen, we find that none of the explanatory variables are statistically significant in explaining aircraft redeployability, and together they are not jointly significant, as the *F*-test reveals. Since airline risk is clearly correlated with each of the explanatory variables, and in particular with the airline credit rating, we conclude that airline risk is not correlated with aircraft redeployability. Thus, a selection bias in which higher default-risk firms are required to pledge collateral of greater redeployability is not supported by the data. Moreover, later on in our regressions we include airline characteristics and airlines fixed effects to control for airline heterogeneity that potentially drives aircraft redeployability.

5.2. Redeployability and credit spreads

We begin with a simple test of Hypothesis 1 which predicts a negative relation between redeployability and credit spreads. We estimate the following specification:

$$Spread_{i,a,t} = \beta \times Redeployability_{i,a,t} + \mathbf{X}_{i,a,t}\boldsymbol{\gamma} + \mathbf{Z}_{a,t-1}\boldsymbol{\delta} + \mathbf{c}_t\boldsymbol{\theta} + \varepsilon_{i,a,t}, \quad (1)$$

where *Spread* is the tranche credit spread above the corresponding treasury yield on the issue date, subscripts indicate tranche (i), airline (a), and year (t), *Redeployability* is one of our three measures of the redeployability of the aircraft portfolio serving as collateral for each tranche, $\mathbf{X}_{i,a,t}$ is a vector of tranche covariates, $\mathbf{Z}_{a,t}$ is a vector of airline controls, $\mathbf{c}_t$ is a vector of year fixed effects, and $\varepsilon_{i,a,t}$ is the regression residual. The tranche covariates include the seniority of the tranche, the log of the tranche size (in $ millions), a dummy variable that equals one if the tranche is callable, a dummy variable that equals one for private placements, and the maturity (in years) of each tranche.[15] The issuing airline control variables are the airline's size, market-to-book ratio, profitability, and the airline S&P credit rating. Airline control variables are calculated as of the beginning-of-year t, hence the lagged t subscript. Regressions are run under OLS, and robust standard errors are clustered by airline and reported in parentheses.

We report the results from estimating regression (1) in the first three columns of Table 6. In the last three columns of Table 6 we include both year and airlines fixed effects. Thus, we estimate the following specification:

$$Spread_{i,a,t} = \beta \times Redeployability_{i,a,t} + \mathbf{X}_{i,a,t}\boldsymbol{\gamma} + \mathbf{Z}_{a,t-1}\boldsymbol{\delta} + \mathbf{c}_t\boldsymbol{\theta} + \mathbf{b}_a\boldsymbol{\psi} + \upsilon_{i,a,t}, \quad (2)$$

where $\mathbf{b}_a$ is a vector of airline fixed effects, $\upsilon_{i,a,t}$ is the regression residual, and all other control variables are defined as in regression (1).

We find that after controlling for tranche characteristics and aircraft controls, and both year and airline fixed effects, higher redeployability is associated with lower credit spreads. This effect is economically sizeable. In the specification without airline fixed effects, moving from the 25th percentile to the 75th percentile in our redeployability measures is associated with a decrease in the spread that is between 21.6 and 23.7 basis points, representing an 11% decrease relative to the mean spread. Adding airline fixed effects, and thus controlling for unobserved heterogeneity in airline characteristics, strengthens the economic magnitudes of the effect of redeployability, with a 25th to 75th percentile movement

[15] We do not control for loan-to-value in these regressions since we do not have loan-to-value data for all the tranches in our data. We later control for loan-to-value in Table 12 for robustness.

Table 6
Collateral value and credit spread.

The dependent variable in the regressions is credit spread (in basis points) over its corresponding treasury yield. Seniority is the tranche seniority (1 = most senior). Private is a dummy variable that equals one for private placement tranches. Tranche size is the logarithm of the dollar value (in $ millions) of the tranche. Call provision is a dummy variable that equals one if the tranche is callable. Maturity is the number of years until the final payment. Airline size is the logarithm of the book value of the airline assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Profitability is defined as operating income over assets. S&P Airline credit rating is the airline long-term credit rating. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type, Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. 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.

Dependent variable =	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread
Seniority	54.17	54.34	54.11	54.49	54.26	54.19
	(5.67)	(5.71)	(5.68)	(5.44)	(5.36)	(5.36)
Private	37.13	34.61	34.74	32.36	25.39	27.80
	(3.65)	(3.47)	(3.37)	(2.87)	(2.07)	(2.42)
Tranche size	1.84	2.41	2.25	4.03	4.49	4.12
	(0.22)	(0.29)	(0.27)	(0.52)	(0.55)	(0.52)
Call provision	72.61	71.73	71.75	68.77	70.01	69.61
	(3.28)	(3.17)	(3.15)	(3.62)	(3.39)	(3.32)
Maturity	0.35	0.32	0.27	0.49	0.49	0.51
	(0.20)	(0.18)	(0.15)	(0.26)	(0.26)	(0.27)
Airline size	−14.95	−15.67	−15.87	93.75	88.05	85.88
	(−2.66)	(−2.70)	(−2.76)	(2.11)	(1.91)	(1.97)
Market-to-book	6.94	8.59	8.93	71.36	76.61	67.34
	(0.24)	(0.30)	(0.32)	(1.90)	(2.07)	(1.90)
Profitability	−259.55	−264.07	−259.51	−459.29	−487.05	−492.59
	(−2.33)	(−2.36)	(−2.30)	(−3.60)	(−3.60)	(−3.67)
S&P airline	5.69	5.68	5.58	2.18	1.79	1.94
Credit rating	(1.77)	(1.78)	(1.74)	(−0.48)	(0.39)	(0.45)
Redeployability	−0.018			−0.051		
(aircraft)	(−2.24)			(−2.85)		
Redeployability		−0.163			−0.394	
(operators)		(−2.33)			(−2.41)	
Redeployability			−0.523			−1.277
($\geqslant$5 aircraft)			(−2.39)			(−3.18)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Airline fixed effects	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.60	0.60	0.60	0.66	0.66	0.66
Observations	225	225	225	225	225	225

in the redeployability measures reducing spreads by between 52.2 and 64.2 basis points. This represents a decrease of between 26.3% and 32.3% of the mean spread. To facilitate comparison of economic magnitudes across measures, Panel A of Table 11 summarizes the economic impact of redeployability on credit spreads.

We have also tried alternative measures of redeployability such as the weighted average age of the aircraft used as collateral, and the noise level of the aircraft (not reported). However, our sample does not exhibit much variation in aircraft age and noise levels, and thus these measures do not show up to be statistically significant in our analysis. Most of the aircraft in our sample are new—the average age of the aircraft in the collateral pool is 1.3 years and the median is 0.0—and likewise, most of the aircraft in our sample meet the FAA FAR Part 36 Stage 3 noise requirement.

Turning to the coefficients of the control variables in Table 6, we find as expected that tranches with higher seniority have lower credit spreads, with a one notch increase in seniority reducing spreads by approximately 54 basis points.[16] Further, we find that private placements are associated with higher credit spreads—consistent with either lower-risk bearing capacity on the part of investors or with increased fear of renegotiation amongst private placements. Callable tranches have higher spreads than those without a call provision, which is to be expected given that the call provision retained by the firm has value. Both the maturity and size of the tranche do not appear to be statistically related to credit spreads. We have tried (results not reported for brevity) interacting seniority with our measures of redeployability—assuming that for more junior tranches redeployability should be more important. The coefficients on the interaction terms are indeed negative, as predicted, implying that redeployability reduces credit spreads more for junior tranches. However, the interaction terms are not statistically significant.

We find that airline size is negatively related to spreads in the specification without airline fixed effects, while it is positively related to credit spreads in the time-series once airline fixed effects are added. Airline market-to-book ratios are positively related to spreads when airline fixed effects are included, but there is no statistically significant relation when the specification does not include airline fixed effects. As would be expected, airline profitability is consistently negatively related to spreads. The marginal

[16] As a reminder, our definition of tranche seniority assigns a value of one to the *highest* ranked tranche.

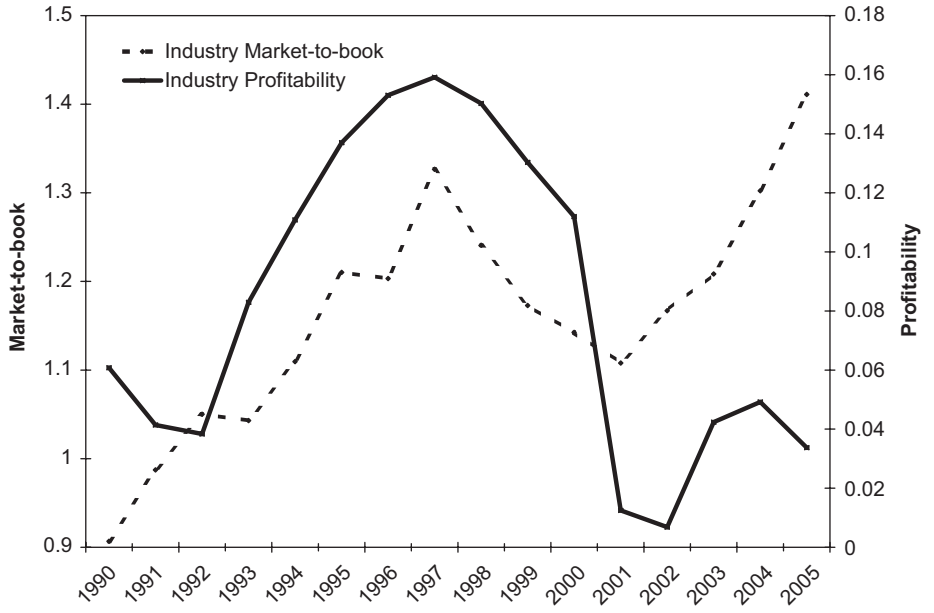

Fig. 1. The cyclicality of the airline industry: This figure provides industry weighted average profitability (right-hand scale) and market-to-book ratio (left-hand scale) over the sample period 1990–2005. Profitability is defined as operating income over assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Airline market values are used as weights.

effect of profitability is large: a one standard deviation increase in airline profitability decreases tranche credit spreads by approximately 30 basis points in the specification without airline fixed effects and approximately 55 basis points in the specification with airline fixed effects, representing 15% and 28% of the mean spread in the sample. Finally, while the point estimates of the coefficients on airline S&P credit rating are positive, indicating a negative relation between airline credit rating and spreads, the effect is insignificant in the specifications with airline fixed effects, and only marginally significant in the specifications without airline fixed effects (t-statistic $= 1.77$).

5.3. Credit spreads and collateral redeployability in industry downturns

In this subsection we examine whether airline industry-wide conditions affect the relation between collateral redeployability and credit spreads.[17] Following Shleifer and Vishny (1992), we hypothesize that the negative relation between redeployability and credit spreads should be stronger during times when the industry is doing poorly, as during these times, the ability to easily redeploy assets of failing firms will be particularly important. In contrast, it might be relatively easy to find buyers even for low redeployability aircraft during industry booms.

To test the effect of industry-wide conditions on credit spreads we examine two proxies for the industry health: (i) the weighted average airline profitability, and (ii) the weighted average airline market-to-book. Fig. 1 displays the evolution of our measures of the state of the airline industry over our sample period. As Fig. 1 illustrates, industry condition peaked during 1997, then deteriorated until 2001–2002, and has recently slightly improved.[18] As a first step, we include a control for industry-wide conditions in regression (2) which relates credit spreads to collateral redeployability. Since industry-wide conditions are equal for all airlines in a given year, year fixed effects are not included in these specifications. The results are shown in Table 7.

As expected, we find a negative relation between spreads and the general health of the airline industry, as proxied by profitability and market-to-book ratios. Further, as can be seen in the table, the negative relation between collateral redeployability and credit spreads continues to hold even after controlling for industry condition. It should be noted that the coefficients on the three measures of redeployability in Table 7 are more negative than the corresponding coefficients in Table 6, suggesting that the year fixed effects are capturing temporal variation not captured by our measures of industry health.

To test the industry downturn hypothesis, i.e., that the negative relation between redeployability and credit spreads should be stronger during times when the industry is doing poorly, we add an interaction term between the measures of airline industry health and each

[17] We thank an anonymous referee for suggesting the empirical tests in this section.

[18] While September 11, 2001, was an exogenous shock to the airline industry leading to deterioration of airlines' profitability and valuation, our sample includes only 16 tranches that were issued after September 2001, and thus, we cannot fully exploit this shock.

Table 7
Industry conditions and credit spread.

The dependent variable in the regressions is credit spread (in basis points) over its corresponding treasury yield. Seniority is the tranche seniority (1 = most senior). Tranche size is the logarithm of the dollar value (in $ millions) of the tranche. Private is a dummy variable that equals one for private placement tranches. Call provision is a dummy variable that equals one if the tranche is callable. Maturity is the number of years until the final payment. Airline size is the logarithm of the book value of the airline assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Profitability is defined as operating income over assets. S&P airline credit rating is the airline long-term credit rating. Industry profitability is a weighted average profitability at the airline industry level. Industry market-to-book is a weighted average industry market-to-book. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type, Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. All regressions include an intercept (not reported) and airline fixed effects. *t*-statistics are calculated using standard-errors that are clustered by airline and reported in parentheses.

Dependent variable =	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread
Seniority	42.92	42.99	42.85	40.50	40.39	40.77
	(4.61)	(4.44)	(4.43)	(4.23)	(4.06)	(4.14)
Private	18.38	2.85	9.76	23.86	6.88	13.31
	(0.51)	(0.07)	(0.28)	(0.62)	(0.16)	(0.36)
Tranche size	−5.75	−5.29	−6.02	−6.18	−5.75	−6.38
	(−1.09)	(−1.02)	(−1.17)	(−1.04)	(−1.01)	(−1.14)
Call provision	22.53	23.42	24.10	28.51	29.94	29.47
	(0.90)	(0.92)	(0.97)	(1.43)	(1.40)	(1.40)
Maturity	1.14	1.16	1.12	1.00	1.03	0.99
	(0.61)	(0.63)	(0.61)	(0.55)	(0.57)	(0.54)
Airline size	125.31	121.84	117.56	145.66	141.34	134.56
	(2.51)	(2.55)	(2.44)	(2.66)	(2.62)	(2.57)
Market-to-book	46.88	56.82	36.22	56.62	67.45	43.40
	(1.82)	(2.31)	(1.35)	(1.83)	(2.29)	(1.34)
Profitability	115.46	81.59	60.75	−201.87	−252.18	−219.03
	(0.84)	(0.60)	(0.50)	(−1.43)	(−2.01)	(−1.87)
S&P airline	−4.73	−5.17	−3.70	0.18	−0.31	0.65
credit rating	(−1.09)	(−1.20)	(−0.91)	(0.04)	(−0.06)	(0.14)
Industry profitability	−812.92	−827.86	−715.35			
	(−5.09)	(−5.35)	(−4.67)			
Industry market-to-book				−253.11	−253.82	−217.34
				(−2.97)	(−3.10)	(−2.81)
Redeployability	−0.087			−0.097		
(aircraft)	(−5.71)			(−5.57)		
Redeployability		−0.716			−0.793	
(operators)		(−5.43)			(−5.05)	
Redeployability			−2.361			−2.626
($\geqslant$5 aircraft)			(−5.97)			(−5.52)
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.47	0.47	0.48	0.45	0.45	0.46
Observations	225	225	225	225	225	225

of our three redeployability measures. In some specifications we also include year fixed effects and thus identify off of the interaction term between redeployability and industry conditions. Naturally, in the specifications that include year fixed effects we do not include the uninteracted industry condition variable as it is absorbed by the year fixed effects.

We present the results in Table 8. For expositional brevity, the table presents only the results for industry condition proxied by the weighted average of airline profitability. The results using the market-to-book measure are similar. Further, for expositional brevity the table includes only the coefficients on the redeployability measure and the interaction term between industry condition and tranche redeployability.

As can be seen from the table, we find qualified support for the hypothesis that the effect of increased redeployability in reducing credit spreads is concentrated during times of relative poor industry performance. Focusing on columns 1–3 of the table, i.e., those without year fixed effects, we find that while the coefficients on the level effect of redeployability are negative (essentially measuring the effect of redeployability at an industry profitability of zero), the coefficients on the interaction terms between the redeployability measures and the weighted average of airline profitability are consistently positive and statistically significant.[19] Thus, when the industry is doing relatively well, the negative effect of collateral redeployability on spreads is diminished. However, the table also shows that after we include year fixed effects, the coefficients of the interaction terms are still positive yet they are not statistically significant. Thus, with the limited number of years in our sample, we lose statistical significance when year fixed effects are added in addition to airline fixed effects.

[19] One of the interaction coefficients is marginally significant with a *t*-statistic of 1.67.

Table 8
Collateral value, industry conditions, and credit spread.

The dependent variable in the regressions is credit spread (in basis points) over its corresponding treasury yield. Industry profitability is a weighted average profitability at the airline industry level. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type; Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. Regressions also include tranche characteristics (seniority, size, a dummy for private placement, and controls for call provisions at tranche maturity), and airline characteristics (airline size, market-to-book, profitability, and S&P airline long-term credit rating) which are not reported for brevity. All regressions include an intercept (not reported) and airline fixed effects. *t*-statistics are calculated using standard-errors that are clustered by airline and reported in parentheses.

Dependent variable =	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread
Redeployability (aircraft)	−0.142			−0.084		
	(−5.34)			(−3.31)		
Redeployability (operators)		−1.208			−0.668	
		(−5.45)			(−3.02)	
Redeployability ($\geqslant$5 aircraft)			−3.347			−1.908
			(−4.79)			(−3.30)
Redeployability (aircraft) ×	0.461			0.285		
Industry profitability$_{t-1}$	(2.18)			(1.55)		
Redeployability (operators)×		4.27			2.368	
Industry profitability$_{t-1}$		(2.85)			(1.62)	
Redeployability ($\geqslant$5 aircraft)×			8.78			5.739
Industry profitability$_{t-1}$			(1.67)			(1.25)
Tranche controls	Yes	Yes	Yes	Yes	Yes	Yes
Airline controls	Yes	Yes	Yes	Yes	Yes	Yes
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.48	0.48	0.48	0.60	0.60	0.60
Observations	225	225	225	225	225	225

5.4. Redeployability and credit ratings

We now turn to Hypothesis 2 and analyze the relation between the redeployability of collateral and credit ratings. Given the ordinal discrete nature of the dependent variable and similar to Blume, Lim, and Mackinlay (1998) we employ an ordered probit model. This model relates credit ratings to observed airline and tranche characteristics through unobserved threshold parameters. The credit rating categories are mapped into a partition of the unobserved threshold parameters range, where the partition is a linear function of the observed explanatory variables.

We assign numeric values to the credit rating categories of Moody's (S&P), with a credit rating of Aaa (AAA) assigned a value of one, a rating of Aa1 (AA+) assigned a value of two, all the way to a rating of C (which is the lowest credit rating in the Moody's scale) that is assigned a value of 21, and a rating of D (which is the lowest credit rating in the S&P scale) that is assigned a value of 22. We define $Tranche\ rating^{M,S}_{i,a,t}$ as either the Moody's (M) or S&P (S) numeric value assigned to the credit rating of tranche i of airline a at time t.

Table 9 reports the results from estimating the ordered probit model by maximum likelihood. Detailed descriptions of the ordered probit procedure are provided in the Appendix. The coefficients in Table 9 do not represent marginal effects. The direction of the marginal effects of the explanatory variables is unambiguously determined by the sign of the coefficients in Table 9 only for the highest and lowest ordered response—i.e. $Pr(Tranche\ rating^{M,S}_{i,a,t} = 1|\mathbf{X})$, $Pr(Tranche\ rating^{M}_{i,a,t} = 21|\mathbf{X})$, and $Pr(Tranche\ rating^{S}_{i,a,t} = 22|\mathbf{X})$.[20] Thus, we first discuss the direction of the effects of the explanatory variables in Table 9 on the probability that a tranche will be rated AAA by S&P (or alternatively Aaa by Moody's).[21]

As Table 9 shows, senior tranches are more likely to be rated AAA/Aaa. In addition, we find that larger tranches are more likely to be rated AAA by S&P ratings, but are not statistically significant in explaining Moody's rating. Callable tranches are less likely to be AAA/Aaa rated and tranche maturity does not seem to have a statistically significant effect on being rated AAA/Aaa. We also control for three airline characteristics in explaining the tranche credit rating: size, market-to-book, and profitability. We find that tranches of larger airlines, and those of airlines with higher market-to-book are more likely to be AAA/Aaa rated.

Focusing on the relation between credit rating and collateral, Table 9 shows that the probability that a tranche will be rated AAA by S&P or Aaa by Moody's is consistently positively related to our measures of collateral redeployability. Thus, consistent with our second hypothesis, credit rating agencies appear to take collateral redeployability into account when determining debt quality, with higher redeployability measures associated with improved tranche credit ratings. We measure the marginal effects of collateral redeployability on the probability that a tranche will be rated AA+, A, and BBB+ and report the economic magnitudes in Panel B of

[20] See Wooldridge, 2001, p. 506.
[21] Put differently, we are analyzing $\partial Prob[rating = AAA/Aaa]/\partial x_i$.

Table 9
Collateral value and credit rating.

The dependent variable in the regressions is either Moody's tranche rating or S&P tranche rating. Seniority is the tranche seniority (1 = most senior). Private is a dummy variable that equals one for private placement tranches. Tranche size is the logarithm of the dollar value (in $ millions) of the tranche. Call provision is a dummy variable that equals one if the tranche is callable. Maturity is the number of years until the final payment. Airline size is the logarithm of the book value of the airline assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Profitability is defined as operating income over assets. S&P airline credit rating is the airline long-term credit rating. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type; Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. The table reports coefficients (not marginal effects) from ordered probit regressions that 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.

Dependent variable =	Moody's credit rating	Moody's credit rating	Moody's credit rating	S&P credit rating	S&P credit rating	S&P credit rating
Ordered probit regressions						
Seniority	1.49	1.49	1.50	1.77	1.78	1.78
	(7.47)	(7.57)	(7.62)	(5.71)	(5.78)	(5.82)
Private	0.18	0.14	0.14	−0.53	−0.59	−0.59
	(0.65)	(0.53)	(0.52)	(−1.54)	(−1.71)	(−1.68)
Tranche size	−0.17	−0.16	−0.16	−0.31	−0.30	−0.30
	(−1.49)	(−1.38)	(−1.42)	(−2.75)	(−2.66)	(−2.70)
Call provision	0.95	0.94	0.93	0.82	0.80	0.80
	(2.33)	(2.27)	(2.23)	(3.00)	(2.92)	(2.87)
Maturity	−0.01	−0.02	−0.01	−0.001	−0.002	−0.003
	(−0.39)	(−0.42)	(−0.48)	(−0.04)	(−0.07)	(−0.14)
Airline size	−0.49	−0.50	−0.51	−0.37	−0.38	−0.39
	(−2.67)	(−2.74)	(−2.77)	(−2.78)	(−2.79)	(−2.91)
Market-to-book	−1.02	−0.97	−0.94	−1.36	−1.33	−1.29
	(−1.83)	(−1.68)	(−1.65)	(−2.05)	(−1.98)	(−1.90)
Profitability	−0.14	−0.20	−0.10	−3.44	−3.50	−3.44
	(−0.07)	(−0.10)	(−0.05)	(−1.55)	(−1.60)	(−1.56)
Redeployability	−0.0003			−0.0004		
(aircraft)	(−1.75)			(−2.32)		
Redeployability		−0.003			−0.003	
(operators)		(−1.89)			(−2.40)	
Redeployability			−0.010			−0.011
($\geqslant$5 aircraft)			(−2.02)			(−2.49)
Fixed effects	Year	Year	Year	Year	Year	Year
Pseudo R^2	0.24	0.25	0.25	0.32	0.32	0.32
Observations	227	227	227	223	223	223

Table 11. As Table 11 shows, a one standard deviation move in the number of aircraft redeployability measure increases the probability that a tranche will have a AA+ credit rating by 2 percentage points, representing an increase of 25.6% relative to the sample mean, and reduces the probability that a tranche will have a BBB+ credit rating by 1 percentage point, representing a decrease of 6.9% relative to the sample mean.[22] Similarly, increases in our other measures of redeployability—the number of operators redeployability measure, and the number of operators with more than five aircraft of similar type—are also associated with higher credit ratings.

5.5. Redeployability, loan-to-value, and tranche maturity

In this section we analyze the relation between collateral redeployability and both loan-to-value ratios and debt maturity. We begin by testing Hypothesis 3 which states that more redeployable collateral supports higher debt capacity using loan-to-value ratio as our dependent variable. In testing Hypothesis 3, we use two baseline specifications: (i) tranche level, and (ii) issue level regressions. In the first specification we calculate the cumulative loan-to value ratio for every tranche. The second specification defines a loan-to-value ratio for each issue as the ratio between the aggregate principal amount of all the tranches within an issue to the appraised collateral value.

In the first specification we estimate the following regression:

$$LTV^{T}_{i,a,t} = \beta \times Redeployability_{i,a,t} + \mathbf{X}_{i,a,t}\boldsymbol{\gamma} + \mathbf{Z}_{a,t-1}\boldsymbol{\delta} + \mathbf{c}_t\boldsymbol{\theta} + \mathbf{b}_a\boldsymbol{\psi} + \upsilon_{i,a,t}, \quad (3)$$

where $LTV^{T}_{i,a,t}$ is the tranche cumulative loan-to-value ratio of tranche (i), airline (a), and year (t). *Redeployability* is one of our three measures of the redeployability of the aircraft portfolio serving as collateral for each tranche, $\mathbf{X}_{i,a,t}$ is a vector of tranche covariates, $\mathbf{Z}_{a,t}$ is a vector of airline controls, $\mathbf{c}_t$ is a vector of year fixed effects, $\mathbf{b}_a$ is a vector of airline fixed effects, and $\varepsilon_{i,a,t}$ is the regression residual. Regressions are run under OLS, and robust standard errors are clustered by airline and reported in parentheses.

The second specification we estimate is given by

$$LTV^{I}_{j,a,t} = \beta \times Redeployability_{j,a,t} + \mathbf{Z}_{a,t-1}\boldsymbol{\delta} + \mathbf{c}_t\boldsymbol{\theta} + \mathbf{b}_a\boldsymbol{\psi} + \upsilon_{j,a,t}, \quad (4)$$

[22] As discussed above, given the shape of the probability function, the effect of an independent variable on the probability of the dependent variable being in a particular bin is non-monotonic in the ranking of the bin.

Table 10
Collateral value, loan-to-value, and tranche maturity.

The dependent variable in columns 1–3 is the cumulative loan-to-value (LTV) at the tranche level. The dependent variable in columns 4–6 is the cumulative loan-to-value (LTV) at the issue level. The dependent variable in columns 7–9 is the tranche maturity in years. Seniority is the tranche seniority (1 = most senior). Private is a dummy variable that equals one for private placement tranches. Tranche size is the logarithm of the dollar value (in $m) of the tranche. Call provision is a dummy variable that equals one if the tranche is callable. Maturity is the number of years until the final payment. Airline size is the logarithm of the book value of the airline assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Profitability is defined as operating income over assets. S&P airline credit rating is the airline long-term credit rating. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type; Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. All regressions include an intercept (not reported) and airline and year fixed effects. *t*-statistics are calculated using standard-errors that are clustered by airline and reported in parentheses.

Model dependent variable =	(1) LTV	(2) LTV	(3) LTV	(4) LTV	(5) LTV	(6) LTV	(7) Maturity	(8) Maturity	(9) Maturity
Seniority	0.10	0.10	0.10	–	–	–	−1.63	−1.62	−1.63
	(12.75)	(13.26)	(12.63)	–	–	–	(−2.91)	(−2.83)	(−2.90)
Private	−0.05	−0.04	−0.05	–	–	–	0.51	0.32	0.41
	(−1.23)	(−1.11)	(−1.18)	–	–	–	(0.29)	(0.19)	(0.24)
Tranche size	0.003	0.002	0.002	–	–	–	2.15	2.17	2.16
	(0.53)	(0.81)	(0.40)	–	–	–	(2.41)	(2.44)	(2.42)
Call provision	0.02	0.02	0.02	–	–	–	−0.82	−0.82	−0.81
	(0.78)	(0.81)	(0.73)	–	–	–	(−0.68)	(−0.66)	(−0.67)
Maturity	−0.002	−0.002	−0.002	–	–	–	–	–	–
	(−0.29)	(−0.20)	(−0.19)	–	–	–	–	–	–
Airline size	−0.21	−0.22	−0.19	−0.004	−0.01	0.02	−4.36	−4.30	−4.50
	(−1.44)	(−1.51)	(−1.30)	(−0.04)	(−0.10)	(0.20)	(−0.82)	(−0.80)	(−0.82)
Market-to-book	−0.04	−0.05	−0.04	−0.08	−0.10	−0.07	3.11	3.29	3.04
	(−0.78)	(−1.06)	(−0.63)	(−2.34)	(−2.23)	(−2.15)	(0.76)	(0.81)	(0.73)
Profitability	−0.23	−0.29	−0.19	−0.15	−0.13	−0.10	−19.01	−18.98	−19.53
	(−0.69)	(−0.81)	(−0.55)	(−0.86)	(−0.84)	(−0.55)	(−1.20)	(−1.13)	(−1.17)
S&P airline	0.01	0.01	0.01	−0.02	−0.02	−0.02	−0.15	−0.14	−0.16
credit rating	(0.56)	(0.47)	(0.55)	(−1.94)	(−2.14)	(−1.88)	(−0.36)	(−0.33)	(−0.36)
Redeployability	0.08			0.09			−1.04		
(aircraft)*1000	(1.90)			(2.72)			(−1.32)		
Redeployability		0.001			0.001			−0.01	
(operators)		(1.92)			(2.65)			(−1.39)	
Redeployability			0.002			0.002			−0.03
($\geqslant$5 aircraft)			(1.63)			(2.34)			(−1.44)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.90	0.90	0.90	0.93	0.93	0.93	0.56	0.56	0.56
Observations	207	207	207	76	76	76	230	230	230
Unit of observation	tranche	tranche	tranche	issue	issue	issue	tranche	tranche	tranche

where $LTV^{I}_{j,a,t}$ is the issue loan-to-value ratio of issue (j), airline (a), and year (t). Since this specification is run at the issue level, it does not include tranche covariates as controls.

It should be noted that tranche characteristics such as loan-to-value, maturity, call provisions, and tranche size are endogenous and jointly determined at the time of the issue. Thus, ideally one would like to utilize an instrumental variable approach to estimate the economic impact of each of these variables. However, since these debt facets are jointly determined, this complicates the use of an instrumental variable. Nevertheless, our specifications allow us to understand the cross-correlations between asset redeployability and tranche characteristics in the data.[23]

The results of regressions (3) and (4) are reported in columns 1 through 6 of Table 10. Consistent with Hypothesis 3, we find a robust positive relation between loan-to-value ratios and collateral redeployability both at the tranche level and the issue level. Collateral pools with higher asset redeployability are associated with higher debt capacity. The coefficients of the redeployability measures in the two specifications are quite similar, although the coefficients in the issue-level specification have higher statistical significance, reflecting the debt capacity of the entire collateral pool.[24] The economic significance implied by the coefficients is sizeable. Moving from the 25th to 75th percentile of our redeployability measures increases loan-to-value ratios by between 9 and 13 percentage points. This corresponds to an increase of between 14% and 21% of the mean tranche loan-to-value ratio, and between 13% and 19% of the mean issue loan-to-value ratio. Panel C of Table 11 summarizes the economic impact of redeployability on debt capacity

[23] See Benmelech, Garmaise, and Moskowitz (2005) and Qian and Strahan (2007) for similar approaches.

[24] We thank an anonymous referee for suggesting this test and its interpretation.

Table 11
Economic significance of collateral redeployability.

Predicted changes in the dependent variables as each redeployability measure varies (i) by one standard deviation, (ii) from the 25th percentile to the 75th percentile, (iii) from the 10th percentile to the 90th percentile. Panel A reports level changes basis points (bp) and percentage changes relative to the sample spread mean (in parentheses). Panel B reports marginal effects of changes in credit rating category probability associated with one standard deviation move, and their corresponding percentage change relative to the sample mean (in parentheses) in the redeployability measures. Panel C reports changes in LTV as well as percent changes relative to the sample LTV mean (in parentheses). The results are computed using the specifications in Tables 6, 8 and 9.

	Standard deviation	25th–75th Percentile	10th–90th Percentile
Panel A: Credit spread			
Redeployability (aircraft)	−40.5 bp	−64.2 bp	−99.5 bp
	(−20.4%)	(−32.3%)	(−50.0%)
Redeployability (operators)	−35.7 bp	−52.2 bp	−85.8 bp
	(−18.0%)	(−26.3%)	(−43.2%)
Redeployability (⩾5 aircraft)	−38.3 bp	−58.0 bp	−93.9 bp
	(−19.3%)	(−29.2%)	(−47.2%)
	$\partial Prob[rating = \mathbf{AA}+]/\partial x$	$\partial Prob[rating = \mathbf{A}]/\partial x$	$\partial Prob[rating = \mathbf{BBB}+]/\partial x$
Panel B: Credit rating			
x = Redeployability (aircraft)	0.02	−0.01	−0.05
	(25.6%)	(−6.9%)	(−35.7%)
x = Redeployability (operators)	0.02	−0.01	−0.05
	(25.6%)	(−6.9%)	(−35.7%)
x = Redeployability (⩾5 aircraft)	0.03	−0.01	−0.06
	(38.4)	(−6.9%)	(−42.9%)
	Standard deviation	25th–75th Percentile	10th–90th Percentile
Panel C: Loan-to-value			
Redeployability (aircraft)	0.071	0.113	0.176
	(11.6%)	(18.4%)	(28.5%)
Redeployability (operators)	0.091	0.133	0.218
	(14.7%)	(21.5%)	(35.3%)
Redeployability (⩾5 aircraft)	0.060	0.091	0.147
	(9.7%)	(14.7%)	(23.9%)

across redeployability measures. Senior tranches have lower loan-to-values by construction; a decrease of one level of tranche seniority increases cumulative loan-to-value ratios by 10 percentage points. Finally, at the issue-level specification (Table 10, columns 4–6), we find that higher airline market-to-book ratios and lower S&P airline credit ratings are associated with lower loan-to-value ratios. Similar to our previous analysis, we also examine whether airline industry-wide conditions affect the relation between collateral redeployability and loan-to-value ratios but we find no evidence that industry conditions affect loan-to-value ratios.

We next turn to test the relation between asset redeployability and debt maturity. We estimate regression (5) at the tranche level and not at the issue level since different tranches within the same issue have different maturities (see Table 1):

$$Maturity_{i,a,t} = \beta \times Redeployability_{i,a,t} + \mathbf{X}_{i,a,t}\boldsymbol{\gamma} + \mathbf{Z}_{a,t-1}\boldsymbol{\delta} + \mathbf{c}_t\boldsymbol{\theta} + \mathbf{b}_a\boldsymbol{\psi} + \upsilon_{i,a,t}, \quad (5)$$

where $Maturity_{i,a,t}$ is the maturity of tranche i of airline a in year t. All control variable are defined as in regression (4). The results are presented in columns 7 through 9 of Table 10. While we find that lower seniority tranches are associated with shorter maturities, we do not find a statistically significant relation between redeployability and tranche maturity. Thus, the evidence in our sample of airline asset-backed securities does not support Hypothesis 4. Our results differ from the findings in Benmelech (2009), and Benmelech, Garmaise, and Moskowitz (2005), who find that higher liquidation values are associated with longer-term debt. One potential explanation for why maturity is not correlated with redeployability in our paper is that senior tranches tend to have longer maturities than mezzanine or subordinated tranches. The average maturity of senior tranches is 17.1 years compared to 13.9 years in mezzanine tranches and 10.5 in junior tranches. If creditors are willing to supply long-term debt only when their tranches are senior, and if our seniority control variable does not fully control for this, it is possible that the seniority effect will dominate redeployability in determining tranche maturity. Moreover, both Benmelech (2009) and Benmelech, Garmaise, and Moskowitz (2005) study 'balloon loans' that require substantial principal payment at the end of the term of the loan—which is consistent with models of debt maturity that assume zero-coupon debt. However, similar to residential mortgages, EETCs are amortized and hence, most of the principal of the loan is already paid by the time of the legal maturity date. In summary, while we do not find a relation between tranche maturity and asset

Table 12
Robustness test: controlling for loan-to-value.

The dependent variable in the regressions is credit spread (in basis points) over its corresponding treasury yield. Loan-to-value is the cumulative loan-to-value (LTV) at the tranche level. Seniority is the tranche seniority (1 = most senior). Private is a dummy variable that equals one for private placement tranches. Tranche size is the logarithm of the dollar value (in $ millions) of the tranche. Call provision is a dummy variable that equals one if the tranche is callable. Maturity is the number of years until the final payment. Airline size is the logarithm of the book value of the airline assets. Market-to-book is calculated as the market value of equity minus the book value of equity, all over the book value of assets. Profitability is defined as operating income over assets. S&P airline credit rating is the airline long-term credit rating. Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type; Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. All regressions include an intercept (not reported) and both year and airline fixed effects. *t*-statistics are calculated using standard-errors that are clustered by airline and reported in parentheses.

Dependent variable =	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread	Credit spread
Loan-to-value	108.21	110.14	108.98	349.12	364.96	343.61
	(0.72)	(0.74)	(0.74)	(2.00)	(2.03)	(2.00)
Seniority	45.02	44.93	44.87	18.04	16.36	18.36
	(7.28)	(7.32)	(7.38)	(1.62)	(1.39)	(1.63)
Private	38.23	36.12	36.25	36.25	24.18	29.75
	(3.23)	(3.16)	(3.15)	(2.99)	(1.72)	(2.54)
Tranche size	0.40	0.99	0.86	2.34	3.92	2.80
	(0.05)	(0.12)	(0.10)	(0.29)	(0.45)	(0.34)
Call provision	66.00	64.96	65.20	55.81	55.69	58.78
	(3.25)	(3.13)	(3.07)	(4.34)	(4.15)	(3.53)
Maturity	0.16	0.11	0.08	0.26	0.09	0.16
	(0.09)	(0.06)	(0.04)	(0.13)	(0.04)	(0.08)
Airline size	−15.67	−16.48	−16.56	179.35	174.68	152.11
	(−1.60)	(−1.64)	(−1.68)	(2.72)	(2.31)	(2.29)
Market-to-book	17.53	19.60	19.23	94.32	107.13	84.20
	(0.72)	(0.78)	(0.81)	(2.90)	(2.91)	(2.99)
Profitability	−210.25	−213.64	−210.24	−342.78	−332.10	−418.18
	(−2.11)	(−2.09)	(−2.05)	(−1.58)	(−1.55)	(−1.84)
S&P airline	7.32	7.31	7.19	2.23	2.14	1.37
credit rating	(1.76)	(1.76)	(1.76)	(0.51)	(0.40)	(0.35)
Redeployability	−0.016			−0.10		
(aircraft)	(−2.98)			(−4.49)		
Redeployability		−0.145			−0.83	
(operators)		(−3.15)			(−3.07)	
Redeployability			−0.457			−2.34
($\geqslant$5 aircraft)			(−3.75)			(−4.03)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Airline fixed effects	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.63	0.63	0.63	0.68	0.68	0.68
Observations	203	203	203	203	203	203

redeployability in our sample, these results may be specific to EETCs or other debt instruments with amortized payments.

5.6. Redeployability and credit spreads controlling for LTV

Having shown that loan-to-value ratios are increasing in our measures of collateral redeployability and are hence endogenous, we now examine whether the relation between tranche credit spreads continues to hold even after controlling for tranche loan-to-value. Since asset redeployability may increase debt capacity, our redeployability measures may be capturing, in part, variations in leverage ratios, which in turn have a direct effect on credit spreads. Since increased loan-to-value ratios tend to increase credit spreads, our previous estimates of the impact of redeployability on credit spreads may be underestimated (i.e., Harris and Raviv, 1990). We thus estimate the following regression:

$$Spread_{i,a,t} = \beta \times Redeployability_{i,a,t} + \lambda \times LTV_{i,a,t} + \mathbf{X}_{i,a,t}\boldsymbol{\gamma} + \mathbf{Z}_{a,t-1}\boldsymbol{\delta} + \mathbf{c}_t\boldsymbol{\theta} + \mathbf{b}_a\boldsymbol{\psi} + \xi_{i,a,t}, \quad (6)$$

where *Spread* is the tranche credit spread above the corresponding treasury yield on the issue date, *Redeployability* is one of our three measures of the redeployability of the aircraft portfolio serving as collateral for each tranche, *LTV* is the tranche cumulative loan-to-value ratio, $\mathbf{X}_{i,a,t}$ is a vector of tranche covariates, $\mathbf{Z}_{a,t}$ is a vector of airline controls, $\mathbf{c}_t$ is a vector of year fixed effects, $\mathbf{b}_a$ is a vector of airline fixed effects (included in the last three columns of the table), and $\xi_{i,a,t}$ is the regression residual. Regressions are run under OLS, and robust standard errors are clustered by airline and reported in parentheses. Since we do not have tranche loan-to-value ratios for all the tranches in our data, our number of observations drops to 203.

We report the results from estimating regression (6) in Table 12. First, we find that when including airline fixed effects, increased loan-to-value is associated with higher tranche credit spreads. The economic magnitude of the effect is quite large, with a standard deviation increase in cumulative loan-to-value ratios increasing credit spreads by between 51 and 54 basis points in the specification with airline fixed effects, representing 26% of the mean

spread. While having the right sign, cumulative loan-to-value is not statistically significant in determining credit spreads when airline fixed effects are not included. The coefficients on the other control variables in Table 12 are consistent with our previous findings.

As Table 12 demonstrates, collateral redeployability is consistently negatively related to credit spreads, even after controlling for tranche cumulative loan-to-value ratios. As expected, since debt capacity should be positively related to collateral redeployability, controlling for cumulative loan-to-value ratios generally increases the economic and statistical significance of our results as compared to those found in Table 6. We find that in the specification without airline fixed effects, moving from the 25th to the 75th percentile in our three redeployability measures reduces tranche credit spreads by approximately 20 basis points, representing a decrease of 10% relative to the mean spread. Controlling for airline fixed effects increases the economic significance of this result, with a 25th to 75th percentile movement in the redeployability measures reducing spreads by between 106 and 126 basis points, representing between 53% and 63% of the mean spread.

It should be noted that, as argued earlier, even these estimates of the effect of redeployability on credit spreads may be understated. Since credit spreads in our sample are calculated as of the issue date of the secured debt, the value of collateral is priced based on the expected probability of liquidation at the time of issue. As the probability of default and liquidation increases, the effect of redeployability on prices will increase. Put differently, for the many airlines which post-ETC or EETC issue experienced financial distress, the estimates in Table 12 represent a lower bound on the effect of redeployability on subsequent credit spreads.[25]

6. Conclusion

In this paper we analyze the effect of collateral on the cost of debt capital and other aspects of debt financing. Theories based on borrower moral hazard and limited pledgeable income predict that collateral increases the availability of credit and reduces its price by limiting the downside risk born by creditors. Upon default, creditors can obtain at least a portion of the return on their investment through the repossession and liquidation of pledged collateral.

Testing these theories is complicated by the very selection problem which they imply: creditors will demand collateral precisely from those borrowers who are riskier. This selection problem leads to a positive relation in the data between the presence of collateral and loan yields. Analyzing the extensive margin of collateral use, therefore, masks the hypothesized negative impact that collateral exhibits on debt yields.

We analyze the intensive, rather than extensive, margin of collateral use. We assemble a novel data set of secured credit issued by U.S. airlines which use aircraft as collateral. We proxy for the ease at which creditors will be able to liquidate collateral upon default by constructing measures of aircraft redeployability. We then test the relation between collateral redeployability and credit spreads, credit rating, loan-to-value ratios, and debt maturity, and estimate its economic significance.

We find a negative relation between tranche credit spreads and expected collateral values. Increased aircraft redeployability is thus associated with cheaper credit as creditors' downside risk upon default is reduced. Our results also show that debt tranches that are secured by more redeployable collateral exhibit higher Moody's and S&P credit ratings as well as higher loan-to-value ratios. We find no relation between redeployability and debt maturity. Taken together, our results suggest that the ability to pledge collateral, and in particular, collateral which is more redeployable, eases financial frictions, lowers the cost of external financing, and increases debt capacity.

Appendix A. Ordered probit construction

Following Blume, Lim, and Mackinlay (1998) we use a latent variable model assuming that a latent variable y^* is determined by

$$y^* = \mathbf{X}\beta + \zeta, \tag{A.1}$$

where $\mathbf{X}$ includes one of our three measures of the redeployability of the aircraft portfolio serving as collateral for each tranche, a vector of tranche covariates, a vector of airline controls, and vector of year fixed effects, and ζ is a standard normal random variable. Let $\alpha_1 < \alpha_2 < \cdots < \alpha_{J-1}$ be the unknown cut points, and define

$$\textit{Tranche rating}_{i,a,t}^{M,S} = \begin{cases} 1 & \text{if } y^* \leqslant \alpha_1, \\ 2 & \text{if } \alpha_1 < y^* \leqslant \alpha_2, \\ . & . \\ . & . \\ . & . \\ J & \text{if } y^* > \alpha_{J-1}, \end{cases}$$

where $J = 21$ for Moody's rating and $J = 22$ in the case of S&P rating. Given the standard normal assumption for $\zeta_{i,a,t}$, we derive the conditional distribution of the tranche credit rating:

$$Pr(\textit{Tranche rating}_{i,a,t}^{M,S} = j|\mathbf{X}) = \begin{cases} \Phi(\alpha_1 - \mathbf{X}\beta) & \text{if } j = 1, \\ \Phi(\alpha_j - \mathbf{X}\beta) - \Phi(\alpha_{j-1} - \mathbf{X}\beta) & \text{if } 1 < j < J, \\ 1 - \Phi(\alpha_{J-1} - \mathbf{X}\beta) & \text{if } j = J, \end{cases}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function (Table A1).

[25] Unfortunately, since we do not have data on yields in the secondary market, we cannot test this prediction directly.

Table A1
Redeployability and airline characteristics.

The dependent variable in the regressions is one of three redeployability measures: Redeployability (aircraft) is the number of aircraft per type; Redeployability (operators) is the number of operators per type, Redeployability ($\geqslant$5 aircraft) is the number of operators who operate at least five aircraft per type. Airline size is the logarithm of the book value of airline assets. Profitability is defined as operating income over assets. Leverage is defined as total debt divided by total assets. Interest coverage is defined as operating earnings before depreciation divided by interest expense. S&P airline credit rating is the airline long-term credit rating. All regressions include an intercept (not reported) and year fixed effects. Also reported are the *p*-values of *F*-tests for the joint significance of the explanatory variables (excluding year fixed effects). *t*-statistics are calculated using standard errors that are clustered by airline and reported in parentheses.

Panel A: Dependent variable: Redeployability (# of aircraft)						
Airline size	−212.00					−197.68
	(−0.70)					(−0.92)
Profitability		3780.45				1661.08
		(1.31)				(0.65)
Leverage			558.35			1589.76
			(0.31)			(0.94)
Interest coverage				386.33		208.80
				(1.03)		(0.76)
S&P airline					−107.11	−107.56
credit rating					(−1.05)	(−1.20)
F-test (*p*-value)						0.407
Adjusted R^2	0.21	0.26	0.18	0.23	0.23	0.340
Observations	225	225	223	225	225	225
Panel B: Dependent variable: Redeployability (# of operators)						
Airline size	−24.90					−22.12
	(−0.74)					(−0.93)
Profitability		415.07				148.13
		(1.22)				(0.51)
Leverage			32.65			173.69
			(0.16)			(0.89)
Interest coverage				53.84		38.07
				(1.28)		(1.19)
S&P airline					−12.58	−10.61
credit rating					(−1.08)	(−0.98)
F-test (*p*-value)						0.339
Adjusted R^2	0.21	0.22	0.19	0.21	0.24	0.29
Observations	225	245	225	225	225	225
Panel C: Dependent variable: Redeployability (# of operators with >5 aircraft)						
Airline size	−8.58					−7.95
	(−0.76)					(−0.99)
Profitability		143.02				58.59
		(1.31)				(0.64)
Leverage			13.91			55.04
			(0.21)			(0.91)
Interest coverage				15.97		0.06
				(1.17)		(0.91)
S&P airline					−4.12	−3.95
credit rating					(−1.08)	(−1.31)
F-test (*p*-value)						0.377
Adjusted R^2	0.23	0.26	0.16	0.25	0.25	0.36
Observations	225	225	225	225	225	225

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