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"Vintage Capital and Credit Protection"

Efraim Benmelech* and Nittai Bergman

*presenting

Vintage Capital and Creditor Protection*

Efraim Benmelech
Harvard University and NBER

Nittai K. Bergman
MIT Sloan School of Management

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Efraim Benmelech, Department of Economics, Harvard University, Littauer Center, Cambridge, MA 02138. E-mail: effi_benmelech@harvard.edu. Nittai Bergman, Sloan School of Management, MIT, 50 Memorial Drive, Cambridge, MA 02142. E-mail: nbergman@mit.edu.

Vintage Capital and Creditor Protection

Abstract

We provide novel evidence linking the level of creditor protection provided by law to the degree of usage of technologically older, vintage capital in the airline industry. Using a panel of aircraft-level data around the world, we find that better creditor rights are associated with both aircraft of a younger vintage as well as firms with larger aircraft fleets. Moreover, we find that more profitable airlines, airlines with lower leverage ratios, and airlines with less debt overhang are less sensitive to prevailing creditor rights in their country. We propose that by mitigating financial shortfalls, enhanced legal protection of creditors facilitates the ability of firms to make large capital investments, adapt advanced technologies and foster productivity.

Introduction

There is a large body of evidence that better legal rules covering protection of corporate shareholders and creditors are associated with more developed financial markets and higher economic growth (La Porta et al., (1997), (1998); King and Levine, (1993); Beck et. al., (2000); and Rajan and Zingales, (1998)). While the empirical regularities found in the data are quite robust, most of the research is based on cross-country outcomes and suffers from small samples and potential identification problems (see Djankov at al. (2007)). In particular, the results from cross-country regressions do not pin down the underlying mechanism through which creditor rights and shareholder protection affect real economic outcomes. This paper attempts to fill this gap. We study the relation between creditor protection and the use of vintage capital in the airline industry in a sample of most of the aircraft in the world (494,653 aircraft-year observations) covering 5,987 operators in 129 countries in the years 1978-2003. We find that airlines enjoying the benefits of higher creditor protection operate aircraft of a newer technology and younger vintage.

The importance of new capital goods for economic growth has been suggested by Solow (1960): "...many if not most innovations need to be embodied in new kinds of durable equipment before they can be made effective. Improvements in technology affect output only to the extent that they are carried into practice either by net capital formation or by the replacement of old-fashioned equipment by the latest models..." More recent theoretical models show that capital of older vintage hampers productivity and growth (Benhabib and Rustichini (1991)), slows technology diffusion (Chari and Hopenhayn (1991)), and increases income inequality across individuals and countries (Jovanovic (1998)). Empirical estimates suggest that around 60% of US per-capita growth is due to technical change that is embodied in new more efficient capital goods (Greenwood, Hercowitz, and Krusell (1997)).[1] Our paper provides novel evidence on the creditor rights channel in technological adaption and capital formation.

While we propose and provide evidence on one mechanism connecting financial constraints and creditor protection to aircraft age and fleet size, our results suggest a broader link between financial development, investor protection and economic activity. Our empirical methodology differs from previous research which has focused mostly on aggregate, macroeconomic outcomes of investor protection such as financial market development and economic growth (King and Levine (1993), La

[1]See Boucekkine, de la Croix, and Licandro (2008) for a survey of the vintage capital literature.

Porta et al. (1997, 1998), Rajan and Zingales (1998)). The wealth of the data and our focus on an important global industry allow careful consideration and identification of the specific mechanism through which investor protection affects and fosters technical progress and economic development.

Our paper adds to a growing body of literature that uses industry- and firm-level data to evaluate the effects of investor protection and financial development on resource allocation (Fisman and Love (2004), Wurgler (2000)), economic growth (Demirguc-Kunt and Maksimovic (1998), Guiso, Sapienza, and Zingales (2005)), and financial contracts and lending structures (Bergman and Nicolaievsky (2007), Braun (2003), Esty and Megginson (2003), Lerner and Schoar (2005), Onega and Smith (2000), and Qian and Strahan (2006)).

We start by developing a simple price-theory model of an airline choosing its scale and average asset age given an *internal* financing constraint and *external* creditor protection that is determined at the country level. The airline must decide on the quantity of aircraft to purchase and their average age. Older aircrafts are assumed to be less efficient – either because of depreciation in aircraft efficiency stemming from their normal use, or because of technological improvements in aircraft design over time. We hypothesize that increased availability of external finance due to enhanced creditor protection will have two important effects on firms. First, when financial constraints are more relaxed, firms will be able to invest in newer, more expensive technologies, and second, since financing considerations will place fewer constraints on firm scale, firms will tend to be larger. We derive three empirical predictions from our simple model. The first prediction is about aircraft age. We expect that, all else equal, airlines operating in countries with lower creditor rights will have older fleets. Second, we predict that, all else equal, airlines operating in countries with lower creditor rights will have smaller fleets. Third, we show that the effect of the level of creditor rights on airline fleet age and size will be smaller for airlines with greater internal funds. Our model is closely related to Eisfeldt and Rampini (2007b) who show that firms which are credit constrained purchase more used, rather than new, capital because, higher ex-post maintenance payments of used capital relaxes current ex-ante financial constraints.

To test these hypotheses, we utilize a dataset which provides information on most of the aircraft operated worldwide. First we confirm our hypothesis that older aircraft tend to be less efficient. Using data on yearly utilization rates for most of the aircraft in the world during the period 1996-2006 we find that older aircraft are utilized less in terms of hours flown per year.

Using detailed profiles of every single aircraft in the world during the period 1978-2003 we then study the relation between the level of creditor protection of the country in which the aircraft is operated and owned and its age. The level of country creditor protection is measured using the creditor rights score as developed by La Porta et al. (1997, 1998), and in particular the more recent score that covers 129 countries in the years 1978-2003 (Djankov et al. (2007)). Consistent with our first hypotheses, our analysis shows that aircraft operated in countries with higher creditor protection are of a younger vintage. Furthermore, we also find that operators' size are larger in countries with better creditor protection. These results continue to hold even after controlling for a variety of country, airline, year, and aircraft model-type fixed-effects.

While omitted variables at the country level are the major concern in cross-country analysis, the panel dimension of our data allows us to control for country fixed-effects and hence to identify off of changes in creditor rights within a country. To further alleviate concerns about an omitted variables problem, we split our sample into aircraft operated by commercial and private airlines, and those operated by the military. We expect the negative relation between aircraft age and fleet size and creditor protection to hold only for non-military operators, since private and commercial operators are those required to raise funds from outside investors in cases of cash flow shortages. Moreover, only commercial and private operators would fall under the bankruptcy provisions of the local corporate and bankruptcy laws which are the essence of the creditor rights score. Our results confirm this conjecture: we find that the creditor rights score is correlated with the age and fleet size of commercial and private operators but is uncorrelated with the age and size of military fleets.

To test our third prediction that the effect of creditor rights will be smaller for airlines with greater internal funds, we focus on airlines with publicly available financial data. In a sample of the 72 world's largest airlines representing 29 countries and 94,272 aircraft, we find that more profitable airlines, airlines with lower leverage ratios, and airlines with less debt overhang (measured by long-term debt) are less sensitive to creditor rights, as our model predicts. While both leverage and long-term debt are clearly endogenous, our identification strategy relies on the interaction effects between country and firm characteristics. Moreover, in order to control for unobserved airline quality we include airline fixed effects in our analysis. Our results hold for both the total fleets of operators around the world (the stock of aircraft) and actual aircraft transactions (the flow of aircraft).

One concern about our findings that is in particular important for the airline industry is the issue of aircraft leasing. Airlines in countries with bad creditor rights may be forced to lease aircraft instead of purchasing them through debt financing as asset repossession might be easier for a lessor than for a creditor (see e.g. Eisfeld and Rampini, (2007a)). While lessors are in general subject to the same bankruptcy provisions that are relevant to creditors (especially secured creditors), some countries adopt lessor-specific rules in bankruptcy similar to Section 1110 in the U.S. that exempts aircraft lessor from automatic stay in a Chapter 11 petition. As an additional robustness check we repeat our analysis for non-leased aircraft only and find economically and statistically stronger results.

The rest of the paper is organized as follows. Section I presents a simple price-theory model. Section II provides a description of our data sources and summary statistics. Section III presents the empirical link between aircraft age and utilization and efficiency. Section IV describes the empirical analysis of the relation between creditor rights and aircraft age and fleet size. Section V provides robustness analysis and Section VI concludes.

I. The Model

We begin by providing a simple model of a firm with an investment opportunity choosing its scale and average asset age given a financing constraint. For consistency with the empirical section we refer to the firm as an airline and its assets as aircraft, although the model obviously generalizes to any type of firm. The model is closely related to Eisfeldt and Rampini (2007b), but assumes that technologies of different vintage are not perfect substitutes in production.

Consider an airline facing a choice regarding its fleet size and composition. The airline must decide the quantity of aircraft to purchase and their average age. Older aircrafts are assumed to be less efficient – either because of depreciation in aircraft efficiency stemming from their normal use, or because of technological improvements in aircraft design over time.

Purchasing a fleet of q aircraft with an average fleet age of efficiency e is assumed to cost $q*e$. An airline operating such a fleet obtains revenue $R(q, e)$, where $R(q, e)$ is twice differentiable, concave, and $\partial^2 R/\partial q \partial e > 0$. Thus, we assume that there are decreasing returns to scale in both fleet size and average fleet efficiency, and that fleet size and efficiency are complements.

Initially, we assume that the airline has no internal funds and must purchase its fleet using funds raised in an external capital market. The airline operates in a country with a level of protection provided to investors parameterized by s, where s measures the fraction of revenue that insiders within the airline can costlessly expropriate from outside investors. Thus, given revenue $R(q,e)$, the airline's pledgeable income – i.e. the maximal amount that it can guarantee as repayment to its investors – is $(1-s)R(q,e)$. Capital markets are assumed to be perfectly competitive, and the discount factor is taken for simplicity to be 1.

To fund a fleet of size q and of average efficiency e, the airline must raise an amount qe of external funds. In doing so, it must commit to repay outside investors a payment P with $P \geq qe$. Additionally, due to the limited pledgeability of income, P must also satisfy $P \leq (1-s)R(q,e)$. Taken together, the airline's maximization problem is therefore,

$$\begin{aligned} Max[R(q,e) - P] \\ s.t.\ P \geq qe \\ P \leq (1-s)R(q,e) \end{aligned} \tag{1}$$

It is easy to see that at the optimum, the first constraint will be binding, implying that the airline's maximization problem is

$$\begin{aligned} Max[R(q,e) - qe] \\ s.t.\ qe \leq (1-s)R(q,e) \end{aligned} \tag{2}$$

As is standard in these problems, because capital markets are perfectly competitive, outside investors break even and therefore the maximand of maximization problem (2) has the airline obtaining the full NPV of the project subject to the financing constraint.

To solve maximization problem (2), we first define q^{fb} and e^{fb} as the (first-best) solutions to the unconstrained problem of $Max_{(q,e)}(R(q,e) - qe)$, which we also assume to be finite. The following proposition characterizes how the second-best solution (q^{sb}, e^{sb}) depends on the level of investor protection of the country in which the airline operates, s.

Proposition 1. *If q and e are sufficiently complementary in that $R * R_{12} > R_1 * R_2$ and also $R * (R_1 + qR_{11}) < q * R_1^2$ then there exists an $\bar{s}$, such that for $s \leq \bar{s}$, $(q^{sb}, e^{sb}) = (q^{fb}, e^{fb})$, while for $s > \bar{s}$, $\partial q^{sb}/\partial s \leq 0$ and $\partial e^{sb}/\partial s \leq 0$.*

Proof. *See Appendix.*

Proposition 1 is quite intuitive. For high enough levels of investor protection, the airline's pledgeable income is high enough to allow it to purchase the first-best fleet. In contrast, for low levels of investor protection (high s) the financing constraint in maximization problem (2) may bind, so that in the second-best solution, as pledgeable income deteriorates (s increases), the firm will reduce both the size of its fleet as well as its average aircraft efficiency.
Recalling that average fleet age is inversely correlated with average fleet efficiency, from Proposition 1 we generate two predictions which are tested in the empirical section:

Prediction 1. *All else equal, airlines operating in countries with lower investor protection will have older fleets.*

Prediction 2. *All else equal, airlines operating in countries with lower investor protection will have smaller fleets.*

We now relax the assumption that the airline must fund all of its fleet acquisition employing external finance, and assume instead that the airline has internal funds, A. Clearly, if $A \geq q^{fb}e^{fb}$, the airline can purchase the first-best fleet with internal funds and obtain the first-best solution irrespective of the level of investor protection in which it operates. If, on the other hand, $A < q^{fb}e^{fb}$, the airline will attempt to raise external capital from the market, which, it is easy to see, involves a financing constraint of $eq \leq A + (1-s)R(e,q)$.

We therefore obtain the following variant of Proposition 1:

Proposition 1b. *(i) For every A with $A \leq q^{fb}e^{fb}$, there exists an $\bar{s}(A)$, such that for $s \leq \bar{s}(A)$, the airline obtains the first-best solution, (q^{fb}, e^{fb}), while for $s > \bar{s}(A)$, $\partial q^{sb}/\partial s \leq 0$ and $\partial e^{sb}/\partial s \leq 0$. (ii) $\partial \bar{s}(A)/\partial A \geq 0$.*

Proof. *See Appendix.*

Similar to Proposition 1, part (i) of Proposition 1b states that for any given level of internal capital A, there exists a level of investor protection below which the airline's investment will be constrained by its limited ability to pledgeabe income, and hence it will have to reduce investment in both the size and average efficiency of its fleet. Further, as is intuitive, part (ii) of the proposition states that when an airline has greater internal funds, the region in which the level of investor protection affects the airline's fleet age and size diminishes.

We thus test the following additional prediction:

Prediction 3. *The effect of the level of investor protection on airline fleet age and size will be smaller for airlines with greater internal funds.*

II. Data and Summary Statistics

This section describes the data sources used in the paper and presents summary statistics for both aircraft age and fleet size.

A. Aircraft Level Data

Throughout our analysis we utilize data from the Ascend CASE database – a leading provider of individual aircraft and airline data which contains ownership and operating information about all commercial and corporate aircraft worldwide as well as many military and government aircraft. We construct a sample of all aircraft that are available in the database for the 129 countries that are included in Djankov at al. (2007). Our sample consists of all aircraft worldwide over the period January 1, 1978 to December 31, 2003 from Ascend CASE database.[2] The data are quite detailed with regard to the individual aircraft and include information on aircraft characteristics such as model-type, serial number, age, operating airline, and owner. In addition to data on aircraft's current operator and owner (the operator is different from the owner for leased aircrafts), Ascend CASE includes information on past owners and users of each aircraft. This enables us to uniquely identify, track and follow most of the aircrafts in the world during our time period.

Panel A of Table 1 displays summary statistics of aircraft age for 4 sub-periods (1978-1979, 1980-1989, 1990-1999, and 2000-2003), and for the entire sample. There are 494,653 aircraft-year observations in the entire sample, with an average (median) age of 13.0 (12.0) years, and a standard deviation of 9.2 years. The sample represents 219 aircraft types, 5,987 operators from 129 countries. As Panel A demonstrates the average aircraft age in the sample increased from 9.1 in the years 1978-1979 to 14.7 in the years 2000-2003, representing an overall aging of aircraft fleets around the world. Our sample covers 89 countries in the 1978-1979 sub-sample, 102 countries in the 1980-1989 sub-sample, and 129 countries onward, as information on creditor rights of post-socialists countries become available between 1989 and the mid 1990s.

[2] Benmelech and Bergman (2007a, 2007b) provide an extensive description of the Ascend CASE database.

In the last two columns of Panel A we split our sample into aircraft operated by commercial and private airlines (Commercial), and those operated by the military and government agencies (Military). The distinction between commercial and military aircraft plays an important role later in the analysis as we expect the negative relation between aircraft age and fleet size and creditor protection to hold only for non-military operators, since military operators would not fall under the bankruptcy provisions of local corporate and bankruptcy laws. There are 373,261 commercial aircraft and 121,392 that are classified as military aircraft in the sample. The commercial sample represents 161 aircraft types, 5,437 operators from 129 countries, while the military sample represents 200 aircraft types, 893 operators from 115 countries. Further, as can be seen in Panel A of the table, military aircraft are older than commercial aircraft; the average age of a commercial aircraft is 12.0 years compared to 16.0 years for military aircraft (p-value for an equal means t-test=0.000).

B. Country Level Data

The information in Ascend CASE also enables us to match data on each individual aircraft to country level macro- and legal variables of the aircraft's country of operator and owner. We thus augment the data from Ascend CASE with country level macro data from the World Bank's World Development Indicators database. This macro data includes GDP, GDP growth, GDP per capita, GDP per capital growth as well as surface (country area in sq km.) and population data. We obtain data on legal origins and creditor rights from the new database assembled by Djankov et al. (2007) that covers 129 countries in the period 1978-2003. This new data is a major improvement upon the La Porta et al. (1997, 1998) data, as it covers many more countries, and tracks their variation in creditor rights score over time. It therefore enables a panel-data analysis using, for example country fixed effects, which identifies off of variation in creditor rights within a country over time.

For each country, the creditor rights index measures four powers of secured lenders in bankruptcy.[3] First, whether there are restrictions on bankruptcy filing; second, whether there is no 'automatic stay' or 'asset freeze' that prevents secured creditors from seizing their collateral. Third, whether secured creditors ate paid first, and finally, whether a trustee different from the management runs the firm during reorganization. A value of one is assigned to each of the provisions when a country's law provides these powers to secured creditors. The creditor rights index is then calculated

[3] See Djankov et. al. (2007) for a comprehensive description of the index and its construction.

by aggregating the scores of the four provisions, so that the creditor rights index varies between a score of 0 (poor creditor rights) and a score of 4 (strong creditor rights). Djankov et. al. (2007) collect time series data on creditor rights for each of the 129 countries, by identifying all major reforms and assessing their impact on the creditor rights score.

Panel B of Table 1 reports summary statistics of the creditor rights index, GDP per capita, and legal origin. The mean (median) creditor rights in the sample is 1.65 (1.0) and the standard deviation is 1.01. The sample includes 279,031 aircraft from countries with English legal origin, 108,415 from countries with French legal origin, 51,865 from Socialist legal origin, 47,580 from German legal origin, and 7,762 aircraft are from countries with a Nordic legal origin. Table 2 lists the top 20 countries with the most aircraft-year observations in the sample, and the bottom countries with the least aircraft-year observations. With a total of 185,476 observations, the U.S. accounts for 37.50% of the sample, followed by the Russian Federation (38,519 aircraft), U.K. (20,077 aircraft), and Canada (18,500 aircraft). The countries with the least observations in the data are Bosnia and Herzegovina (44 aircraft), Albania (49 aircraft), Togo (62 aircraft), and Niger (66 aircraft).

C. Airline Level Data

Finally, we match aircraft information to airline financial data where available. Information on airline financial data is obtained from Compustat Global. We collect all firms in SIC codes 4500-4580 and manually match them to the aircraft level data from Ascend CASE. We also supplement the information with data from Compustat North America for U.S. airlines. After matching Ascend CASE to Compustat Global and Compustat North America and restricting the sample to the countries covered by Djankov et al. (2007), we are left with 72 airlines from 29 countries, representing a panel of 94,272 aircraft-year observations.

III. Aircraft Age and Usage

An underlying assumption throughout our study is that assets of an older vintage are either less technologically advanced and hence less efficient, or that older vintage aircraft are less efficient due to physical depreciation. We therefore begin our empirical analysis with motivational evidence testing this assumption in the context of aircraft. Measuring individual aircraft efficiency requires information on inputs (number of seats, men hour, fuel costs, operating times, routes, etc.) and outputs (number of passengers, revenue, arrival times). We cannot measure aircraft efficiency directly as we do not have access to these data at such a fine resolution for individual aircraft. Instead, we utilize data from the Ascend Case database on aircraft usage as an approximation of aircraft efficiency. Spanning the period 1996-2006, the data provides hourly utilization rates for 25,009 aircraft worldwide. For each aircraft in the sample, the data tallies the number of hours flown each year, as well as the aircraft type and year of build. We hypothesize that if aircraft efficiency is indeed decreasing with aircraft vintage, airlines will tend to decrease the operating times of their older vintage aircraft. Thus, for example, if older vintage aircraft are less fuel-efficient, to the extent possible, airlines will shift their operations to the newer vintage aircraft in their fleet. Moreover, older aircraft require more maintenance and engines overhauls that would ground older aircraft for longer periods of time compared to newer ones.

Table 3 reports the results from estimating the relation between annual hourly usage and aircraft age for all aircraft with non-zero usage.[4] For each aircraft-year pair, we calculate the age of an aircraft as the time that elapsed from its year of build. All specifications include year fixed effects to account for temporal variation in average aircraft usage.

As can be seen from the table, the coefficient on aircraft age is consistently negative and is statistically significant at the 1% level whether we cluster the standard errors by aircraft-type or at the individual aircraft level. Thus, consistent with our underlying assumption that older vintage aircraft are less efficient, we find that aircraft usage declines with age. This result is robust to the addition of both aircraft type and aircraft fixed effects. The economic magnitude of this effect is quite significant: a one-standard-deviation increase in aircraft age of 8.62 years decreases aircraft yearly usage by approximately 450 hours, representing an 18 percent decline relative to the sample mean hourly usage of 2466 hours.

Table 4 examines the relation between aircraft age, broken down by aircraft decile and aircraft usage. Consistent with the evidence presented in Table 3, we find that yearly aircraft usage is monotonically decreasing in aircraft age decile. For example, aircraft in the 5th age-decile are flown between 423 and 257 less hours than those in the first age decile.

Figures 1a and 1b provide a graphical representation of this monotonic relation between age

[4]Since aircraft may drop out of the sample when they are retired from active service, we analyze the relation between usage and age only for aircraft that have been utilized during the year. Thus, we analyze the intensive, rather than extensive, margin, and as such our results can be viewed as a lower bound on the relation between age and utilization.

and usage. To construct the figures we regress yearly aircraft usage on the set of indicator variables defined for each possible value of aircraft age, while including year fixed effects as well. Figure 1a graphs the coefficients on the age indicator-variables along with their 95 percent confidence interval calculated by clustering at the aircraft-type level.[5] The graph thus illustrates the evolution of aircraft usage with aircraft age. Figure 1b repeats the analysis but includes aircraft-type fixed effects in the regression calculating the coefficients on the age indicator variables. As can be seen from both figures, consistent with our assumption that aircraft efficiency improves over time, aircraft usage declines with aircraft age.

IV. Creditors Rights and Aircraft Age

A. Baseline Results

Our simple model shows that the effects of financial constraints should be exacerbated in countries with poor creditor rights, where the availability of debt capital may be limited and its cost much higher. We therefore predict that airlines that operate in countries with poorer investor protection operate older vintage aircraft with older technologies.[6] To test this prediction, we calculate the age of every aircraft in the 129 countries that are in our sample during the period 1978-2003 and run the following baseline regression:

$$Age_{iact} = f(Creditor\, rights_{ct}, \mathbf{X}_{ct}, \mathbf{y}_t, \mathbf{z}_{ac}). \tag{3}$$

The dependant variable in this regression, Age_{iact}, is the age of aircraft i operated by operator a in country c in year t. Creditor rights is the creditor rights score of country c in year t, as measured by Djankov, et al. (2007). $\mathbf{X}_c$ is a vector of country-specific control variables which includes the logarithm of country c's GDP per capita, the logarithm of its population and the logarithm of its area. In addition, in some specifications we include as control variables a set of indicator variables indicating the legal origin of the country – common law, French, German, Nordic, or Socialist.[7] Finally, all regressions include year fixed effects, $\mathbf{y}_t$, and depending on the specification may also include country, aircraft model-type, and operator fixed effects represented by the vector of variables

[5] The indicator variable for age equaling one is omitted, so that all coefficients are calculated in relation to the usage of aircraft of age one.

[6] As prima facie evidence in support of this hypothesis, we were told in conversations with practitioners from the legal department of one of the world largest aircraft lessors, that country level bankruptcy procedures and efficiency play a crucial role in their decision whether to enter a leasing transaction in a specific country.

[7] The common law dummy variable is omitted in specifications that include legal origin indicator variables.

z. All regression are estimated with both heteroscedasticity robust standard errors, and standard errors clustered by country. In general the standard errors that are clustered by country are much larger than the robust standard errors, and since our variable of interest is creditor rights which is determined at the country level, we consider our results to be significant only when they pass the higher hurdle of clustering by country.

Table 5 provides results of regression (3) over the entire sample. As hypothesized, we find that enhanced creditor rights are consistently negatively associated with aircraft age. Thus, as the first column of Table 5 demonstrates, with year and country fixed effects, increasing a country's creditor rights score from 0 to 4, reduces the age of aircraft by 4.4 years, or 34.0% of the mean aircraft age of 12.95 years. When country legal origin is controlled for, and country fixed effects naturally dropped (as there is no variation in legal origin in our time period), the magnitude of this effect is reduced by half, although qualitatively it remains similar. Indeed, aircraft age remains negatively related to creditor rights even when year, country, and operator fixed effects that account for 5,987 different operators in the data are added to the specification (column 5). Finally, aircraft age is negatively related to creditor rights and is statistically significant at the 1% level even when year, country, operator, and aircraft-type fixed effects, representing 219 different aircraft types are added (column 6). In sum, consistent with our prediction, aircraft are younger in countries with better creditor rights controlling for GDP per capita, population, area and a battery of fixed-effects at the aircraft type, operator, and country level.

While, as is usually the case, in cross-country analysis the main empirical challenge is endogeneity, we utilize the panel nature of our data and the changes in creditor rights over time to overcome an omitted variables problem. By including country and operator fixed effects, we control for unobserved heterogeneity of operators and countries. In these specifications we identify off of changes in creditor rights over time within a country, or variation in the creditor rights scores of countries in which similar model typed aircraft are operated. Indeed, we find that in specifications which include country fixed effects, the negative association between creditor rights and age is the largest which is consistent with a large effect of the legal reforms identified by Djankov, et al. (2007).

B. Commercial vs. Military Aircrafts

In Table 6, for every country, we divide our sample into aircraft operated by commercial airlines and private operators, and those operated by militaries, armed forces and government agencies. For example, as of December 31, 2003 there are ten federal agencies or military operators in the U.S. in our sample: Federal Aviation Administration, NASA, US Air Force, US Air National Guard, US Army, US Army National Guard, US Coast Guard, US Customs Service, US Marine Corps, and the US Navy. Likewise, as of December 31, 2003, there are four military operators and one government agency in the Islamic Republic of Iran: Iran National Cartographic Center, Iranian Air Force, Iranian Army, Iranian Navy, and the Iranian Revolutionary Guard.

We expect the negative relation between aircraft age and creditor protection to be concentrated amongst commercial and private aircraft operators, since these are the firms which would be required to raise funds from external investors in cases of financial shortfalls. In addition, commercial and private firms would fall under the bankruptcy provisions of the local corporate and bankruptcy laws which are the essence of the creditor protection score, while government agencies, militaries and other armed forces would not since the external financing channel would hardly seem to be relevant for such planes.

Panel A of Table 6 breaks down the average aircraft age by the creditor rights index for the full sample, the subsample of commercial aircraft, and the subsample of military aircraft. As can be seen from the table, the age of commercial aircraft is generally decreasing with countries' creditor protection scores: on average, aircraft in countries with the best creditor protection score are 1.11 years younger than those in countries with the worst creditor protection scores (the difference is statistically significant at the 1 percent level). In contrast, as hypothesized, military aircraft exhibit no such relation between aircraft age and creditor rights score. Actually, when focusing on military aircraft, we find a *positive* relation between the two, with military aircraft in countries with the highest creditor rights score on average 3.59 years older than those in countries with the worst creditor rights. Panel B of the table repeats this analysis by providing a break down of the fraction of aircraft older than 20 years by creditor rights. Again, the fraction of commercial aircraft older than 20 is smallest in countries with the best creditor protection, while in contrast, the fraction of military aircraft older than 20 is greatest in countries with the best creditor protection.

To formally test this hypothesis, Table 7 reports the results of running regression 3 separately for commercial aircraft and aircraft operated by the military. Consistent with the results in Table 6, in all specifications, the age of commercial aircraft is more negatively related to creditor rights than is the age of military aircraft. Indeed, when we control for year and aircraft-type fixed effects and include the legal origin dummies in the regressions (columns 3 and 4), the magnitude of the creditor rights coefficient is less than a third than that of the corresponding coefficient in the commercial aircraft regression. Moreover, the negative coefficients on creditor rights are never statistically significant in the military aircraft subsample when we cluster the standard errors by country. As clustering by country is the relevant hurdle rate, we conclude that none of the creditor rights coefficients in the military aircraft regressions are statistically different from zero.

For robustness, we repeat the analysis in Table 7 using probit regressions. We define an indicator variable that takes on the value of one when an aircrafts age is greater than 20 years and zero otherwise. An additional indicator variable is constructed taking on the value of one when an aircrafts age is greater than 30 years and zero otherwise. We then run the following Probit specification:

$$Pr(Old_{iact} = 1 | Creditor\, rights_{ct}, \mathbf{X}_{ct}, \mathbf{y}_t) = \int_{-\infty}^{z} \phi(k) dk \tag{4}$$

where *Old* is either one of the two indicator variables described above, Creditor rights is the creditor rights score of country c in year t as measured by Djankov et al. (2007), $\mathbf{X}_c$ is the vector of control variables used in regression 3, $\phi(k)$ is the standard normal density, and $z = CreditorRights_c + \mathbf{X}_c + \mathbf{y}_t$.

These Probit regressions are run employing both the commercial aircraft sub-sample and the military aircraft sub-sample over three sample periods: 1978–2003, 1990–2003, and 2000–2003. We consider different time periods to take into account the fact that aircraft age distributions are naturally changing over time – e.g. in the 1970s there were few commercial aircraft older than 20 years.

The results, which are shown in Table 8 (marginal effects are reported), are very much consistent with those in Table 7. In the commercial subsample, when an airline is located in a country with increased creditor rights, there is a lower probability of its aircraft being of an old vintage. Indeed, over the sample period 1978 - 2003, increasing a countrys level of investor protection from a creditor-rights score of 0 to a creditor rights score of 4, reduces the likelihood that firms operating in this country will operate old aircraft - as proxied by having an age greater than 20 - by an economically significant 38.7% relative to the unconditional mean. This effect increases to 57.3% relative to the mean in the period 2000-2003 when using the 30 year cutoff as a proxy for old vintage aircraft. Finally, as before, in none of the military aircraft sub-samples do the old aircraft indicator variables respond to creditor rights in a statistically significant manner, and their coefficients are lower than their commercial counterparts.

C. Creditor Rights, Financial Constraints and Aircraft Age

We now turn to analyze the effect of creditor rights on aircraft age conditional on the financial position of the operator. According to prediction 3 of our model and consistent with Eisfeldt and Rampini (2007b), we expect the effect of creditor rights on aircraft age to be larger for more financially constrained airlines. Since airlines with greater internal funds are less likely to rely on debt or lease financing they should be less affected by the legal system or local financial development. We obtain information on airline financial data from Compustat Global. We are able to match 72 airlines from 29 countries to the countries covered by Djankov et al. (2007), representing a panel of 94,272 non-military aircraft.

We test prediction 3 using interaction terms between the country's creditor rights index and airline-level measures of financial distress. Our approach is similar to Rajan and Zingales (1998) who identify the effects of financial development on growth using interaction terms between financial development (at the country level) and financial dependence (at the industry level). Our analysis focuses on two measures of financial constraints: leverage and long-term debt, both used by Eisfeldt and Rampimi (2007) which were found empirically to be determinants of used capital investment. We obtain similar results using other measures such as cash holdings and profitability. We estimate the following regression:

$$Age_{iact} = Creditor\,rights_{ct} + FinConst_{act} + Creditor\,rights_{ct} \times FinConst_{act} + \mathbf{X}_c + \mathbf{y}_t + \mathbf{z}_{ac} + \epsilon_{iact} \quad (5)$$

As in regression 3, Age_{iact}, is the age of aircraft i operated by operator a in country c in year t. Creditor rights is the creditor rights score of country c in year t, as measured by Djankov et al. (2007), $FinConst_{act}$ is a measure of the airline financial constraints (either leverage defined as total debt divided by the book value of assets, or long-term debt defined as long-term debt divided by the book value of assets), $Creditor\,rights_{ct} \times FinConst_{act}$ is an interaction term between creditor rights and airline financial constraints, $\mathbf{X}_c$ is a vector of country-specific control variables which includes the logarithm of country c's GDP per capita, the logarithm of its population and the logarithm of its area. In addition, in some specifications we include as control variables a set of indicator variables indicating the legal origin of the country. Finally, all regressions include year fixed effects, $\mathbf{y}_t$, and depending on the specification may also include country and operator fixed effects represented by the vector of variables $\mathbf{z}$. All regression are estimated with both heteroscedasticity robust standard errors, and standard errors clustered by country. Results are provided in Table 9.

Consistent with prediction 3, the interaction term between creditor rights and leverage (second and fifth columns in Table 9), and the interaction term between creditor rights and long-term debt (fourth and last columns) are negative, indicating that the effect of creditor rights on age is concentrated in financially constrained airlines. While both leverage and long-term debt are clearly endogenous, our identification strategy in Table 9 relies on the interaction between country and firm characteristics. Moreover, in order to control for unobserved operator quality we include operator fixed effects in the last two columns and find both statistically and economically significant results. Focusing on the second column of Table 9, we find that reducing a countrys level of investor protection from a creditor-rights score of 4 to a creditor rights score of 0, increases the average age of aircraft operated by airlines in the 25th percentile of leverage by 0.59 years. In contrast, amongst airlines in the 75th leverage percentile, i.e. those that are arguably more financially constrained, we find that reducing creditor rights from a score of four to a score of 0 increases average age by a much larger 2.98 years.

As a further robustness check, we repeat our analysis employing probit regressions using the two indicator variables used earlier for old age aircraft with cutoff points of 20 and 30 years.

The results are presented in Table 10. As above, the interaction terms between creditor rights and our two measures of financial constraints, leverage and long-term debt, are negative. As the table shows and consistent with prediction 3 of the model, there are more old planes in countries with low creditor protection, especially amongst firms with high leverage or long-term debt ratios.

D. Creditor Rights and Fleet Size

We now turn to analyze the relation between creditor rights and fleet size. According to Prediction 2 of the model, firms operating in countries with better creditor rights should operate on average larger fleets. This is because operator scale will not be constrained by the availability and cost of external finance. This prediction is broadly consistent with the empirical finding in Kumar, Rajan, and Zingales (2002) who find that the average firm size is larger in countries with better institutional development.

In order to test this prediction we need a measure of fleet size. Measuring fleet size, however, is somewhat complicated by the fact that airline fleets include multiple aircraft types of different size and use. Thus, a measure of fleet size must weigh aircraft of different variety in an appropriate manner. For example, a passenger capacity measure such as the number of seats will not capture the size of cargo aircraft. Rather than committing to one particular weight system, we test Prediction 2 using a number of weighing schemes. To do so, for each aircraft type in our sample, we gather information on that aircraft type's maximal seat capacity, its maximal takeoff weight, and the aircraft type's wingspan. This data is gathered from Singfield (2005) as well as from a variety of internet sources. Based on this information, for each operator and year in our sample, we then construct four measures of fleet size. The first is simply an equal-weighted sum of all aircraft operated. The remaining three measures of fleet size weigh each aircraft in the fleet using one of three weights described above. Thus, these measures are: (1) the sum of the seat capacities of all aircraft in the fleet, (2) the sum of the maximal takeoff weight of all aircraft in the fleet, and (3) the sum of the wingspans of all aircraft in the fleet.

Having constructed these four fleet-size measures, we then run the following regression specification for all operator fleets in our sample period of 1978-2003:

$$log(Size_{act}) = f(Creditor\,rights_{ct}, \mathbf{X}_{ct}, \mathbf{y}_t, \mathbf{z}_{ac}), \tag{6}$$

The dependant variable, log(Size$_{act}$), is the logarithm of each of our four fleet-size measures for operator a in country c in year t. As usual, Creditor rights is the creditor rights score of country c in year t, as measured by Djankov, et al. (2007), and $\mathbf{X}_c$ is a vector of country-specific control variables which includes the logarithm of country cs GDP per capita, the logarithm of its population and the logarithm of its area. All regressions include year fixed effects, $\mathbf{y}_t$, country fixed-effects, and operator fixed effects represented by the vector of variables $\mathbf{z}$. The regressions are estimated with both heteroscedasticity robust standard errors, and standard errors clustered by country. As before, since our variable of interest is creditor rights which is determined at the country level, we consider our results to be significant only when they pass the higher hurdle of clustering by country. Finally, as in the case of aircraft age, regression 6 is estimated separately for commercial operators and military operators.

The results are provided in Table 11. As our results demonstrate, using all four fleet-size proxies, the coefficient on the creditor rights index is consistently positive and statistically significant in the commercial operators regressions after controlling for GDP per capita, population, area, as well as year, country, and operator fixed effects. In contrast to commercial operators, and consistent with the results in Section **??**, there is no robust relation between creditor rights and fleet size amongst military operators. None of the creditor rights coefficients are statistically different from zero in any of the military operators regressions, and the point estimates in these regressions are always lower than their commercial regressions counterparts (they are actually negative in 2 out of 4 regressions). Thus, consistent with prediction 2 of the model, airlines in countries with higher creditor rights do indeed operate larger fleets. Given that we run a semi-log specification with respect to creditor rights, the coefficient of creditor rights is equal to the percentage change in fleet size associated with a unit change in creditor rights. This effect is economically significant. For example, moving from the lowest creditor rights score of zero, to the highest score of four, increases the number of aircraft in a commercial airline's fleet by 26.8 percent. Moving from the lowest to the highest score of creditor rights increases total fleet seat capacity by 80 percent. The effect for the remaining two fleet size measures – total fleet maximal takeoff weight and total fleet wingspan – is 71.2 and 64.4 percent, respectively. As an aside, the fact that the effect of increased creditor protection on fleet size is smaller for the non-weighted number-of-aircraft fleet measure than when weighing fleet size by aircraft seat capacity, maximal takeoff weight, and wingspan, suggests that the increase in the number of aircraft due to enhanced investor protection concentrates amongst larger, and hence more expensive, planes.

Finally, we study the relation between fleet size and creditor rights conditional on the financial constraints that an airline is facing using the sample of 72 airlines from Tables 9 and 10. For each of the airlines in the data we calculate our 4 measures of fleet size and run the following regression specification:

$$log(Size_{act}) = Creditor\,rights_{ct} + FinConst_{act} + Creditor\,rights_{ct} \times FinConst_{act} + \mathbf{X}_c + \mathbf{y}_t + \mathbf{z}_{ac} + \epsilon_{iact} \quad (7)$$

The dependant variable, log(Size$_{act}$), is the logarithm of each of our four fleet-size measures for operator a in country c in year t. Creditor rights is the creditor rights score of country c in year t, as measured by Djankov et al. (2007), $FinConst_{act}$ is a measure of the airline financial constraints (either leverage defined as total debt divided by the book value of assets, or long-term debt defined as long-term debt divided by the book value of assets), $Creditor\,rights_{ct} \times FinConst_{act}$ is an interaction term between creditor rights and airline financial constraints, $\mathbf{X}_c$ is a vector of country-specific control variables which includes the logarithm of country c's GDP per capita, the logarithm of its population and the logarithm of its area. In addition, all regressions include year fixed effects,

$\mathbf{y}_t$, country fixed-effects, and operator fixed effects represented by the vector of variables $\mathbf{z}$. All regression are estimated with both heteroscedasticity robust standard errors, and standard errors clustered by country. Results are provided in Table 12. We find no evidence that creditor rights affect airlines size in a statistically significant manner or that financially constrained airlines benefit more from creditor rights. We believe that the lack of results in Table 12 stem from the fact that by studying airlines with publicly available financial data, we are focusing on the largest airlines in each of the 29 countries we cover, and thus a selection bias with respect to size works against us finding any relation between creditor rights, financial constraints and airline size.

V. Robustness Tests

In this section we add several robustness tests to our main empirical analysis. In the first robustness check we repeat our analysis for non-leased aircraft. For our second robustness test we obtain data on aircraft purchases and show that our results hold for investment decisions and not only for existing aircraft fleets.

A. Creditor Rights, Aircraft Age and Leasing

One concern with our findings that is important for the airline industry is the issue of aircraft leasing. We do not distinguish between airlines that lease aircraft instead of purchasing them through debt financing.[8] Airlines in countries with bad creditor rights may be forced to lease aircraft instead of purchasing them through debt financing since asset repossession might be easier for lessors. While lessors are in general subject to the same bankruptcy provisions that are relevant to creditors (especially secured creditors), countries may adopt lessor-specific rules in bankruptcy similar to Section 1110 in the U.S. that exempts aircraft lessor from automatic stay in a Chapter 11 petition. While special provisions for lessors in bankruptcy are not that common outside the U.S., this issue is an empirical one.[9] For robustness we repeat our analysis for non-leased aircraft only and report the results in Table 13.

It should be noted that if airlines in countries with bad creditor rights are more likely to use lease financing, then it would work against our finding a negative relation between aircraft age and

[8] Lease financing of aircraft is fairly common, particularly in the United States (See e.g. Benmelech and Bergman 2007 and Gavazza 2007).

[9] According to industry practitioners the reason for the general lack if development in European EETC market is due to differing legal systems and in particular the uniqueness of section 1110 in the U.S.

creditor rights.[10] Moreover, this argument suggests that focusing on aircraft which are *not* leased, would yield stronger results as compared to focusing on the full sample. This is indeed what we find in Table 13 where we repeat the analysis in Table 10 but include only non-leased aircraft. Our results are stronger, both economically and statistically, when we consider only non-leased aircraft. As can be seen, the coefficients on creditor rights in the specifications without interaction terms (columns 1,2,5,6), and the coefficients on the interaction between either leverage or long-term debt and creditor rights (columns 3,4,7,8), are uniformly more negative than those in Table 13. Thus, we find a stronger negative relation between age and creditor rights when focusing only on planes which are not financed by leasing.

B. Creditor Rights and Aircraft Purchases

Our analysis so far presented evidence on the link between creditor rights and aircraft age by studying the age structure of existing aircraft fleets (i.e. aircraft stock). This section provides direct evidence on the relation between creditor rights, financial constraints and *investment* in used aircraft using data on used aircraft transactions. We obtain data on aircraft transactions from the CASE Ascend data base. We drop from the sample sale and lease-back transactions as they do not represent a real transaction but rather a different ownership classification for the same aircraft. Our sample includes 37,296 aircraft transactions during the years 1978-2003, representing 129 countries and 6,737 operators.

We then run the following regression specification over the entire sample of transactions:

$$Age_{iact} = f(Creditor\, rights_{ct}, \mathbf{X}_{ct}, \mathbf{y}_t, \mathbf{z}_{ac}), \tag{8}$$

where the dependant variable, Age, is simply the age of the aircraft being purchased, As usual, Creditor rights is the creditor rights score of the acquirer's country, as measured by Djankov, et al. (2007), and $\mathbf{X}_c$ is a vector of country-specific control variables which includes the logarithm of country c's GDP per capita, the logarithm of its population and the logarithm of its area. All regressions include year fixed effects, $\mathbf{y}_t$, and depending on the specification may also include country and operator fixed effects represented by the vector of variables $\mathbf{z}$.

[10] Eisfeldt and Rampini (2007a) show that since the repossession of leased assets is easier than foreclosure on collateral of secured debt, lease financing should have higher debt capacity than secured debt.

Results are presented in Table 14. As can be seen in the first column of the table, controlling for year, country and operator fixed-effects, creditor rights is negatively related to aircraft age and is statistically significant at the 5.8% level. Moving from a creditor-rights score of 0 to 4 reduces aircraft age by 2.8 years, representing a decline of 18.1% relative to the unconditional sample mean (15.5 years). In the remainder of Table 14 we restrict our sample to aircraft that were purchased by airlines for which we have financial data. We were able to match 3,925 transactions to 68 airlines from 29 countries for the years that financial data are available. Columns 2 and 3 of Table 14 report the results from estimating regression 5 in the aircraft purchases data using interactions between either leverage or long-term debt, and creditor rights to identify the differential effect that better creditor rights have on financially constrained airlines. As before, the coefficient of the interaction terms are negative and statistically significant coefficient implying that airlines with greater internal funds are less affected by creditor rights. Finally, in the last two columns of the table we repeat the analysis using probit regressions and an indicator variable that equals one for aircraft older than 20, and zero otherwise. The probit regressions confirm our earlier finding and are consistent with OLS regressions. Our empirical results in the investment regressions are similar to those in Eisfeldt and Rampini (2007b) who find that financially constrained firms are more likely to invest in used capital.

VI. Conclusion

Most of the evidence that legal protection of investors is associated with more developed financial markets and faster economic growth is based on cross-country outcomes and suffers from small sample and other econometric issues. In particular, results from cross-country regressions do not identify the channel through which legal protection affects real economic outcomes. Our paper adds to the growing body of micro-level evidence that suggests that financial development facilitates growth

We provide novel evidence linking creditor rights and vintage capital using a panel of aircraft-level data around the world. Consistent with theories that emphasize the protection of property rights as essential for economic development, we find that better creditor rights are associated with aircraft of a younger vintage and firms with larger aircraft fleets. Moreover, we find that more profitable airlines, airlines with lower leverage ratios, and airlines with less debt overhang are less sensitive to creditor rights as they may use internal funds, rather than external capital, to finance investment.

The evidence in our paper shows that legal protection of creditor rights affects both capital age and firm scale. Better creditor protection helps airlines to mitigate financial short-falls and enhance investment in newer, more efficient and more technological advanced aircraft. While we study the relation between vintage aircraft and creditor rights, our results propose a broader link, not confined only to the airline industry, between investor protection, real corporate investment and economic growth; Legal protection of creditors facilitates the ability of firms to make large capital investments, adapt advanced technologies and foster productivity.

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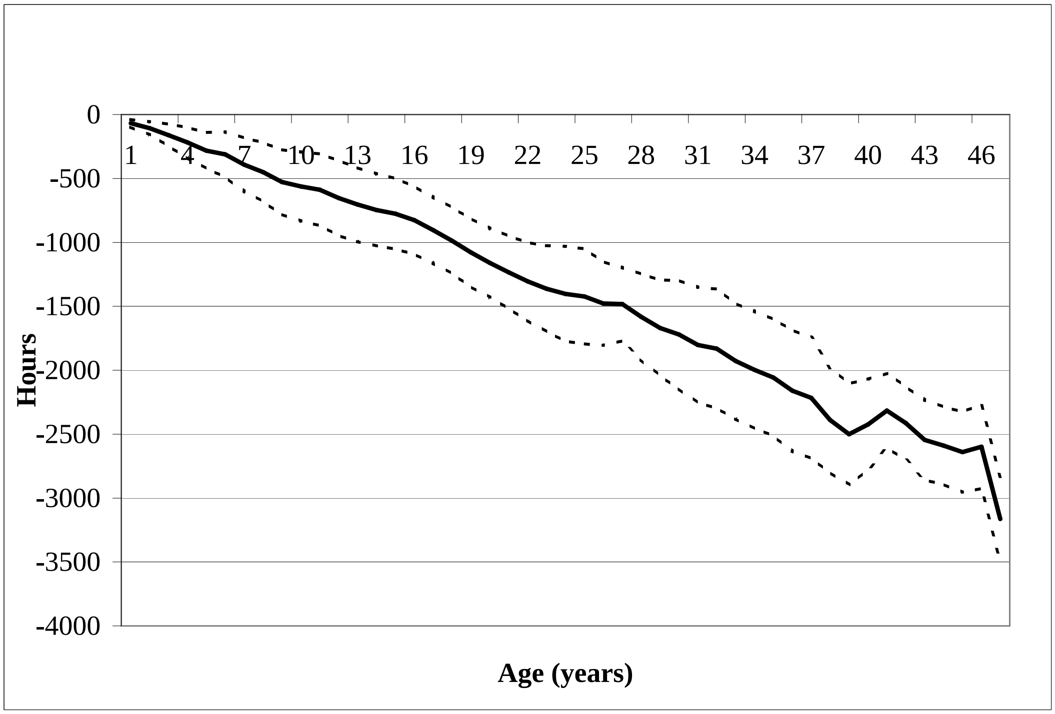

FIGURE 1: Annual hourly utilization as a function of aircraft age. Regression coefficients are calculated using year fixed effects. 5% and 95% bonds are calculated using standard errors that are clustered by aircraft type.

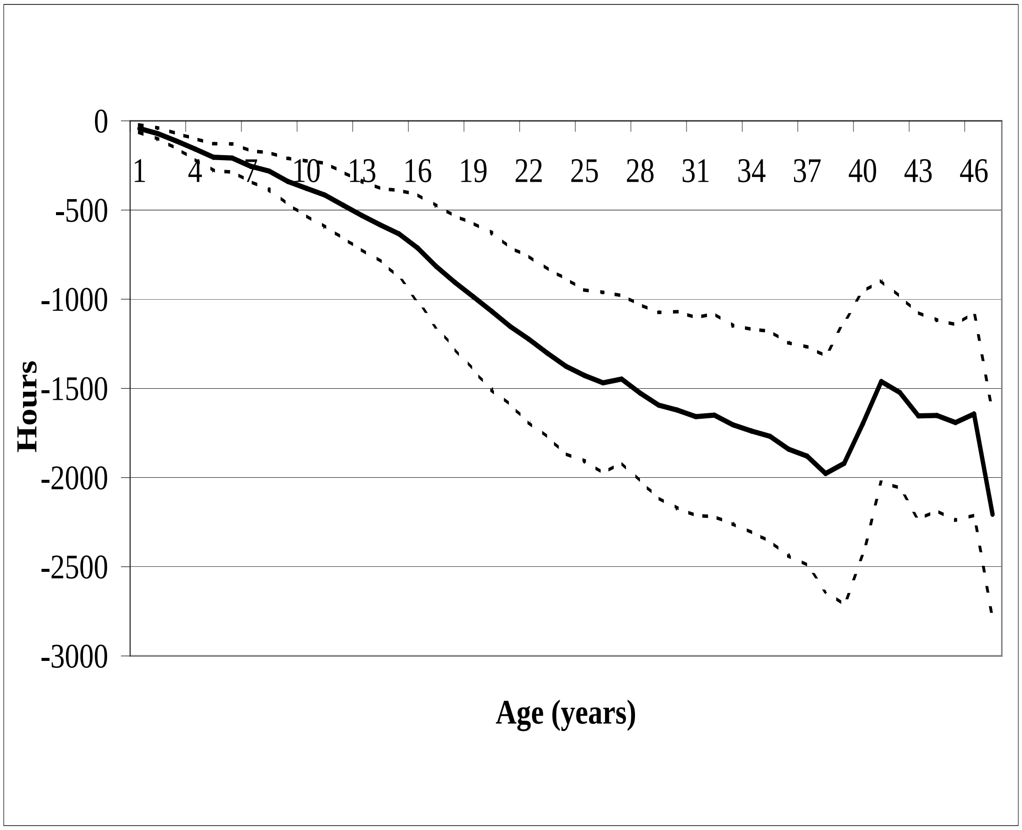

FIGURE 2: Annual hourly utilization as a function of aircraft age. Regression coefficients are calculated using year and aircraft-type fixed effects. 5% and 95% bonds are calculated using standard errors that are clustered by aircraft type.

Table 1:
Summary Statistics

Panel A: Aircraft Age

	1978-1979	1980-1989	1990-1999	2000-2003	Full Sample	Commercial	Military
AIRCRAFT AGE							
Minimum	0	0	0	0	0	0	0
25th Percentile	4	5	5	6	6	5	8
Mean	9.1	11.0	13.5	14.7	13.0	12.0	16.0
Median	10	11	12	13	12	11	15
75th Percentile	13	17	21	22	19	18	23
Maximum	32	42	52	56	56	56	47
Standard deviation	5.5	7.4	9.4	10.6	9.2	8.8	9.8
# of Aircraft types	96	136	196	202	219	161	200
# of Operators	969	2,134	4,051	3,133	5,987	5,437	893
# of Countries	89	102	129	129	129	129	115
# of Observations	18,953	129,427	238,327	107,946	494,653	373,261	121,392

Panel B: Country Characteristics

	Creditor rights	GDP per capita	English legal origin	French legal origin	German legal origin	Nordic legal origin	Socialist legal origin
Minimum	0	$82.16	0	0	0	0	0
25th Percentile	1	$2,109.9	0	0	0	0	0
Mean	1.65	$17,201.72	0.56	0.22	0.10	0.02	0.11
Median	1	$19,559.0	1	0	0	0	0
75th Percentile	2	$28,262.6	1	0	0	0	0
Maximum	4	$45,390.5	1	1	1	1	1
Standard deviation	1.01	$12,414.5	0.50	0.41	0.30	0.13	0.31
Number of Observations by legal origin			279,031	108,415	47,580	7,762	51,865

This table reports summary statistics for aircraft age and country characteristics. The summary statistics for aircraft age are reported for the periods 1978-1979, 1980-1989, 1990-1999, 2000-2003, as well as for the entire period. The table also report summary statistics separately for commercial and military aircraft.

Table 2:
Countries with Most and Least Aircraft

	Country	Commercial	Military	Total	Share
	Countries with Most Aircrafts 1978-2003				
1.	United States	147,880	37,596	185,476	37.50%
2.	Russian Federation	24,129	14,390	38,519	7.79%
3.	United Kingdom	15,396	4,681	20,077	4.06%
4.	Canada	15,356	3,144	18,500	3.74%
5.	France	10,441	3,400	13,841	2.80%
6.	China	9,499	3,250	12,749	2.58%
7.	Brazil	6,741	4,702	11,443	2.31%
8.	Japan	9,530	1,656	11,186	2.26%
9.	Germany	10,120	954	11,074	2.24%
10.	Spain	6,053	3,121	9,174	1.86%
11.	Australia	7,189	1,628	8,817	1.78%
12.	India	2,740	5,464	8,204	1.66%
13.	Indonesia	5,956	1,888	7,844	1.59%
14.	Ukraine	4,734	2,378	7,112	1.44%
15.	Mexico	4,846	1,029	5,875	1.19%
16.	Italy	4,807	1,036	5,843	1.18%
17.	Iran	2,097	2,422	4,519	0.91%
18.	Argentina	2,667	1,203	3,870	0.78%
19.	Netherlands	3,250	512	3,762	0.76%
20.	Saudi Arabia	2,128	1,551	3,679	0.74%
	Countries with Least Aircrafts 1978-2003				
110.	Georgia	159	0	159	0.032%
111.	Uganda	155	0	155	0.031%
112.	Mali	99	53	152	0.031%
113.	Mauritania	97	47	144	0.029%
114.	Namibia	135	4	139	0.028%
115.	Lesotho	76	48	124	0.025%
116.	Cambodia	113	9	122	0.025%
117.	Sierra Leone	107	0	107	0.022%
118.	Chad	77	28	105	0.021%
119.	Slovenia	85	7	92	0.019%
120.	Macedonia	90	0	90	0.018%
121.	Burundi	87	0	87	0.018%
122-3.	Haiti	71	11	82	0.017%
122-3.	Benin	82	0	82	0.017%
124.	Rwanda	79	0	79	0.016%
125.	Central African Republic	67	0	67	0.014%
126.	Niger	17	49	66	0.013%
127.	Togo	18	44	62	0.013%
128.	Albania	49	0	49	0.010%
129.	Bosnia and Herzegovina	44	0	44	0.009%

This table ranks countries on the total number of aircraft in the sample. Share is total aircraft divided by total aircraft in the sample.

Table 3:
Aircraft Age and Usage

Dependent Variable=	Hours per Year	Hours per Year	Hours per Year	Hours per Year
Age	-57.6	-51.9	-56.5	-56.5
	(6.22)	(9.97)	(5.44)	(0.854)
Constant	3113.6	3128.9	3168.8	3168.8
	(156.22)	(87.82)	(63.10)	(10.59)
Fixed-Effects				
Year	Yes	Yes	Yes	Yes
Aircraft Type	No	No	Yes	Yes
Aircraft	No	No	No	No
Clustering by	Aircraft type	Aircraft type	Aircraft type	Aircraft
# of Aircraft Types	76	76	76	76
# of Aircraft	25,009	25,009	25,009	25,009
Adjusted R^2	0.20	0.57	0.79	0.79
Observations	179,836	179,836	179,836	179,836

The dependent variable is aircraft yearly usage in hours. Age is the age of the aircraft. All regressions include year fixed effects. Standard-errors, reported in parenthesis, are clustered either by aircraft type or by individual aircraft.

Table 4:
Aircraft Usage by Age Decile

Dependent Variable=	Hours per Year	Hours per Year	Hours per Year
Age Decile			
1	Omitted	Omitted	Omitted
2	-95.26	-67.52	-67.52
	(32.40)	(15.38)	(5.80)
3	-184.99	-133.23	-133.23
	(55.06)	(26.81)	(6.85)
4	-286.61	-181.11	-181.11
	(86.59)	(34.96)	(8.85)
5	-423.82	-257.25	-257.25
	(112.72)	(52.18)	(10.50)
6	-509.09	-339.71	-339.71
	(131.21)	(76.86)	(12.08)
7	-630.95	-462.98	-462.98
	(137.16)	(90.25)	(13.91)
8	-797.47	-674.59	-674.59
	(126.18)	(149.25)	(17.07)
9	-1,176.12	-1,058.01	-1,058.01
	(142.73)	(222.27)	(22.67)
10	-1,647.47	-1,443.45	-1,443.45
	(180.25)	(249.30)	(26.60)
Fixed-Effects			
Year	Yes	Yes	Yes
Aircraft Type	No	Yes	Yes
Clustering by	Aircraft type	Aircraft type	Aircraft
# of Aircraft Types	76	76	76
# of Aircraft	25,009	25,009	25,009
Adjusted R^2	0.20	0.57	0.57
Observations	179,836	179,836	179,836

The dependent variable is aircraft yearly usage in hours. Age deciles are indicator variables for the ten deciles of aircraft age calculated over the entire sample. All regressions include an intercept (not reported) and year fixed effects. Standard-errors, reported in parenthesis, are clustered either by aircraft type or by individual aircraft.

Table 5:
Creditor Rights and Aircraft Age

Dependent Variable=	Age	Age	Age	Age	Age	Age
Log GDP per capita	-2.434	-0.439	0.147	0.143	-1.547	-0.482
	(0.087) a	(0.010) a	(0.007) a	(0.007) a	(0.086) a	(0.052) a
	(0.600) a	(0.175) b	(0.114)	(0.099)	(0.890) c	(0.551)
Log Population	9.568	-0.493	-0.201	-0.072	2.764	1.306
	(0.220) a	(0.015) a	(0.008) a	(0.009) a	(0.174) a	(0.096) a
	(2.362) a	(0.227) b	(0.149)	(0.128)	(1.527) c	(0.618) b
Log Area	3.293	0.329	0.229	0.092	-0.294	-0.388
	(6.263)	(0.013) a	(0.007) a	(0.008) a	(0.223)	(0.089) a
	(8.422)	(0.213)	(0.097) b	(0.119)	(1.344)	(0.455)
Creditor rights	-1.097	-0.460	-0.176	-0.171	-0.930	-0.469
	(0.041) a	(0.016) a	(0.009) a	(0.009) a	(0.040) a	(0.023) a
	(0.440) b	(0.225) b	(0.103) c	(0.095) c	(0.388) b	(0.174) a
French legal origin		-0.584		-0.090		
		(0.040) a		(0.024) a		
		(0.523)		(0.348)		
German legal origin		-3.592		-1.062		
		(0.045) a		(0.029) a		
		(1.020) a		(0.444) b		
Nordic legal origin		-2.053		-0.305		
		(0.097) a		(0.029) a		
		(0.649) a		(0.475)		
Socialist legal origin		3.298		0.918		
		(0.051) a		(0.040) a		
		(0.567) a		(0.498) c		
Fixed-Effects						
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	No	No	No	Yes	Yes
Aircraft Type	No	No	Yes	Yes	No	Yes
Operator	No	No	No	No	Yes	Yes
# of Countries	129	129	129	129	129	129
# of Aircraft Types	219	219	219	219	219	219
# of Operators	5,987	5,987	5,987	5,987	5,987	5,987
Adjusted R^2	0.12	0.09	0.70	0.70	0.45	0.76
Observations	494,653	494,653	494,653	494,653	494,653	494,653

The dependent variable is the age of the aircraft. Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All regressions include an intercept (not reported) and year fixed effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6:
Aircraft Age by Creditor Rights: Commercial Vs. Military Aircrafts

Panel A: Aircraft Age

Creditor rights	0	1	2	3	4	0-4 Diff
Full Sample	13.52	13.23	13.59	11.12	13.42	0.10
	(0.05)	(0.02)	(0.03)	(0.03)	(0.06)	(0.08)
	31,362	251,775	96,998	89,684	24,829	
Commercial Aircraft	12.89	12.18	12.68	10.386	11.78	1.11
	(0.06)	(0.02)	(0.03)	(0.03)	(0.07)	(0.09)
	23,074	195,451	67,288	68,367	19,081	
Military Aircraft	15.27	16.88	15.68	13.45	18.86	-3.59
	(0.11)	(0.04)	(0.05)	(0.06)	(0.13)	(0.17)
	8,291	56,324	29,710	21,317	5,748	

Panel B: Aircraft Older than 20 Years

Creditor rights	0	1	2	3	4	0-4 Diff
Full Sample	0.232	0.232	0.231	0.144	0.252	-0.02
	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)	(0.004)
	31,362	251,775	96,998	89,684	24,829	
Commercial Aircraft	0.209	0.193	0.206	0.120	0.184	0.025
	(0.003)	(0.001)	(0.002)	(0.001)	(0.003)	(0.004)
	23,074	195,451	67,288	68,367	19,081	
Military Aircraft	0.296	0.370	0.287	0.219	0.476	-0.179
	(0.005)	(0.002)	(0.003)	(0.003)	(0.007)	(0.008)
	8,291	56,324	29,710	21,317	5,748	

This table stratifies average aircraft age (Panel A) and the probability that the aircraft age is 20 years or older (Panel B), by the creditor rights index. Means, standard errors and number of aircraft-year observations are reported for the full sample as well as for the commercial and military subsamples. The last column reports the differences and standard errors of an equal means t-test between countries with a creditor rights index of 0 countries with a creditor rights index of 4.

Table 7:
Creditor Rights and Aircraft Age: Commercial Vs. Military Aircrafts

	Commercial Age	Military Age	Commercial Age	Military Age	Commercial Age	Military Age
Log GDP per capita	-2.761	-0.889	0.097	0.478	-2.241	-0.757
	(0.098) a	(0.163) a	(0.008) a	(0.022) a	(0.100) a	(0.156) a
	(0.599) a	(1.550)	(0.096)	(0.223) b	(0.678) a	(1.597)
Log Population	8.991	4.077	-0.247	0.547	1.897	4.552
	(0.256) a	(0.381) a	(0.010) a	(0.025) a	(0.191) a	(0.375) a
	(2.544) a	(4.786)	(0.106) b	(0.284) c	(1.432)	(4.952)
Log Area	3.176	83.531	0.190	-0.282	0.602	-7.630
	(6.058)	(8.176) a	(0.008) a	(0.022) a	(0.197) a	(0.586) a
	(7.245)	(34.520) b	(0.112) c	(0.240)	(1.088)	(6.493)
Creditor rights	-0.950	-0.648	-0.218	-0.062	-0.787	-0.761
	(0.046) a	(0.085) a	(0.010) a	(0.027) b	(0.044) a	(0.083) a
	(0.455) b	(0.812)	(0.094) b	(0.262)	(0.358) b	(0.837)
French legal origin			-0.052	-0.507		
			(0.025) b	(0.066) a		
			(0.315)	(0.735)		
German legal origin			-0.809	-2.459		
			(0.030) a	(0.109) a		
			(0.416) c	(1.153)		
Nordic legal origin			-0.504	0.643		
			(0.053) a	(0.188) a		
			(0.576)	(1.583)		
Socialist legal origin			0.755	1.857		
			(0.051) a	(0.088) a		
			(0.540)	(1.141)		
Fixed-Effects						
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	No	No	Yes	Yes
Aircraft Type	No	No	Yes	Yes	Yes	Yes
Operator	No	No	No	No	Yes	Yes
# of Countries	129	114	129	114	129	129
# of Aircraft Types	161	200	161	200	161	200
# of Operators	5,437	893	5,437	893	5,437	893
Adjusted R^2	0.14	0.19	0.76	0.56	0.49	0.32
Observations	373,261	121,392	373,261	121,392	373,261	121,392

The dependent variable is the age of either commercial or military aircraft. Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All regressions include an intercept (not reported) and year fixed effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8:
Creditor Rights and Old Aircrafts

Sample	Commercial	Commercial	Military	Military	Commercial	Military
Time period	1978-2003	1990-2003	1978-2003	1990-2003	2000-2003	2000-2003
Dependent variable	Age>20	Age>20	Age>20	Age>20	Age>30	Age>30
Log GDP per capita	-0.024	-0.031	0.045	0.040	-0.016	0.030
	(0.001) a	(0.001) a	(0.001) a	(0.001) a	(0.001) a	(0.002) a
	(0.008) a	(0.011) a	(0.011) a	(0.015) a	(0.005) a	(0.014) b
Log Population	-0.023	-0.035	0.006	-0.020	-0.016	-0.017
	(0.001) a	(0.001) a	(0.002) a	(0.002) a	(0.001) a	(0.003) a
	(0.010) b	(0.014) b	(0.013)	(0.017)	(0.007) b	(0.014)
Log Area	0.016	0.025	-0.012	0.006	0.012	0.001
	(0.001) a	(0.001) a	(0.001) a	(0.002) a	(0.001) a	(0.003)
	(0.009) b	(0.012) b	(0.010)	(0.016)	(0.006) c	(0.013)
Creditor rights	-0.021	-0.031	-0.015	-0.003	-0.016	-0.009
	(0.001) a	(0.001) a	(0.002) a	(0.002)	(0.001) a	(0.004) b
	(0.009) b	(0.013) b	(0.019)	(0.027)	(0.008) b	(0.028)
French legal origin	-0.021 *	-0.030 *	-0.075 *	-0.029 *	-0.024 *	-0.100 *
	(0.001) a	(0.003) a	(0.004) a	(0.005) a	(0.001) a	(0.007) a
	(0.020)	(0.027)	(0.031) b	(0.043)	(0.015)	(0.035) a
German legal origin	-0.105 *	-0.130 *	-0.156 *	-0.142	-0.059 *	-0.156 *
	(0.002) a	(0.003) a	(0.005) a	(0.007) a	(0.002) a	(0.007) a
	(0.023) a	(0.039) a	(0.034) a	(0.061) b	(0.015) a	(0.034) a
Nordic legal origin	-0.076 *	-0.123 *	-0.066 *	-0.042	-0.058 *	-0.045 *
	(0.004) a	(0.005) a	(0.012) a	(0.018) a	(0.004) a	(0.024) c
	(0.022) a	(0.031) a	(0.069)	(0.119)	(0.015) a	(0.086)
Socialist legal origin	0.063 *	0.066 *	0.067 *	0.065 a	-0.018 *	0.041 *
	(0.003) a	(0.003) a	(0.005) a	(0.006) a	(0.003) a	(0.010) a
	(0.021) b	(0.037) c	(0.045)	(0.040)	(0.020)	(0.043)
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.09	0.05	0.10	0.03	0.04	0.04
Observations	372,641	265,314	121,437	80,628	84,831	23,176

The dependent variable is a dummy variable that takes the value of one for aircraft older than 20 years (columns 1-4) or 30 years (columns 5-6). Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All columns report marginal effects from estimating probit regressions. All regressions include an intercept (not reported) and year fixed effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively. * dy/dx is for discrete change of dummy variable from 0 to 1.

Table 9

Creditor Rights, Financial Constraints and Aircraft Age

Dependent Variable=	Age	Age	Age	Age	Age	Age
Log GDP per capita	0.524	0.521	0.394	0.390	0.012	-0.014
	(0.050) a	(0.049) a	(0.049) a	(0.049) a	(0.389)	(0.384)
	(0.624)	(0.606)	(0.635)	(0.630)	(1.542)	(1.675)
Log Population	0.335	0.427	0.329	0.417	3.494	2.593
	(0.039) a	(0.040) a	(0.039) a	(0.040) a	(1.220) a	(1.268) b
	(0.207)	(0.219) c	(0.212)	(0.225) c	(6.189)	(8.561)
Log Area	0.149	0.169	0.158	0.178	-59.556	-68.137
	(0.025) a	(0.026) a	(0.025) a	(0.026) a	(12.082) a	(11.955) a
	(0.207)	(0.249)	(0.209)	(0.252)	(11.199) a	(10.115) a
Creditor rights	-0.720	0.386	-0.747	0.265	1.378	1.451
	(0.039) a	(0.073) a	(0.039) a	(0.072) a	(0.200) a	(0.188) a
	(0.338) b	(0.521)	(0.344) b	(0.560)	(0.562) b	(0.799) c
Leverage	3.516	7.159			1.651	
	(0.159) a	(0.304) a			(0.359) a	
	(1.417) b	(1.687) a			(1.007)	
Creditor rights×Leverage		-2.522			-2.286	
		(0.144) a			(0.219) a	
		(0.993) b			(0.533) a	
LT Debt			3.547	7.284		8.900
			(0.173) a	(0.329) a		(0.353) a
			(1.669) b	(2.052) a		(1.838) a
Creditor rights×LT Debt				-2.593		-3.754
				(0.158) a		(0.216) a
				(1.096) b		(1.404) b
French legal origin	-1.304	-1.351	-1.276	-1.267		
	(0.107) a	(0.107) a	(0.107) a	(0.107) a		
	(0.979)	(1.005)	(0.996)	(1.031)		
German legal origin	-2.516	-2.887	-2.421	-2.892		
	(0.090) a	(0.092) a	(0.090) a	(0.093) a		
	(0.911) a	(0.891) a	(0.920) a	(0.905) a		
Nordic legal origin	0.465	0.918	0.395	0.855		
	(0.247) c	(0.250) a	(0.247)	(0.250) a		
	(1.081)	(1.187)	(1.086)	(1.196)		
Socialist legal origin	2.862	2.739	2.750	2.635		
	(0.284) a	(0.283) a	(0.285) a	(0.284) a		
	(1.579) c	(1.521) c	(1.634)	(1.598)		
Fixed-Effects						
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country	No	No	No	No	Yes	Yes
Operator	No	No	No	No	Yes	Yes
# of Countries	29	29	29	29	29	29
# of Operators	72	72	72	72	72	72
Adjusted R^2	0.05	0.05	0.05	0.05	0.26	0.26
Observations	94,272	94,272	94,272	94,272	94,272	94,272

Table 9 – continued from previous page

The dependent variable is the age of the aircraft. Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. Leverage is total debt divided by total assets. LT Debt is long-term debt divided by total assets. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All regressions include an intercept (not reported) and year fixed effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10

Creditor Rights, Financial Constraints and Old Aircrafts

Dependent Variable=	Age>20	Age>30	Age>20	Age>30	Age>20	Age>30	Age>20	Age>30
Log GDP per capita	0.004	-0.004	0.003	-0.004	-0.003	-0.005	-0.004	-0.005
	(0.002)	(0.001) a	(0.002)	(0.001) a	(0.002)	(0.001) a	(0.002) c	(0.001) a
	(0.019)	(0.001) a	(0.019)	(0.001) a	(0.020)	(0.001) a	(0.019)	(0.001) a
Log Population	0.017	0.004	0.019	0.004	0.0172	0.004	0.019	0.004
	(0.002) a	(0.001) a	(0.002) a	(0.001) a	(0.002) a	(0.001) a	(0.002) a	(0.001) a
	(0.008) b	(0.001) a	(0.009) b	(0.001) a	(0.008) b	(0.001) a	(0.009) b	(0.001) a
Log Area	-0.002	0.002	-0.002	0.002	-0.002	0.002	-0.001	0.002
	(0.001)	(0.001) a	(0.001)	(0.001) a	(0.001)	(0.0004) a	(0.001)	(0.0004) a
	(0.009)	(0.001) a	(0.100)	(0.001)	(0.010)	(0.001)	(0.010)	(0.001)
Creditor rights	-0.043	-0.006	-0.016	0.002	-0.045	-0.006	-0.013	0.0024
	(0.002) a	(0.001) a	(0.005) a	(0.001) a	(0.002) a	(0.001) a	(0.005) a	(0.0008) a
	(0.013) a	(0.002) b	(0.032)	(0.002)	(0.014) a	(0.002) b	(0.030)	(0.001)
Leverage	0.155	0.012	0.223	0.034				
	(0.007) a	(0.002) a	(0.013) a	(0.004) a				
	(0.033) a	(0.004) a	(0.071) a	(0.006) a				
Creditor rights×Leverage			-0.059	-0.022				
			(0.009) a	(0.002) a				
			(0.059)	(0.005) a				
LT Debt					0.162	0.014	0.252	0.040
					(0.007) a	(0.002) a	(0.014) a	(0.005) a
					(0.036) a	(0.005) a	(0.066) a	(0.007) a
Creditor rights×LT Debt							-0.076	-0.026
							(0.010) a	(0.003) a
							(0.058)	(0.005) a
French legal origin	-0.064 *	-0.007 *	-0.065 *	-0.007 *	-0.063 *	-0.006 *	-0.064 *	-0.006 *
	(0.004) a	(0.001) a	(0.004) a	(0.001) a	(0.004) a	(0.001) a	(0.004) a	(0.001) a
	(0.025) b	(0.002) a	(0.024) b	(0.002) a	(0.026) c	(0.002) a	(0.025) c	(0.002) a
German legal origin	-0.109 *	N/A	-0.111 *	N/A	-0.110 *	N/A	-0.113 *	N/A
	(0.002) a		(0.002) a		(0.002) a		(0.002) a	
	(0.012) a		(0.012) a		(0.013) a		(0.012) a	
Nordic legal origin	-0.024 *	N/A	-0.017 *	N/A	-0.025 *	N/A	-0.015 *	N/A
	(0.012) c		(0.013)		(0.012) c		(0.013)	
	(0.028)		(0.033)		(0.028)		(0.035)	
Socialist legal origin	0.002 *	-0.005 *	-0.004 *	-0.005 *	-0.005 *	-0.005 *	-0.013 *	-0.004 *
	(0.014)	(0.001) a	(0.014)	(0.001) a	(0.012) a	(0.001) a	(0.012)	(0.001) a
	(0.049)	(0.002) a	(0.047)	(0.002) a	(0.048)	(0.002) a	(0.045)	(0.001) a
Fixed-Effects								
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	No	No	No	No	No	No	No	No
Operator	No	No	No	No	No	No	No	No
# of Countries	29	29	29	29	29	29	29	29
# of Operators	72	72	72	72	72	72	79	72
Pseudo R^2	0.06	0.15	0.06	0.15	0.06	0.15	0.06	0.15
Observations	94,272	64,421	94,272	64,421	94,272	64,421	94,272	64,421

Table 10 – continued from previous page

The dependent variable is a dummy variable that takes the value of one for aircraft older than 20 years (columns 1,3,5,7) or 30 years (columns 2,4,6,8). Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. Leverage is total debt divided by total assets. LT Debt is long-term debt divided by total assets. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All columns report marginal effects from estimating probit regressions. All regressions include an intercept (not reported) and year fixed effects. *t*-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively. * dy/dx is for discrete change of dummy variable from 0 to 1.

Table 11:
Creditor Rights and Fleet Size: Commercial Vs. Military Aircrafts

Size=	Commercial Number	Military Number	Commercial Seats	Military Seats	Commercial Weight	Military Weight	Commercial Wings	Military Wings
Log GDP per capita	0.223	0.347	0.602	0.686	0.638	0.984	0.500	0.815
	(0.025) a	(0.043) a	(0.073) a	(0.166) a	(0.088) a	(0.174)	(0.059) a	(0.115) a
	(0.045) a	(0.097) a	(0.128) a	(0.400) c	(0.136) a	(0.392)	(0.105) a	(0.246) a
Log Population	0.101	0.056	0.344	0.078	0.355	-0.679	0.218	-0.079
	(0.048) b	(0.075)	(0.133) a	(0.267)	(0.160) b	(0.442)	(0.120) c	(0.237)
	(0.125)	(0.179)	(0.299)	(0.631)	(0.315)	(0.875)	(0.281)	(0.447)
Log Area	-0.132	0.388	-0.248	0.607	-0.204	1.881	-0.238	1.004
	(0.039) a	(0.116) a	(0.112) a	(0.370)	(0.118) c	(0.553) a	(0.104) b	(0.334) a
	(0.096)	(0.239)	(0.249)	(0.739)	(0.255)	(1.021) c	(0.230)	(0.555) c
Creditor rights	0.067	-0.061	0.200	0.009	0.178	0.155	0.161	-0.053
	(0.010) a	(0.017) a	(0.032) a	(0.052)	(0.047) a	(0.092) c	(0.025) a	(0.041)
	(0.037) c	(0.039)	(0.075) a	(0.101)	(0.096) c	(0.134)	(0.077) b	(0.069)
Fixed-Effects								
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Operator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Countries	129	110	129	110	129	110	129	110
# of Operators	5,276	743	5,276	743	5,276	743	5,276	743
Adjusted R^2	0.85	0.93	0.87	0.91	0.83	0.91	0.86	0.76
Observations	32,477	7,049	32,477	7,049	32,477	7,049	32,477	7,049

The dependent variable is fleet size defined as the logarithm of either 1) the sum of all aircraft operated, (2) the sum of the seat capacities of all aircraft in the fleet, (3) the sum of the maximal takeoff weight of all aircraft in the fleet, and (4) the sum of the wingspans of all aircraft in the fleet. Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. All regressions include an intercept (not reported) year fixed effects, country fixed-effects, and operator fixed-effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 12:
Creditor Rights, Financial Constraints and Fleet Size

Dependent Variable=	Number	Seats	Weight	Wings	Number	Seats	Weight	Wings
Log GDP per capita	0.628	1.500	1.525	1.356	0.612	1.479	1.519	1.343
	(0.210) a	(0.503) a	(0.495) a	(0.460) a	(0.203) a	(0.483) a	(0.484) a	(0.442) a
	(0.185) a	(0.557) b	(0.526) a	(0.545) b	(0.162) a	(0.511) a	(0.504) a	(0.497) a
Log Population	0.452	2.539	2.358	1.840	0.581	2.686	2.380	1.978
	(0.515)	(1.346) c	(1.249) c	(1.300)	(0.518)	(1.338) b	(1.242) c	(1.289)
	(0.807)	(2.649)	(2.181)	(2.536)	(0.774)	(2.619)	(2.200)	(2.509)
Log Area	5.488	9.872	8.511	10.632	5.604	10.114	8.647	10.889
	(3.923)	(9.374)	(8.074)	(9.570)	(3.853)	(9.196)	(7.938)	(9.381)
	(0.944) a	(2.203) a	(2.590) a	(2.292) a	(0.867) a	(2.013) a	(2.371) a	(2.098) a
Creditor rights	0.098	0.258	0.316	0.228	0.087	0.194	0.216	0.180
	(0.082)	(0.199)	(0.206)	(0.197)	(0.079)	(0.178)	(0.177)	(0.175)
	(0.119)	(0.307)	(0.319)	(0.288)	(0.116)	(0.276)	(0.265)	(0.251)
Leverage	0.438	0.839	0.919	0.924				
	(0.291)	(0.679)	(0.689)	(0.702)				
	(0.423)	(0.885)	(0.966)	(0.958)				
Creditor rights×Leverage	-0.145	-0.236	-0.300	-0.259				
	(0.139)	(0.325)	(0.328)	(0.327)				
	(0.221)	(0.491)	(-0.300)	(0.497)				
LT Debt					0.275	0.442	0.674	0.612
					(0.302)	(0.656)	(0.686)	(0.689)
					(0.393)	(0.753)	(0.838)	(0.842)
Creditor rights×LT Debt					-0.126	-0.148	-0.238	-0.210
					(0.150)	(0.344)	(0.348)	(0.345)
					(0.225)	(0.500)	(0.519)	(0.499)
Fixed-Effects								
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Operator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Countries	29	29	29	29	29	29	29	29
# of Operators	72	72	72	72	72	72	79	72
Adjusted R^2	0.91	0.92	0.93	0.92	0.89	0.91	0.93	0.91
Observations	649	649	649	649	649	649	649	649

The dependent variable is fleet size defined as the logarithm of either 1) the sum of all aircraft operated, (2) the sum of the seat capacities of all aircraft in the fleet, (3) the sum of the maximal takeoff weight of all aircraft in the fleet, and (4) the sum of the wingspans of all aircraft in the fleet. Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. Leverage is total debt divided by total assets. LT Debt is long-term debt divided by total assets. All columns report marginal effects from estimating OLS regressions. All regressions include an intercept (not reported) year fixed effects, country fixed-effects, and operator fixed-effects. *t*-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis. Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 13
Creditor Rights, Financial Constraints and Old Aircrafts (Non-leased Aircrafts)

Dependent Variable=	Age>20	Age>30	Age>20	Age>30	Age>20	Age>30	Age>20	Age>30
Log GDP per capita	-0.007	-0.011	-0.010	-0.011	-0.012	-0.012	-0.015	-0.010
	(0.003) a	(0.001) a	(0.003) a	(0.001) a	(0.003) a	(0.001) a	(0.003) a	(0.001) a
	(0.021)	(0.003) a	(0.020)	(0.002) a	(0.022)	(0.003) a	(0.021)	(0.002) a
Log Population	0.038	0.007	0.043	0.007	0.039	0.007	0.045	0.006
	(0.003) a	(0.001) a	(0.003) a	(0.002) a	(0.003) a	(0.001) a	(0.003) a	(0.001) a
	(0.012) a	(0.002) a	(0.013) a	(0.002) a	(0.012) a	(0.002) a	(0.014) a	(0.002) a
Log Area	0.003	0.011	0.004	0.010	0.003	0.010	0.004	0.009
	(0.002)	(0.001) a	(0.002) b	(0.001) a	(0.002)	(0.001) a	(0.002) c	(0.001) a
	(0.014)	(0.002) a	(0.014)	(0.002) a	(0.015)	(0.002) a	(0.015)	(0.002)
Creditor rights	-0.053	-0.007	0.003	0.007	-0.055	-0.007	0.003	0.007
	(0.004) a	(0.001) a	(0.009)	(0.003) a	(0.004) a	(0.001) a	(0.000)	(0.002) a
	(0.021) a	(0.003) c	(0.047)	(0.005)	(0.022) a	(0.003) c	(0.044)	(0.003) b
Leverage	0.127	0.024	0.274	0.064				
	(0.011) a	(0.004) a	(0.023) a	(0.010) a				
	(0.054) b	(0.008) a	(0.088) a	(0.014) a				
Creditor rights×Leverage			-0.118	-0.038				
			(0.015) a	(0.006) a				
			(0.076)	(0.010) a				
LT Debt					0.145	0.026	0.311	0.071
					(0.011) a	(0.004) a	(0.025) a	(0.011) a
					(0.068) b	(0.009) a	(0.101) a	(0.017) a
Creditor rights×LT Debt							-0.135	-0.046
							(0.017) a	(0.007) a
							(0.079) c	(0.010) a
French legal origin	-0.086 *	-0.005 *	-0.088 *	-0.006 *	-0.088	-0.005	-0.090	-0.006
	(0.006) a	(0.002) c	(0.006) a	(0.0016) a	(0.006) a	(0.001) c	(0.006) a	(0.001) a
	(0.041)	(0.002)	(0.038) c	(0.002) b	(0.042)	(0.002)	(0.040) c	(0.002) a
German legal origin	-0.156 *	N/A	-0.163 *	N/A	-0.157	N/A	-0.166	N/A
	(0.003) a		(0.003) a		(0.004) a		(0.003) a	
	(0.017) a		(0.016) a		(0.019) a		(0.016) a	
Nordic legal origin	0.038 *	N/A	0.068 *	N/A	0.037	N/A	0.071	N/A
	(0.024) c		(0.028) a		(0.024)		(0.028)	
	(0.060)		(0.075)		(0.060)		(0.077)	
Socialist legal origin	-0.070 *	-0.010 *	-0.079 *	-0.010 *	-0.071	-0.010	-0.081	-0.008
	(0.012) a	(0.002) a	(0.011) a	(0.002) a	(0.012) a	(0.002) a	(0.011)	(0.002) a
	(0.038)	(0.003) a	(0.034) c	(0.003) a	(0.040)	(0.004) a	(0.035)	(0.003) a
Fixed-Effects								
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	No	No	No	No	No	No	No	No
Operator	No	No	No	No	No	No	No	No
# of Countries	29	29	29	29	29	29	29	29
# of Operators	72	72	72	72	72	72	79	72
Pseudo R^2	0.09	0.15	0.09	0.16	0.09	0.16	0.09	0.16
Observations	49,497	30,423	49,497	30,423	49,497	30,423	49,497	30,423

The dependent variable is a dummy variable that takes the value of one for aircraft older than 20 years (columns 1,3,5,7) or 30 years (columns 2,4,6,8). Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. Leverage is total debt divided by total assets. LT Debt is long-term debt divided by total assets. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All columns report marginal effects from estimating probit regressions. All regressions include an intercept (not reported) and year fixed effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis. Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively. * dy/dx is for discrete change of dummy variable from 0 to 1.

Table 14:
Creditor Rights, Financial Constraints and Used Aircraft Purchases

Dependent Variable=	Age	Age	Age	Age>20	Age>20
Log GDP per capita	-1.212	0.813	-0.912	-0.015	-0.011
	(0.485) b	(2.700)	(2.581)	(0.012)	(0.012)
	(0.753)	(4.834)	(4.486)	(0.022)	(0.021)
Log Population	0.700	41.052	37.518	0.072	0.065
	(0.510)	(14.892) a	(14.503) a	(0.012) a	(0.012) a
	(1.058)	(34.937)	(31.807)	(0.030) b	(0.029) b
Log Area	0.430	33.285	28.755	0.037	0.035
	(0.425)	(19.044) c	(19.150)	(0.009) a	(0.009) a
	(0.791)	(19.184) c	(18.426)	(0.013) a	(0.013) a
Creditor rights	-0.691	0.411	0.493	0.067	0.090
	(0.217) a	(1.174)	(1.063)	(0.028) b	(0.026) a
	(0.361) c	(2.326)	(2.292)	(0.058)	(0.057)
Leverage		7.075		0.545	
		(2.168) a		(0.084) a	
		(2.559) a		(0.141) a	
Creditor rights×Leverage		-4.782		-0.219	
		(1.513) a		(0.062) a	
		(2.334) b		(0.125) c	
LT Debt			10.683		0.805
			(2.289) a		(0.094) a
			(2.285) a		(0.150) a
Creditor rights×LT Debt			-6.334		-0.326
			(1.632) a		(0.069) a
			(2.747) b		(0.136) b
Fixed-Effects					
Year	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	No	No
Operator	Yes	Yes	Yes	No	No
# of Countries	129	29	29	29	29
# of Operators	6,737	68	68	68	68
R^2/Pseudo R^2	0.62	0.37	0.37	0.07	0.08
Observations	37,296	3,925	3,925	3,925	3,925

The dependent variable is either the age of the aircraft (columns 1, 2, 3), or a dummy variable that takes the value of one for aircraft older than 20 years (columns 4,5). Log GDP per capita is the natural logarithm of real GDP per capita. Log Population is the natural logarithm of the population, Log Area is the natural logarithm of the country surface in sq. km. Creditor rights is an index aggregating creditor rights, following Djankov et al. (2007). The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. Leverage is total debt divided by total assets. LT Debt is long-term debt divided by total assets. French legal origin, German legal origin, Nordic legal origin, and Socialist legal origin are dummy variables that identify the legal origin of the Company law or Commercial Code of each country. All columns report marginal effects from estimating probit regressions. All regressions include an intercept (not reported) and year fixed effects. t-statistics are calculated using standard-errors that are clustered by airline and reported in parenthesis.Robust standard errors (second row) and standard errors clustered by country (third row) are reported in parentheses. a, b and c denote statistical significance at the 1%, 5%, and 10% levels, respectively.