Submitted to *Econometrica*

HOW CHAPTER 11 CHANGES THE GAME: INVESTMENT AND BANKRUPTCY IN THE U.S. AIRLINE INDUSTRY

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Although economists agree that insolvency policy influences capital investment, few models consider its impact on competitive strategy. Those that do tend to equate bankruptcy with liquidation, ignoring the restructuring and reemergence that commonly characterize Chapter 11 cases. Moreover, because the U.S. Bankruptcy Code permits abrogation of long-term contracts (e.g. for labor or capital) under Chapter 11, it provides otherwise constrained firms an opportunity to right-size, generating a non-financial link between investment and bankruptcy. To investigate this link and its implications for competitive strategy, I estimate a dynamic oligopoly game of investment and reorganization using data on the U.S. airline industry. Counterfactual simulations imposing a liquidation-only insolvency policy suggest that the option to reorganize under Chapter 11 increases capacity by up to 20%. I also find evidence that the last major reform of the U.S. Bankruptcy Code, in 2005, likely contributed to the "capacity discipline" widely observed in the industry thereafter.

KEYWORDS: bankruptcy, airlines, capacity, investment, oligopoly.

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I owe special thanks to Andrew Sweeting, Jimmy Roberts, Peter Arcidiacono, Tracy Lewis, and Daniel Xu for their invaluable suggestions, guidance, and encouragement. I also wish to thank the Duke Economics Department and Andrew Sweeting for data acquisition, and Allan Collard-Wexler, Steve Puller, Ariel Pakes, seminar participants at Purdue, Duke, Rochester, Indiana University, Northwestern, University of Iowa, Louisville, Williams College, and University of Kentucky, and my kind officemates for their helpful comments. Johanna Tejada provided excellent research assistance. All errors are my own.

1. INTRODUCTION

"If you want to take the island, burn the boats." - Julius Caesar

Commitments are only as good as their credibility, as military leaders have known for millennia. Economists formalized the notion decades ago,[1] dubbing the maximally credible commitment "irreversibility." But what happens when the irreversible can be reversed? In the case of long-run contracts, this is precisely what Chapter 11 of the U.S. Bankruptcy Code provides. Long-run contractual commitments (e.g. collective bargaining agreements, pension benefit arrangements, capital leases, etc.) are common in industry, and in many cases they effectively create a cost to downsize. In so doing, they produce a strongly credible commitment with obvious strategic implications. Yet in Chapter 11 reorganization, bankruptcy judges have the power to modify or rescind those contracts, leading one to ask how the reorganization option influences the strategic interaction of firms.

Capital investment - and especially investment in capacity - seems the most salient example of commitment in the industrial organization (I.O.) literature, as well as the most consequential for industry dynamics, growth, and welfare. Yet studies of capital investment in I.O. typically ignore bankruptcy entirely.[2] Those models that do allow for bankruptcy tend to equate it with exit, and while liquidation under Chapter 7 of the Bankruptcy Code can be likened to exit,[3] the vast majority of large corporate bankruptcy cases in the U.S. *reorganizations* - filed under Chapter 11.[4] Unlike liquidation proceedings, Chapter 11 cases are brought forth - usually voluntarily - with the goal of exiting from bankruptcy court protection, not exiting from the market, and more than two thirds of large public firms filing under Chapter 11 do eventually emerge from bankruptcy.[5] To the extent that irreversibility

[1] See, for example, the seminal books by Schelling (1960) and Porter (1980).

[2] A partial reading list might include such papers as Arrow (1968), Bertola and Caballero (1994), Ericson and Pakes (1995), Abel and Eberly (1996), Besanko and Doraszelski (2004), Bloom et al. (2007), and Besanko et al. (2010).

[3] See, for example, seminal works such as Brander and Lewis (1988) and Cooley and Quadrini (2001).

[4] Author's calculations based on LoPucki (2017). Among publicly traded U.S. firms that filed under Chapter 11 between 1980 and 2017 and had at least \$100 million in assets (in 1980 dollars), 97.8% filed under Chapter 11.

[5] Author's calculations based on LoPucki (2017). Among publicly traded U.S. firms that filed under Chapter 11 between 1980 and 2017 and had at least \$100 million in assets (in 1980 dollars), 67.5% emerged from bankruptcy.

is achieved through long-run contracts, then, Chapter 11 must affect the equilibrium behavior of forward-looking firms, yet the literature has heretofore overlooked this question.

Given the potential impact bankruptcy law may have on competitive strategy, capital investment, and industry dynamics, one might expect scholars in law and economics or corporate finance to have studied its implications - and they have - yet both fields typically ignore competitive strategy. For example, while investment and bankruptcy are recognized as endogenous decisions in the corporate finance literature, models of capital investment and capital structure focus primarily on single-firm settings. The same is true of the law and economics literature, where the intricacies of insolvency policy have clear bearing upon an individual firm's investment and bankruptcy decisions, but without regard for the impact of those decisions on equilibrium inter-firm behavior. Moreover, while both literatures clearly link bankruptcy law to *ex ante* investment, the mechanism of action is almost always financial. Yet successful emergence from Chapter 11 reorganization is not typically effected by changes in financial structure alone, but by thorough reevaluation and careful pruning of the company's operations - pruning which might otherwise be prevented by long-run contracts. Given this non-financial link between bankruptcy and investment, it seems natural to ask whether endogenizing both choices in the familiar I.O. context of strategic interaction generates any new insights, and indeed it does.

As this paper demonstrates, the handling of contracts under the U.S. Bankruptcy Code can have a direct impact - and one distinct from any financing considerations - on the *ex ante* investment behavior of imperfectly competitive firms. I examine the intuitive yet overlooked relationship between capital investment and Chapter 11 reorganization in three parts. First, I exploit an increase in the expected cost of reorganization due to the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) of 2005, which made significant changes to Chapter 11. Legal scholars and practitioners agree that the 2005 reform restricted debtor protection overall and reduced the likelihood of successful reorganization, particularly for the largest and most complex corporations.[6] I

I should note, however, that prior to 2019, outcomes were considerably more grim for small business bankruptcies, a fact addressed by the passage of the Small Business Reorganization Act.

[6] See, for example, Iverson (2018); Coelho (2010); Gilson (2010); Ayotte and Morrison (2009); Gottlieb et al. (2009); Selbst (2008); Herman (2007); Altman and Hotchkiss (2010); and Sprayregen et al. (2005).

use this size/complexity-dependent exposure to BAPCPA as the basis for a difference-in-differences analysis using data on fleet investment in the U.S. airline industry. My results suggest a nearly 14% reduction in capacity by large firms relative to small ones in the years following the reform.

Second, I develop a structural empirical model to isolate and quantify the effects of long-run contracting and reorganization on oligopoly investment. The model allows firms to both enter and exit Chapter 11 in a continuous-time, discrete-choice, dynamic game, which I estimate using data on airline capacity, bankruptcy, and profit. According to my estimates, BAPCPA roughly doubled the expected cost of Chapter 11 bankruptcy.

Third, using the parameters estimated from the structural model, I simulate two counterfactual scenarios. In the first, I simulate equilibrium behavior as though BAPCPA had never been passed, finding an increase in industry capacity of about 5%. This analysis suggests that BAPCPA may have played a role in the “capacity discipline"[7] observed in the airline industry after 2005. While the phenomenon has been well documented and discussed since that time, explanations for its persistence have been little more than conjectures. This paper offers a new and evidence-based mechanism, namely, an underlying change in bankruptcy law may have made holding capacity less desirable. In the second scenario, I simulate a new equilibrium in which reorganization is prohibitively costly, allowing me to measure the overall effect of the Chapter 11 option (i.e. in addition to Chapter 7 liquidation) on industry capacity. I find that eliminating Chapter 11 reduces total industry capacity by as much as 20%, suggesting that the relatively debtor-friendly nature of insolvency policy in the U.S. tends to increase investment overall.

The airline industry presents the ideal context in which to test the link between investment and bankruptcy for three main reasons. First, the volatility of air travel demand and the prevalence of contractual labor and capital lease agreements in this industry make Chapter 11 especially appealing for distressed airlines. That is, they heavily use long-term contracts, and they face volatile demand that sometimes necessitates breaching those contracts. Second, the prevalence of bankruptcy in the industry suggests it may be strategically used. To

[7] While no precise definition for this term is provided in industry publications, slow or moderated investment during periods of high demand coupled with a willingness to disinvest during periods of low demand will serve as my working definition in this paper.

the extent that forward-looking firms internalize the reorganization option, they may tend to over-commit to long-term contracts, resulting in rampant bankruptcy when demand falls. The notorious insolvency of U.S. airlines fits this pattern. Third, anecdotal evidence suggests that an airline's Chapter 11 filing can be strategically timed, indicating that bankruptcy is far from an exogenous event.

The remainder of this paper proceeds as follows: In Section 2, I review the relevant literature before providing necessary background on bankruptcy law and the airline industry in Section 3. These sections provide context for my three-part empirical strategy, described in Section 4, and the associated data on capacity, bankruptcy, and profit that I use, which is described in Section 5. Section 6 presents all results and counterfactuals before concluding. Note also the availability of an Online Appendix, which analyzes an illustrative theoretical model and provides additional details on bankruptcy provisions, reforms, and trends relevant to the airline industry.

2. LITERATURE REVIEW

A number of studies have combined insights from industrial organization, corporate finance, and law and economics, yet none has shown how Chapter 11 can influence capital investment under imperfect competition. In this section I summarize the relevant components of these three strands of literature, highlighting this important gap. My paper also augments the considerable body of work on airline competition by proposing a mechanism for capacity discipline.

Beginning with Arrow (1968) and Spence (1979), industrial economists have recognized the important role of investment (ir)reversibility for firm behavior. Porter (1980) establishes the importance of commitment for competitive strategy, while Pindyck (1986) demonstrates that irreversibility of investment reduces optimal capacity relative to an environment where investment decisions are reversible. This seminal paper identified the real option value associated with delaying such an investment when demand is uncertain. Jou and Lee (2008) extend earlier analyses in the real options literature to an oligopolistic industry. Their model incorporates choices over capital structure, investment scale and timing, and bankruptcy filing, but by treating investments as fixed and bankruptcy as final, the authors necessarily abstract away from both the evolution of capital in the industry and the transient nature of Chapter 11 protection, thereby overlooking the question at hand in this paper.[8]

A related literature pertains to strategic capacity decisions, and capacity buildup is often described as an effective means of deterring entry. Eaton and Lipsey (1979), for example, show that anticipated growth leads to buildup of capacity by incumbents that, when compared to the decisions of potential entrants, appears premature. Besanko et al. (2010) examines a dynamic model of capacity investment, finding that greater product homogeneity and capacity reversibility promote capacity preemption races. My results tell a similar story. That is, when reorganization becomes more costly, investment becomes less reversible, and capacity build-up during good states of the world declines. Relative to this strand of literature, then, the key contribution of my paper is to demonstrate how this sort of behavior can arise from a change in insolvency policy, which is not traditionally associated with models of capacity build-up in I.O.

While many authors have examined market competition and entry in airlines, few have covered capacity investment, and none at the industry level.[9] Relating price and capacity competition at the market level, Snider (2009) develops a dynamic structural model in which cost asymmetries between large and small air carriers lead to predatory behavior. Another example is Röller and Sickles (2000), which measures market power using conjectural variation in the European airline industry. The authors employ a two-stage framework in which firms first purchase airplanes, and then compete in prices. Aguirregabiria and Ho (2010) analyze a dynamic model of oligopolistic airline competition to identify factors influencing the adoption of hub-and-spoke networks. They find that the cost of entry on a route declines with the airline's scale of operation at the endpoints of the route, and for large carriers, strategic entry deterrence is also an important factor.[10] In contrast to these studies, my focus is industry-level capacity, abstracting away from network development and market entry.

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[8] For the same reason, the terminal nature of war-of-attrition models, such as the one in Takahashi (2015), would be inappropriate for examining Chapter 11 reorganization.

[9] For an overview of developments in market-level entry models, see Li et al. (2022) and citations therein.

[10] Along similar lines, earlier work by Hendricks et al. (1997) showed that operating a spoke market at a loss could be a dominant strategy for a hub carrier in response to entry by another firm into the spoke market.

While studies of bankruptcy in the airline industry examine both the market- and industry-level behavior of firms in financial distress, they ignore the dynamic interplay between bankruptcy and capital investment. For example, Ciliberto and Schenone (2012) conclude that bankrupt airlines reduce prices under bankruptcy protection and increase them after emerging from bankruptcy, while competitors' prices do not change significantly.[11] The authors also find that bankrupt airlines permanently prune overall route structures, reduce flight frequency, and shed capacity. In particular, relative to pre-bankruptcy figures, routes, frequency, and capacity fall by about 25% under bankruptcy protection, and by another 25% upon emergence from Chapter 11.[12] Not surprisingly, Jayanti and Jayanti (2011) show that an airline's bankruptcy filing or shutdown is good news for equity-holders of rival airlines, while emergence of a carrier from bankruptcy generally reduces rivals' firm value. Whereas these papers study what happens *during* bankruptcy, I examine the role bankruptcy law plays in determining what happens *outside* of bankruptcy as well.

Any episode of insolvency presupposes the presence of debt, so before describing the impact of bankruptcy law on firms' investment decisions, we must acknowledge the more general role of capital structure on those decisions. Since at least the 1980s, economists have recognized that capital structure may influence product market competition. Viewing bankruptcy as default-induced exit, Brander and Lewis (1986, 1988) describe two effects. The "limited liability effect" captures the incentive a firm will have to pursue riskier product market strategies because equity holders do not share in downside risk below the point of bankruptcy. The "strategic bankruptcy effect" captures the incentive for a firm to pursue product market strategies that will increase the likelihood of competitor bankruptcy, which is contingent upon competitors' financial structures. To isolate the linkages between financial markets and product markets, Brander and Lewis (1986) treat capital investment as fixed, allowing firms to choose their debt/equity ratios in the first stage of a two-stage duopoly model.[13] The limited liability effect they describe is therefore solely due to short-

[11] Earlier work by Borenstein and Rose (1995) and Busse (2002) also finds that firms in poor financial condition are more likely to reduce prices.

[12] Earlier work by Borenstein and Rose (2003) suggested modest declines in service levels as a result of bankruptcy.

[13] One might wonder why I do not simply extend this model to allow for another stage in which firms choose capital investment, either before or after choosing capital structure. First, in the Brander and Lewis (1986, 1988)

run competition in output effected through changes in variable inputs. Linking capital structure to input decisions is Matsa (2010), which demonstrates how the presence of collective bargaining agreements can impact the choice of debt levels. Abstracting away from the capital investment decision allows the aforementioned authors to focus on capital structure decisions and to avoid the additional effects of commitment, studied by Dixit (1980), Eaton and Lipsey (1980), Brander and Spencer (1983), and others. Whereas Brander and Lewis (1986) and Matsa (2010) linked the capital structure decision with output market strategies, holding investment levels fixed, I will ignore the capital structure decision to identify how changes in bankruptcy law can influence capital investment decisions that are otherwise irreversible. The interested reader should review the citations within Brander and Lewis (1986, 1988) for foundational articles on capital structure choice, and in particular, for exceptions to the Modigliani and Miller (1958) theorems.[14]

With respect to the bankruptcy decision itself, the corporate finance literature has adopted endogenous liquidation as the standard model, beginning with Leland (1994) and Leland and Toft (1996), but recent work has begun to incorporate the reorganization option.[15] Despite these advances, corporate finance models of capital investment and/or capital structure understandably focus on the financing choices of firms, primarily in single-agent settings. Suo et al. (2013) and references therein provide a few examples. Broadie et al. (2007) extend these models of optimal capital structure by allowing for reorganization under Chapter 11 in addition to liquidation under Chapter 7. Hamoto and Correia (2012) provide a nice overview of the different models of default, liquidation, and bankruptcy, identifying Broadie et al. (2007) as the only paper to incorporate Chapter 11, although several authors

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models, bankruptcy is viewed as liquidation/exit, and my primary purpose in this paper is to analyze the most salient alternative, reorganization. Second, while understanding the full strategic interplay among investment, capital structure, insolvency policy, and product market competition is undoubtedly crucial for our understanding, I view isolating the effect of insolvency policy on investment behavior as a necessary first step. Third, a dynamic model which captures the ups and downs of the market is necessary for realistically modeling investment and disinvestment.

[14] A good reading list would certainly begin with Meckling and Jensen (1976), Myers (1977), and Bulow and Shoven (1978).

[15] See, for example, the excellent work of Sundaresan and Wang (2007), Broadie et al. (2007), Li et al. (2014), Nishihara and Shibata (2016), Corbae and D'Erasmo (2021), Antill and Grenadier (2019), and references therein.

separate the default and liquidation decisions. More recently, two fantastic papers by Antill and Grenadier (2019) and Corbae and D'Erasmo (2021) both incorporate the liquidation vs. reorganization choice. Antill and Grenadier (2019) develop a model of optimal capital structure that includes dynamic bargaining between creditors and equityholders. Corbae and D'Erasmo (2021) estimate a general equilibrium model of firm dynamics with endogenous entry and exit of competitive firms in order to examine the effects upon firm dynamics of a proposed bankruptcy reform. Both of these papers push the frontier forward a great deal, yet both remain focused on the financing decisions of firms and the financial provisions of bankruptcy law. Thus, any discussion of the (ir)reversibility of capital investment - and especially its strategic implications - remains untethered to this strand of the literature.

The law and economics literature on insolvency policy in general, and Chapter 11 reorganization in particular, is detailed and wide-ranging. While this strand of the literature takes quite seriously the strategic interactions amongst debtors, creditors, and other stakeholders, especially during bankruptcy proceedings, strategic interaction amongst rival firms appears absent. Instead, the analysis typically centers on the firm and its stakeholders in order to evaluate the efficiency and efficacy of bankruptcy policy, especially the effects of bankruptcy law's provisions on the bargaining process before and during bankruptcy[16]; the investment decision during times of financial distress[17]; and the efficiency with which the current bankruptcy regime liquidates nonviable entities and resuscitates viable ones.[18] Clearly there is a great deal of overlap here with corporate finance, as incentives (or disincentives) for investing and borrowing induced by bankruptcy law have implications for firm value and financial performance. For excellent overviews of the economic thinking surrounding bankruptcy, see Jackson (1984), White (1989), and White (2007). With respect to investment in particular, the effect of bankruptcy law generally hinges on the agency conflict between owners and managers in choosing the optimal riskiness of projects undertaken. That effect is, in turn, mediated by the treatment of the firm in bankruptcy (i.e.

[16]See, for example, Bebchuk and Chang (1992).

[17]See, for example, Gertner and Scharfstein (1991), Schwartz (1994), and Adler (1995).

[18]See, for example, White (1994) and Eraslan (2008).

priority rules, deviations from them, provisions governing the bargaining process, etc.).[19] Bebchuk (2002) provides thorough coverage of this issue in presenting an analysis of the *ex ante* costs of deviating from the absolute priority rule in bankruptcy. Rasmussen (1994) examines the *ex ante* investment effects of then-current bankruptcy law as well as various proposed reforms. He notes well that bankruptcy changes more than just capital and ownership structure. In many cases, it leads to changes in leadership and operations as well, and the prospect of these changes has important implications for *ex ante* behavior. In this paper, I focus on the malleability of long-run contracts in Chapter 11, and I demonstrate that it does indeed matter for *ex ante* investment decisions in the context of imperfect competition. Whether we are concerned with the efficiency of bankruptcy policy, its effects on borrowing and capital structure, or its potential to alter the product market behavior of firms, understanding how it influences *ex ante* investment in this context is an important dimension of the discussion. With that in mind, let us proceed.

3. BACKGROUND

In this section I present three elements of background information that together motivate the link between investment and bankruptcy in the U.S. airline industry. First, I explain some of a firm's key risks and rewards of filing for bankruptcy in the U.S. Second, I describe the 2005 bankruptcy law reform in detail. Third, I explain the appeal of Chapter 11 specific to airlines in the U.S., demonstrating that airline bankruptcy patterns are consistent with strategic use of Chapter 11.

3.1. *Bankruptcy*

3.1.1. *Bankruptcy Basics*

The traditional economic justification[20] for bankruptcy protection is as a solution to a collective action problem, namely, the allocation of an insolvent firm's assets. In the U.S.,

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[19] An important exception in that regard is Rose-Ackerman (1991) and related works that consider the behavioral implications of a manager's personal aversion to bankruptcy on account of overinvestment in the company itself.

[20] For an extended treatment, see Jackson (1984).

when a firm defaults[21] on a debt obligation, the creditor whose claim is in default has the right to sue for relief in state court. Secured creditors have the additional right to seize the collateral underlying their claims. A financially distressed firm with many creditors is therefore liable to become a tragedy of the commons. When left to its individual legal rights, each creditor has incentive to secure as big a share of the firm's assets as possible, as quickly as it can, to the detriment of the other creditors and the company's chances for success. Much like a bank run, this kind of behavior can turn temporary insolvency into complete financial ruin. Bankruptcy law provides a way of collectivizing creditors' behavior, with the goal of avoiding inefficient firm failures.

To this end, the U.S. Bankruptcy Code offers two forms of bankruptcy protection to business entities: liquidation under Chapter 7 and reorganization under Chapter 11. Both processes begin with an "automatic stay" that protects the firm from legal action and asset seizure, but they differ in their subsequent treatment of insolvency. Chapter 7 is pursued (voluntarily or otherwise) when a company is unlikely to return to profitability, even with substantially reduced debt obligations. It provides for an orderly closure of the company, sale of assets, and repayment of claims. Chapter 11 is afforded to companies that have a reasonable chance of remaining a going concern, particularly if they renegotiate their obligations to creditors, vendors, employees, tax authorities, and other stakeholders. Under Chapter 11, a financially distressed corporation can typically negotiate away substantial portions of debt and other liabilities, sometimes on the order of cents on the dollar.

The courtroom is not the only place a firm's financial distress can be resolved, of course. Litigation is costly, and most secured creditors would prefer to continue receiving debt payments than to own the underlying collateral. Consequently, debt renegotiations (called "workouts") are common in the U.S. However, as White (2007) points out, the negotiation process is imperfect, and workouts can be easily derailed by hold-out creditor classes. In their study of 169 instances of financial distress among large public corporations in the 1980s, Gilson et al. (1990) find that slightly less than half (80) of firms successfully restructure their debt outside of bankruptcy. Success was more likely when firms had greater

[21] Note that default need not be due to failure to make payments. Technical default occurs when one of the provisions of the debt agreement is violated (e.g. if working capital, cash on hand, or liquidity ratios fall below pre-specified levels).

intangible assets, a higher proportion of bank debt, and fewer distinct creditor classes.[22] The 89 unsuccessful firms in the study all filed for Chapter 11.

3.1.2. *The Bankruptcy Process*

Here I briefly explain the overall process of Chapter 11 and Chapter 7 and describe the history of bankruptcy law in the U.S. For a more thorough treatment, see White (2007) and Branch et al. (2007).

Under Chapter 7, a court-appointed or elected trustee manages the orderly shutdown and liquidation of the company. The trustee's goal is to convert the company's assets to cash as quickly as possible, while seeking to maximize the value received for those assets. Since even distressed companies are typically worth more than the sum of their parts, sale of substantially all of the firm's assets to a single party is not uncommon. The proceeds are then distributed to claimants according to the absolute priority rule (APR). Also known as liquidation preference, the APR dictates the order in which unsecured claims are paid and stipulates that no class of creditor be paid until all more senior classes have been paid in full. In order of priority, the major divisions are as follows:

1. Administrative Claims (including legal fees)
2. Statutory Claims (including certain unpaid taxes, rents, wages, and benefits)
3. Unsecured Creditors' Claims (including trade credit, bonds, and legal claims)
4. Post-filing Interest on Paid Claims
5. Equity

Secured creditors are notably absent from the APR ordering because their claims on particular assets remain valid in bankruptcy. Creditors with secured claims are entitled to their collateral or its fair market value (usually replacement value) before any unsecured claims are paid.

Whereas Chapter 7 outlines the orderly paying of creditors' claims, Chapter 11 provides an orderly way to renegotiate those claims. While the ultimate goal of Chapter 11 reorganization is reemergence from bankruptcy as a going concern, many firms are unsuccessful. Failure can take two forms, conversion or dismissal, each of which results from

[22] Debt restructuring outside of bankruptcy typically requires unanimous consent of all creditors whose claims are in default, so the likelihood that at least one creditor holds out increases in the number of creditors.

the bankruptcy judge's approval of the specified motion. A motion to convert the case to Chapter 7 will, if granted, lead to liquidation. A motion to dismiss the case will, if granted, lift the automatic stay and remove the proceeding from bankruptcy court. In the case of dismissal, negotiations with creditors can continue, but creditors now have the option to seize collateral or sue the debtor in state court. Iverson (2018) and Morrison (2007) indicate that, in most cases, dismissal is tantamount to liquidation.

Chapter 11 centers on the firm's reorganization plan, which outlines debt repayment and firm restructuring. The plan must also estimate firm value as a going concern and show that it exceeds liquidation value. Upon proposal, the judge must first approve the disclosure statement (the plan), before it can be voted on by creditors. If, at each level of seniority, at least 50% of creditors by number and 2/3 of creditors by value accept the plan, then it is deemed accepted by that class.[23] Even after creditors have voted on the plan, the judge still has the ability to approve or reject the plan. Most commonly, the judge may approve a plan that was voted down if he or she feels that doing so is in the best interest of the firm. Such a decision is known as a "cram-down" and requires that the plan be feasible, filed in good faith, and superior to liquidation in terms of creditors' recovery.

A reorganization plan need not be approved on the first try (or the second or third, for that matter). The number of attempts is really only limited by the time and patience of the bankruptcy judge. For the first 120 days of bankruptcy, the debtor is given the exclusive right to file a reorganization plan. Often 120 days will be far from enough time to formulate a plan that is agreeable to all parties, so a judge may grant extensions of this exclusivity period if he or she sees fit. Once this period expires, any creditor group or case trustee may file an alternative plan and seek approval. Figure 1 illustrates the overall bankruptcy process.

3.1.3. *Bankruptcy Provisions of Interest*

Of particular import in the context of the airline industry are Sections 1110, 1113, and 1114 of the Bankruptcy Code, which deal with aircraft leases, collective bargaining agreements, and retiree benefits, respectively. Negotiating more favorable terms with lessors,

[23]Note that, in order to vote, a creditor must be impaired, in that it will receive less than 100% recovery under the plan.

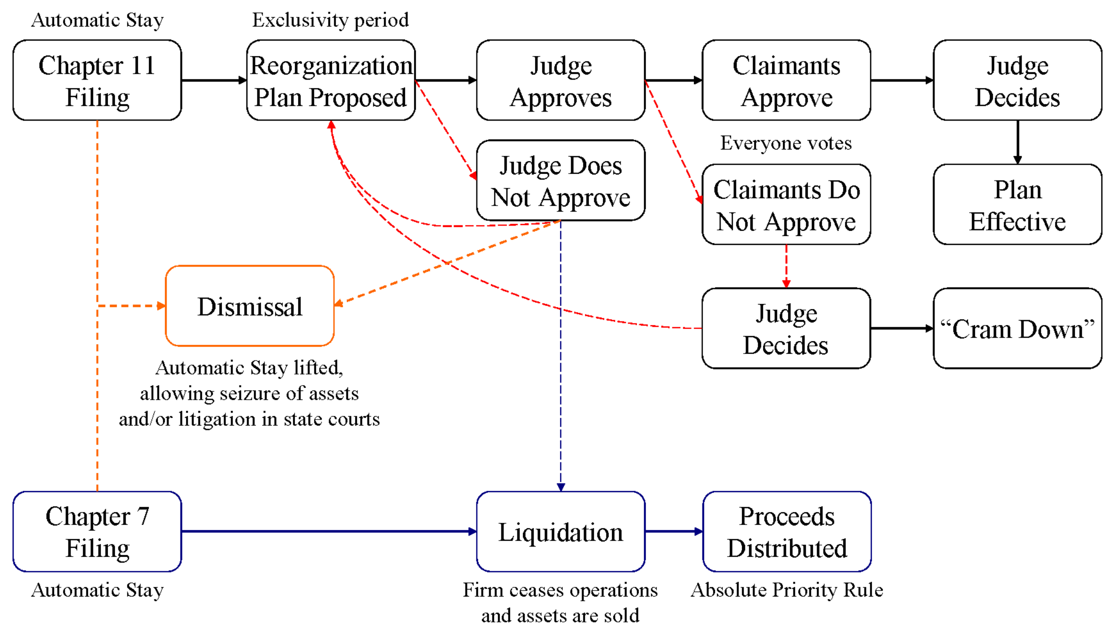

FIGURE 1.—The Bankruptcy Process

unions, and retirees can yield enormous cost savings for airlines in Chapter 11, and each of these provisions gives the debtor considerable bargaining power, owing to the unattractive outside options (i.e. contract abrogation) of their respective bargaining partners.[24]

3.2. *BAPCPA 2005*

3.2.1. *Overview of BAPCPA 2005*

In order to say whether or not bankruptcy law matters for investment, I need to observe the investment response to an exogenous change in bankruptcy law. To do so I exploit the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA). This section summarizes the reform, providing evidence that it increased the expected cost of filing Chapter 11, especially for larger firms.

Several times throughout the 19th century, the U.S. Congress established and repealed bankruptcy legislation, but not until the Bankruptcy Act of 1898 did any set of rules gain permanence.[25] While bankruptcy law experienced minor changes in subsequent decades,

[24] For section-specific details, see the Online Appendix.

[25] For a brief history of bankruptcy in the U.S., see Bak et al. (2008).

the Bankruptcy Reform Act of 1978 was its last major overhaul. The 1978 Act, commonly referred to as the Bankruptcy Code, was such a substantial change that its effect on filing rates has been the subject of considerable research.[26] In 1994, the Bankruptcy Reform Act established a commission to review the Bankruptcy Code, and that commission eventually proposed BAPCPA, widely viewed as the most substantial change since 1978.

Although its primary target was consumer bankruptcy abuse, BAPCPA made a number of substantive changes to Chapter 11 designed to prevent large corporations' abuse of the bankruptcy option by making Chapter 11 filings more difficult. Coelho (2010) finds that the market response to public announcements of bankruptcy filing has been more severe since the reform relative to the pre-BAPCPA period, lending empirical validity to what Gilson (2010) and many other scholars had already agreed upon: the new Bankruptcy Code restricts debtor protection and reduces the likelihood of a successful reorganization. In support hereof, Coelho (2010) cites Altman and Hotchkiss (2010); Gottlieb et al. (2009); and Ayotte and Morrison (2009) as well.[27] Iverson (2018)'s conclusion that busy judges more often leave firms to their own devices agrees with the creditor-friendly perception of BAPCPA as well. Since bankruptcy court judges see both business and consumer cases, the drastic decline in consumer bankruptcy filings following BAPCPA substantially reduced judges' overall caseloads. Iverson (2018) identifies this effect and suggests that judges with lighter caseloads are more inclined to dismiss or convert Chapter 11 cases, thereby increasing the probability of liquidation.

Even before the reform went into effect, it was commonly expected to shift bargaining power to creditors. While uncertainty surrounded the manner in which BAPCPA would eventually be implemented in the courts, the consensus among legal professionals was that BAPCPA would probably be bad for debtors, especially large ones and those with particular classes of assets. I now detail the reform components most relevant for large companies, relying collectively on Sprayregen et al. (2005), Herman (2007), Selbst (2008), and Levin (2005).

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[26] See, for example, Bhandari and Weiss (1993), Domowitz and Eovaldi (1993), White (1987), Boyes and Faith (1986), and Nelson (2000)

[27] Other authors have investigated the effects of BAPCPA, but most focus on its impact upon consumer bankruptcy and related behaviors. Gross et al. (2021) is one recent example.

3.2.2. *Changes of Interest*

The first and arguably most important change was the Act's limitation of the exclusivity period for filing a plan of reorganization. The exclusivity period is the time during which the company has the sole right to put forth a plan of reorganization for consideration by stakeholders. Once the exclusivity period has expired, other parties, such as creditor committees or labor unions, can put forth alternative plans and call for a vote. Under the old regime, large corporations were regularly granted extensions lasting up to several years.[28] The 2005 reform set a hard and fast limit of 18 months for exclusivity, and 20 months for acceptance of an exclusive plan. These limits, as Selbst (2008) explains, were "aimed at curbing the perceived abuse of debtors spending too long in Chapter 11 and using exclusivity to coerce concessions from creditors." The new limit increased the likelihood of losing exclusivity, especially for large companies. In a 2005 report by law firm Kirkland & Ellis, James Sprayregen[29] and co-authors explained that, "...in many cases, changes in collective bargaining agreements and pension plans...and similar issues cannot be resolved in 20 months." Moreover, BAPCPA's change to exclusivity was likely to have a greater impact on airlines than on industry in general. Before the reform came into effect, airlines were about twice as likely as other firms to exceed the 20-month threshold for acceptance of a plan.[30] My own conversations with legal experts confirm that, at least for the largest of firms, BAPCPA's curtailment of the exclusivity period alone turned the process of reorganization into almost assured liquidation.

Coupled with the reduced exclusivity period is a slightly increased scope for dismissal or conversion of a bankruptcy case. By limiting the discretion of the bankruptcy judge, the Act made it more likely for courts to convert a reorganization into a liquidation if procedural requirements are not met. Firms are not only more likely to lose control of the reorganization process by losing exclusivity, but also more likely to lose reorganization as

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[28] United Airlines, for example, required three years before a reorganization plan was confirmed.

[29] Sprayregen's relevant reorganization expertise includes representation of United Airlines, Japan Airlines, and Trans World Airlines (TWA).

[30] Among similarly-sized public companies filing for Chapter 11 between 1980 and 2005 that eventually emerged from bankruptcy, 32% of non-airline companies took longer than 608 days (the new statutory maximum) to confirm an exclusive plan of reorganization, versus 62% of airline companies during this time.

an option in the event of dismissal or conversion. Compounding this threat is the decline in consumer bankruptcy filings that followed BAPCPA, which Iverson (2018) associates with higher probability of dismissal or conversion for Chapter 11 cases.

Further changes - all of which favored creditors - include reforms in the treatment of employee wages and benefits, nonresidential property leases, and recently delivered goods.[31] On the whole, therefore, the 2005 reform clearly appears to have increased the probability of liquidation, thereby raising the expected cost of Chapter 11 from the firm's perspective.

3.3. *Bankruptcy in the U.S. Airline Industry*

Airline bankruptcy and airline capacity are inextricably linked. Every legacy air carrier has undergone bankruptcy, each time ranking among the top ten largest bankruptcies of the year by asset value.[32] Ciliberto and Schenone (2012), Benmelech and Bergman (2008), and others demonstrate that bankruptcy is a common time to cut capacity and right-size the labor force, and a number of provisions in the Bankruptcy Code make Chapter 11 especially appealing for airlines looking to downsize. If abrogating contracts in Chapter 11 is less costly than breaching them outside of bankruptcy court, then firms will be more willing to sign those contracts in the first place (i.e. invest in capacity) relative to their behavior in a world without Chapter 11. The pattern of rapid investment followed by extensive bankruptcy that we would expect to find is clearly evident in the airline industry.[33]

Not only is bankruptcy a valuable option, but there is evidence to suggest it may be strategically timed. Former CEO of American Airlines, Robert Crandall, suggested in an interview that the company should have chosen to file for Chapter 11 during the earlier wave of bankruptcies by large legacy carriers.[34] "I would have done it then because I knew that [the other major airlines] would emerge with a huge cost advantage," he says. More than just a voluntary strategy for managing financial distress, the bankruptcy option can also be misused. Delaney (1992) details Continental Airlines' 1983 bankruptcy filing, starkly

[31] These reforms, along with a discussion of non-legislative changes to the bankruptcy process, are discussed in more detail in the Online Appendix.

[32] Top 20 largest public bankruptcies by year, available since 1995 from www.BankruptcyData.com.

[33] For an excellent overview of the domestic commercial airline industry, see Borenstein and Rose (2013).

[34] http://www.charlierose.com/view/interview/12228

illustrating its strategic intent and abusive nature. The more general case for bankruptcy's strategic nature is debatable. Flynn and Farid (1991) and Tavakolian (1995) argue that bankruptcy has lost much of its previous stigma and grown into a viable business strategy for turning around failing companies. But Moulton and Thomas (1993) provide empirical evidence that, if it is a deliberate strategy, it is not usually a successful one.[35]

Perhaps the best evidence for both the strategic timing of Chapter 11 filings and the potential impact of BAPCPA on bankruptcy costs is the fact that both Delta Air Lines and Northwest Airlines independently filed for Chapter 11 in September of 2005, just one month before BAPCPA came into effect. Industry experts claim that BAPCPA played a key role in Northwest's decision, and that Delta's filing was long expected, suggesting the company had sufficient ability to time the decision.[36]

4. EMPIRICAL STRATEGY

My empirical approach to studying the link between bankruptcy and investment is three-fold. First, I perform a difference-in-differences analysis of airline data to test whether investment behavior changed following BAPCPA. Second, I estimate a dynamic, structural model of investment and bankruptcy to measure the incremental firm-level cost due to that reform. Finally, I use the estimated parameters to simulate two counterfactual scenarios in which 1) BAPCPA was never enacted, and 2) Chapter 11 reorganization is effectively prohibited.

4.1. *Difference-in-Differences Model*

While airline fleet investment has fallen since BAPCPA was enacted, further analysis is necessary if we are to attribute the decline to an increase in bankruptcy cost. To separate the effect of a bankruptcy cost change from the effects of time, demand, or other macroeconomic variables, we would like to compare BAPCPA's effect on investment behavior across two groups of airlines - one that was affected by the change, and one that was not. Here I describe my preliminary difference-in-differences approach to test that implication by comparing large and small airlines before and after BAPCPA.

[35] Ciliberto and Schenone (2012) provide additional evidence for the strategic use of bankruptcy in airlines.

[36] See, for example, Maynard (2005) and Corridore (2005).

The specifics of the BAPCPA reform suggest that its effects will have been felt most by large and/or highly complex firms, significantly reducing their likelihood of successful reemergence from Chapter 11. Intuitively, the more parties with which a firm must negotiate, the slower it will expect to gain support for an exclusive plan, making conversion, dismissal, or cram-down more likely. I use firm size[37] as a proxy for complexity, based on the observation that larger entities tend to have more creditors, more bankruptcy committees, more entities filing joint bankruptcy petitions, and so forth.[38] I verify that firm size is correlated with bankruptcy duration using Lynn LoPucki's database of public firm filings and outcomes. After controlling for demand, seasonality, and firm type, I find do evidence that larger firms reduced investment more than smaller firms during the post-BAPCPA era.

4.2. *Structural Model*

In this section I describe the structural model that will be estimated and used to perform counterfactual simulations. The model benefits my analysis in three critical ways. First, the continuous-time approach is both intuitive and computationally tractable to solve. Second, the model produces numerical comparative statics that can be independently supported by the illustrative theoretical model I provide in the Online Appendix. Finally, the model lends itself well to estimation using conditional choice probability (CCP) methods, which greatly expedite computation.

To empirically analyze the relationship between reorganization and investment behavior, only a dynamic model is suitable. Most structural dynamic models in the airline literature describe market-level decisions, which are complicated in their own right, but in this case I must look at the industry as a whole. The number of players in my model is therefore necessarily large, making the computation of Markov Perfect Equilibria (MPE) for a traditional discrete-time, simultaneous-move model (i.e. an Ericson and Pakes (1995)-style (EP) model) somewhat difficult. One way to ease the computational burden is to assume that firms make decisions based on less (or less precise) information. For example, Aguirregabiria and Ho (2012) examine industry-wide route network decisions by making assumptions to simplify the set of payoff-relevant variables for each of 22 airlines. A similar

[37] I measure size as the number of available aircraft seats in the fourth quarter of 2004.

[38] One might also consider the number of unions, the number of outstanding debt classes, etc. as proxies.

concept is used more generally by Weintraub et al. (2008), who introduce the concept of oblivious equilibrium to approximate EP models when many firms are involved.[39] Another approach, pioneered by Hotz and Miller (1993) and Hotz et al. (1994) and adapted to the I.O. context by Bajari et al. (2007) and others,[40] has been to estimate players' actual choice probabilities from the data, incorporating them into a dynamic programming framework. The model I employ combines this second approach with a continuous-time model, further expediting computation.

4.2.1. *Setup: Discrete Choices in Continuous Time*

A continuous-time, discrete-choice model is an intuitive and computationally tractable way to model interaction among a relatively large number of firms. I now lay down the foundations of this model, following Arcidiacono et al. (2016), henceforth referred to as ABBE (2016).

Consider a continuous-time, infinite-horizon game following ABBE (2016), in which N firms compete in capacity levels with the option to file for bankruptcy. At any given time, a firm is fully represented by a capacity level $q_i \in Q$ and a bankruptcy state b_i, which equals 1 if the firm is under Chapter 11 protection and 0 otherwise. The state of the game is characterized by the set of all players' states as well as the demand state, $\alpha \in \{\alpha_{lo}, \alpha_{hi}\}$, and a state governing the bankruptcy regime, ϕ, equal to 0 before the BAPCPA reform and 1 after the reform takes effect on 10/17/2005. Let $\theta \in \Theta$ represent the vector of economic states and $x \in X$ represent the vector of firms' states. Flow profit for firm i is $u_i = u(x_i, x_{-i}; \theta)$.

The state evolves according to a number of independent, continuous-time processes governing the arrival of move opportunities for nature and for all N players. Nature flips the demand state whenever the opportunity arises, and those opportunities follow a Poisson process with parameter γ. Firm capacity and bankruptcy adjustment opportunities follow separate Poisson processes with parameters λ_a and λ_b, respectively. When a capacity adjustment opportunity arrives, a firm may choose to remain in its current state, increase capacity by one increment, decrease capacity by one increment, or exit. Exit and entry are

[39] See also extensions to this work, including Weintraub et al. (2010) and Benkard et al. (2015).

[40] Pakes et al. (2007), Pesendorfer and Schmidt-Dengler (2003), Ryan (2012), Dunne et al. (2006), and Aguirregabiria and Mira (2007), to name a few.

accounted for by adjustment to and from a level of zero capacity. If the firm changes capacity levels, it incurs a potentially asymmetric adjustment cost that depends on whether or not the firm is currently in bankruptcy. When a bankruptcy adjustment opportunity arrives, the firm may choose to remain in its current state or change its bankruptcy status. A firm filing for Chapter 11 incurs no explicit cost to transition into bankruptcy, but a firm exiting bankruptcy incurs an explicit cost to adjust its capital structure via court approval of a plan of reorganization. This cost reflects the bargaining power of creditors and is therefore conditional upon the bankruptcy regime. For example, if bankruptcy is more creditor-friendly, then the firm must sacrifice more of its equity upon exit, making reemergence from Chapter 11 more costly.

The structural parameters of interest are the capacity adjustment costs and bankruptcy exit costs, which together make up the set of state transition costs, $\psi_{j,k}$, to transition to state j from state k. Firms maximize expected lifetime profits, discounting at common, continuous rate of time preference ρ and taking their opponents' strategies as given.

The value to player i of being in state k can be written as

$$\begin{aligned} V_{i,k} = \frac{1}{\rho + N\lambda_a + N\lambda_b + \gamma} \Big\{ & u_{i,k} + \gamma V_{i,l(demand,k)} \\ & + \lambda_a \mathbb{E}\left[V_{i,l(i,k;a)}\right] + \lambda_b \mathbb{E}\left[V_{i,l(i,k;b)}\right] \\ & + \sum_{i' \neq i} \lambda_a \mathbb{E}\left[V_{i,l(i',k;a)}\right] + \sum_{i' \neq i} \lambda_b \mathbb{E}\left[V_{i,l(i',k;b)}\right] \Big\} \end{aligned}$$

where

$$\mathbb{E}\left[V_{i,l(i,k;r)}\right] = \mathbb{E} \max_{j \in J_{i,k;r}} \left\{ V_{i,l(i,j,k)} + \psi_{jk} + \epsilon_{ij} \right\}$$

and

$$\mathbb{E}\left[V_{i,l(i',k;r)}\right] = \sum_{j \in J_{i',k;r}} \sigma_{i',j,k} \mathbb{E}\left[V_{i,l(i',j,k)}\right]$$

and where $r \in \{a, b\}$ is the type of move opportunity (a representing capacity and b representing bankruptcy), $l(i, j, k)$ is the state resulting from player i making choice j from state k, and $J_{i,k;r}$ is the corresponding choice set. When a move opportunity arrives, agents receive a Type I Extreme Value shock, ϵ_{ij}, to the value of each possible choice, such that the probability of player i making a particular choice j from state k when the move arrival type is r takes the familiar logit form:

$$\sigma_{ijkr} = \frac{\exp(V_{i,l(i,j,k)} + \psi_{jk})}{\sum_{j' \in J_{i,k;r}} \exp(V_{i,l(i,j',k)} + \psi_{j'k})}$$

4.2.2. *Structural Model Implications*

One significant advantage of my structural model is that it generates numerical comparative statics that line up qualitatively with the illustrative theoretical model I provide in the Online Appendix. The model undertaken there is quite simple, and it focuses attention on the irreversibility of investment in a dynamic duopoly. Firms add capital during high-demand states, disinvest capital during low-demand states, and downsize stochastically via costly reorganization. The capacity discipline phenomenon, which I illustrate numerically here, appears in the equilibrium of that model as well. That is, higher reorganization costs reduce a firm's incentive to invest during periods of high demand and increase its likelihood of disinvestment during periods of low demand, suggesting that a policy change which makes Chapter 11 more costly from the firm's perspective will tend to rein in capital investment behavior overall.

I calibrate my structural model as a duopoly with three possible capacity levels: exit (0), low (1), and high (2). Low demand is set to make a player indifferent between exiting and remaining in the market when she is the only incumbent and has low capacity. High demand is set to ensure that both firms earn a profit even when both are at high capacity. Nature's move arrival rate is set to 0.25, implying a change every 4 years to loosely reflect the macroeconomic cycle. Players' move arrival rates are 2, implying 2 choices per year on average, for each choice type. I set the flow cost[41] of holding a unit of capacity to $2

[41] I interpret time in annual units, so a flow cost of c generalizes to a rate of c per year in the absence of discounting. Firms discount at continuous rate of time preference ρ, such that a flow cost of c yields an annualized cost of $\int_0^1 c{*}\mathrm{e}^{-\rho t}dt = c * \frac{1-\mathrm{e}^{-\rho}}{\rho}$. A flow cost of 1 for one year when $\rho = 0.1$ therefore has a present value of about 0.95.

million, and the flow cost of being in bankruptcy to \$250,000.[42] Increasing capacity outside of bankruptcy or decreasing capacity under bankruptcy protection are costless, while the cost of decreasing capacity outside of bankruptcy or increasing capacity within bankruptcy is set to \$4 million.[43] The continuous rate of time preference is set to 10%.

Figure 2 presents conditional probabilities of increasing and decreasing capacity based on this intuitive calibration. The probability of increasing capacity is conditional on having low capacity when demand is good, while the probability of decreasing capacity is conditional on having high capacity when demand is bad. Declining investment and rising disinvestment in these two situations reflects the two sides of capacity discipline at work: caution on the upswing and haste in downturns.[44] More interestingly, this effect appears more pronounced in the presence of competition. Both panels present equilibrium strategies under the same three competitive scenarios: 1) when the firm is the only incumbent; 2) when the firm faces a low-capacity opponent; and 3) when the firm faces a high-capacity opponent. In panel (a), we see that the effect of an increase in bankruptcy emergence cost has a mild, negative effect on investment when the firm faces only a potential entrant. Observing the slope for each case, we see that this effect is amplified when the firm faces an actual competitor. In panel (b), we find increased disinvestment probability as a function of rising bankruptcy emergence cost, and again we see a stronger effect when the firm faces actual competition. In both cases, the strongest (i.e. steepest) effect occurs when the

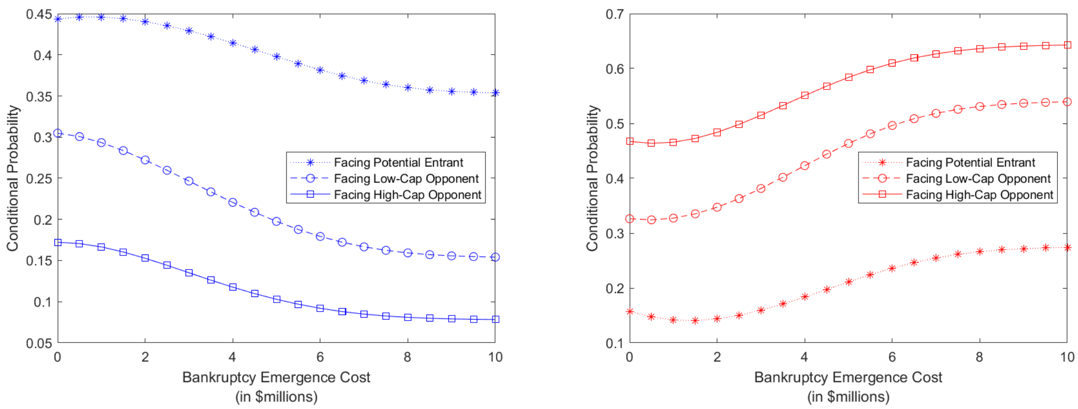
[42] According to AMR Corporation's 2010 10-K filing, the company's aircraft rental expense of \$580 million was distributed over a fleet of 241 aircraft under operating lease, suggesting a cost of \$2.4 million per aircraft. While a flow cost of bankruptcy of \$250,000 may seem too low, this conservatism is meant to highlight the role of bankruptcy emergence cost, which I allow to vary from \$0 to \$10 million.

[43] Again using AMR Corporation's 2010 10-K filing, we can estimate an early lease termination fee of about \$10 million per aircraft, based on a \$94 million charge for grounding 9 Airbus A300s prior to lease expiration. This value roughly amounts to completion of a 5-year lease term, and more than half of AMR's leased fleet had remaining lease terms of 5 years or more. However, a given airline is unlikely to rent more than 50% of its fleet. Setting the adjustment cost to twice the annual lease term is therefore a somewhat conservative figure. Setting the upward adjustment cost under bankruptcy protection to be the same value simply eases explanation of the calibration.

[44] Note that since the probability of filing for bankruptcy falls with bankruptcy emergence cost, the probabilities of both investment and disinvestment rise. Therefore, to compare the relative appeal of investment and disinvestment, the plotted probabilities are conditional on choosing not to file for bankruptcy.

firm faces a low-capacity opponent, suggesting that the strategic appeal of commitment is strongest when my opponent is solidly in the game, but lacks a dominant position.

FIGURE 2.—Investment and Disinvestment Probabilities vs. Bankruptcy Emergence Cost



(a) Investment in Good Times

(b) Disinvestment in Bad Times

4.2.3. *Estimation Using Conditional Choice Probabilities*

CCP methods begin by estimating players' state-specific choice probabilities directly from the data. The Type I Extreme Value assumption for the distribution of the choice-specific error term then allows one to combine the estimated CCPs with a guess of the structural parameters to construct the value function. Representing the value function in this way eliminates the computationally costly value function iteration loop characteristic of full-solution methods.[45] In what follows I explain how to implement this method.

The normal algorithm for nested-fixed-point estimation by maximum likelihood is

1. guess parameters
2. converge to value function
3. compute likelihood using the CCPs associated with that value function and the parameter guess
4. maximize the likelihood by changing the guess

[45]Moreover, CCPs provide a reasonable equilibrium selection criterion by assuming the relevant equilibrium is the one played in the data.

CCP estimation skips step 2 of this process, replacing it with a step 0, in which empirical CCPs are estimated from the data. This step is performed only once, outside the maximum likelihood loop.

The empirical CCPs are estimated as flexibly as possible and can be thought of as a kind of interpolation in which one uses the data to infer the probabilities with which agents will make every relevant choice at every observed node in the state space, even if such choices or their resultant states never occur in the data. I estimate conditional choice probabilities using a linear-in-parameters multinomial logit specification, such that the probability of capacity choice $j' \in J_a$ from state k is

$$\frac{\exp(X_k \beta_{j'})}{\sum_{j \in J_a} \exp(X_k \beta_j)}$$

conditional on the arrival of a capacity move. X_k is a matrix of regressors specific to state k, and β_j is the jth column of β, a matrix of coefficients for which the column associated with the continuation choice is normalized to zero. The set of regressors includes own capacity and its square, the sum of opponents' capacities and its interaction with own capacity, own bankruptcy state and its interaction with all of the above, the demand state and its interaction with all of the above, and an indicator for the implementation of BAPCPA and its interaction with all of the above. I also assume that I know the common, continuous rate of time preference, ρ.

4.2.4. *Constructing the Likelihood*

In order to write the likelihood of the data as a function of only the empirical CCPs and structural parameters requires the presence of either a terminal state or some sort of finite dependence. I use firm exit as a terminal state in order to take advantage of CCP methods. Suppose I observe every non-continuation choice $j > 0$ for each player, and that I observe all changes in market demand (high or low). I now derive the likelihood, using ABBE (2016) as a guide. What we observe is a series of events and their points in time. Let the state space be indexed by $k = \{1, ..., K\}$, and let Q_0 be the $K \times K$ intensity matrix governing exogenous state transitions. Let Q_N be the intensity matrix governing agent-related state transitions. An intensity matrix characterizes a finite-state Markov jump process, in which the elements of Q represent the rates at which the possible transitions occur. For example, if $K = 3$, we have intensity matrix

$$Q = \begin{matrix} q_{11} & q_{12} & q_{13} \\ q_{21} & q_{22} & q_{23} \\ q_{31} & q_{32} & q_{33} \end{matrix}$$

For $l \neq k$, q_{kl} is the hazard rate for transitions from state k to state l, that is,

$$q_{kl} = \lim_{h \to 0} \frac{\mathbb{P}\left[X_{t+h} = l | X_t = k\right]}{h}$$

For $l = k$, q_{kk} is the overall rate at which the process leaves state k and is defined as a negative number

$$q_{kk} = -\sum_{l \neq k} q_{kl}$$

such that the sum across any given row is always zero. The intensity matrix tells us everything we need to know about the transition process. In particular, we know that the duration in state k has an exponential distribution with parameter $-q_{kk}$. That is,

$$F_k(t) = 1 - \exp(-t \sum_{l \neq k} q_{kl})$$

and

$$f_k(t) = \left(\sum_{l \neq k} q_{kl}\right) \exp(-t \sum_{l \neq k} q_{kl})$$

Conditional on a jump occurring, the probability of transitioning to state l from state k is $\frac{q_{kl}}{\sum_{l' \neq k} q_{kl'}}$. Therefore, the joint likelihood of a jump occurring at time τ from state k to state l is

$$\begin{aligned} L_{k,l,\tau} &= \left(\sum_{l \neq k} q_{kl}\right) \exp(-\tau \sum_{l \neq k} q_{kl}) \times \frac{q_{kl}}{\sum_{l' \neq k} q_{kl'}} \\ &= q_{kl} \exp(-\tau \sum_{l \neq k} q_{kl}) \end{aligned}$$

Putting this back into the terms of the model, where Q_N governs players and Q_0 governs nature, we can write the likelihood separately for nature's moves and players' moves. Let choice $j = 0$ be a player's continuation choice, such that the state does not change. Then the likelihood that the next state change occurs after time τ and is the result of player i making capacity choice $j > 0$ is given by

$$\lambda_a \sigma_{ijk} \exp\left[-\tau\left(\sum_{l\neq k} q^0_{kl} + \sum_i \lambda_a \sum_{j\neq 0} \sigma_{aijk} + \sum_i \lambda_b \sum_{j\neq 0} \sigma_{bijk}\right)\right]$$

which can be written

$$\lambda_a \sigma_{ijk} \exp\left[-\tau\left(\sum_{l\neq k} q^0_{kl} + \sum_{r\in\{a,b\}} \lambda_r \sum_i (1-\sigma_{ri0kt})\right)\right]$$

Similarly, the likelihood that the next state change occurs after time τ and is the result of nature changing the state from k to l is

$$q^0_{kl} \exp\left[-\tau\left(\sum_{l\neq k} q^0_{kl} + \sum_{r\in\{a,b\}} \lambda_r \sum_i (1-\sigma_{ri0kt})\right)\right]$$

Given data on T observations of a change in the state and associated length of time, τ, since the last state change, we construct the likelihood, $L(Q_0, \lambda_a, \lambda_b, \theta)$, of the data as follows:

$$\begin{aligned} L(.) = \prod_{t=1}^{T} & \left\{ q^0_{kl} \exp\left[-\tau_t\left(\sum_{l\neq k} q^0_{klt} + \sum_{r\in\{a,b\}} \lambda_x \sum_i (1-\sigma_{ri0kt})\right)\right]\right\}^{d_t} \\ & \times \left\{ \lambda_b \sigma_{bijkt} \exp\left[-\tau_t\left(\sum_{l\neq k} q^0_{klt} + \sum_{r\in\{a,b\}} \lambda_r \sum_i (1-\sigma_{ri0kt})\right)\right]\right\}^{(1-d_t)b_t} \\ & \times \left\{ \lambda_a \sigma_{aijkt} \exp\left[-\tau_t\left(\sum_{l\neq k} q^0_{klt} + \sum_{r\in\{a,b\}} \lambda_x \sum_i (1-\sigma_{ri0kt})\right)\right]\right\}^{(1-d_t)(1-b_t)} \end{aligned}$$

where d_t indicates a demand move, and b_t indicates a bankruptcy move.

Noting that $q_{kl}^0 = \gamma$ and taking logs, we can write the log-likelihood function as follows:

$$
\begin{aligned}
l(\psi; \gamma, \lambda_a, \lambda_b, \rho, \hat{\sigma}, \hat{\beta}, \hat{\alpha}) = \sum_{t=1}^{T} \{ & d_t \log(\gamma) \\
& + (1 - d_t)\, b_t \log\left(\lambda_b \tilde{\sigma}_{bjkt}\right) \\
& + (1 - d_t)(1 - b_t) \log\left(\lambda_a \tilde{\sigma}_{ajkt}\right) \\
& - \tau_t \left(\gamma + \sum_{r \in \{a,b\}} \lambda_r \sum_i (1 - \tilde{\sigma}_{ri0kt}) \right) \}
\end{aligned}
$$

Maximizing the log-likelihood above yields estimates for the structural parameters. See Blevins (2016) for a discussion of identification.

4.2.5. *Flow Profit Estimation*

A key element of the state-specific value function is the flow profit, u_{ik}, in that state. Given the highly complex nature of network-level competition in the airline industry, I refrain from explicitly modeling network choice.[46] Instead, I model flow profit in the domestic U.S. market as a reduced-form function of state variables such as the carrier's capacity, the aggregate capacity in the market, and consumer demand. One of the many advantages of analyzing the U.S. airline industry is the abundance of data, including quarterly line-item-level accounting data. I proxy for flow profits using a carrier's inflation-adjusted earnings before interest, taxes, depreciation, and amortization (EBITDA). To estimate flow profit as a function of the state, I regress the set of carrier-quarter EBITDA values on the associated time-weighted average values of each state variable for each carrier-quarter. Estimating flow profit in this way allows me to abstract away from modeling utilization or network effects.

4.3. *Counterfactual Equilibria*

Armed with structural parameter estimates, I can solve for equilibria under alternative assumptions and measure the corresponding industry statistics. The first counterfactual,

[46]The interested reader will find a host of articles tackling that challenge, beginning with the basic entry model of Berry (1992) and stretching to more complex models such as Aguirregabiria and Ho (2010).

measuring the overall effect of BAPCPA on industry capacity, does not require me to resolve. Instead, I simply forward simulate the choice probabilities estimated in the first stage, holding the bankruptcy regime fixed. My second counterfactual makes reorganization prohibitively costly in order to examine just how much the Chapter 11 option influences industry capacity levels. In this case, resolving for equilibrium is required, and this section explains how to do so.

For a given set of parameters θ, I can solve for a symmetric, anonymous Markov Perfect Equilibrium (MPE) using value function iteration. Existence of equilibrium is shown in ABBE (2016). The solution process can take some time, especially for large games, which is why full-solution estimation can be extremely time-consuming. CCP methods allow me to avoid solving for equilibrium during estimation, but doing so is necessary for simulating data from the model.

The number of possible states for each bankruptcy regime is $2\,(2Q)^N$, representing a severe curse of dimensionality. To make the state space more manageable, I take advantage of exchangeability (a.k.a. anonymity) to reduce the number of *payoff-relevant* states over which the value function must be computed. This approach results in a much smaller state space of size $S = 4Q\binom{2Q+N-2}{N-1}$.[47] The value function iteration program proceeds thusly:

1. Guess V, an $S \times 1$ vector
2. Compute firm 1's expected value of a move arrival
   (a) Compute the normalized choice-specific values (including adjustment costs)
   (b) Expected value of moving is the inclusive value term (the log-sum)
3. Compute conditional choice probabilities (CCPs) for other players
4. Compute firm 1's expected value of each opponent's move arrival[48]

[47] To understand how this helps, consider that a 7-player game with 5 capacity choices has 20 million basic states, but only 100,100 anonymous states.

[48] This is just the sum of the values (from firm 1's perspective) associated with each possible choice for each possible opponent, weighted by the corresponding CCP.

5. Update V according to the updating equation

$$V_{i,k} = \frac{1}{\rho + N\lambda_a + N\lambda_b + \gamma} \Big\{ u_{i,k} + \gamma V_{i,l(demand,k)} + \lambda_a \mathbb{E}\left[V_{i,l(i,k;a)}\right] + \lambda_b \mathbb{E}\left[V_{i,l(i,k;b)}\right] + \sum_{i' \neq i} \lambda_a \mathbb{E}\left[V_{i,l(i',k;a)}\right] + \sum_{i' \neq i} \lambda_b \mathbb{E}\left[V_{i,l(i',k;b)}\right] \Big\}$$

where i indexes the firm, k indexes the current state, and l indexes the future state. We repeat this process until V converges.[49]

Before moving on, it may be instructive to describe the value function in asset pricing terms. Let us first re-write it this way

$$\rho V_{i,k} = u_{i,k} + \gamma \left(V_{i,l(demand,k)} - V_{i,k}\right) + \lambda_a \left(\mathbb{E}\left[V_{i,l(i,k;a)}\right] - V_{i,k}\right) + \lambda_b \left(\mathbb{E}\left[V_{i,l(i,k;b)}\right] - V_{i,k}\right) + \sum_{i' \neq i} \lambda_a \left(\mathbb{E}\left[V_{i,l(i',k;a)}\right] - V_{i,k}\right) + \sum_{i' \neq i} \lambda_b \left(\mathbb{E}\left[V_{i,l(i',k;b)}\right] - V_{i,k}\right)$$

The formulation above indicates that the instantaneous opportunity cost of holding an asset (ρV), should be equal to the dividend flow received from that asset (u) plus the capital gain realized when a change in value occurs ($V' - V$), weighted by the chance of that gain being realized (λ_a,λ_b, or γ). We can simplify the value function expression by substituting the following:

$$\mathbb{E}\left[V_{i,l(i,k;r)}\right] = \mathbb{E} \max_{j \in J_{i,k;r}} \left\{ V_{i,l(i,j,k)} + \psi_{jk} + \epsilon_{ij} \right\}$$

$$\mathbb{E}\left[V_{i,l(i',k;r)}\right] = \sum_{j \in J_{i',k;r}} \sigma_{i',j,k} \mathbb{E}\left[V_{i,l(i',j,k)}\right]$$

where $r \in \{a, b\}$ is the type of move opportunity, and $J_{i,k;r}$ is the corresponding choice set. Firms' strategies/CCPs are given in σ, and instantaneous payoffs (i.e. capacity adjust-

[49] Convergence is not guaranteed for a multi-player game, but when estimating the model, opponents' CCPs are fixed, reducing the process to a single-player dynamic programming problem, which is guaranteed to converge.

ment costs and bankruptcy exit costs) are given in ψ_{jk}. The key benefit of continuous-time modeling is that only one event can occur at a time. Firms' state transitions are therefore deterministic conditional upon their choices, such that $\mathbb{E}\left[V_{i,l(i',j,k)}\right] = V_{i,l(i',j,k)}$. Finally, our assumption on the error structure allows us to write the inclusive value term, $\mathbb{E}\max_{j\in X_{i,k;r}}\left\{V_{i,l(i,j,k)} + \psi_{jk} + \epsilon_{ij}\right\}$, as

$$\gamma_{eul} + \log \sum_{j\in J_{i,k;r}} \exp\left(V_{i,l(i,j,k)} + \psi_{jk}\right)$$

where γ_{eul} is Euler's constant.

5. DATA

I employ three data sets, which together allow me to match capacity and bankruptcy decisions with firm profitability over time. The first is the Ascend Online Fleets database, originally maintained by Flightglobal (now Cirium), which is part of the LexisNexis Risk Solutions Group.[50] The data base contains ownership and technical data on over 200,000 aircraft worldwide. I aggregate Cirium's daily aircraft-level data to measure airlines' fleet size. The second data set includes the timing and outcome of all bankruptcy filings in the U.S. airline industry. The third is a set of publicly available databases maintained by the U.S. Department of Transportation (DOT). Data on quantities and prices for commercial passenger air travel come primarily from the Airline Origin & Destination Survey, known as Data Bank 1B (DB1B).[51] I supplement the DB1B data with the Form 41 Traffic database (T100) and the Form 41 Financial database. Below I describe each data set in further detail.

5.1. *Daily Fleet Data*

Capacity is defined as the number of seats in a carrier's aircraft fleet, grouped into a number of bins. Daily fleet data comes from the Ascend Online Fleets data base, which works well with a continuous-time modeling approach because it provides a daily snapshot

[50] I am grateful to the Duke Economics Department and Andrew Sweeting for purchasing this data. More details can be found at the company's Website: https://www.cirium.com/

[51] A wealth of air traffic information is publicly available for download from the Bureau of Transportation Statistics (http://www.transtats.bts.gov/). The DB1B data since 1993 are freely available here, and earlier years are available for purchase in hard copy.

of aircraft ownership and usage. Each observation covers all passenger aircraft operated in North America, including their registration and serial numbers, owners and operators (indicating leased vs. owned), aircraft and engine types and manufacturers, and status (in storage, on order, in service, etc.), among other details. I aggregate this data into daily fleet snapshots for all domestic passenger air carriers. Fluctuations in operating fleet serve as the key indicator of capacity investment. However, I must account for the fact that many aircraft are purchased years ahead of time. The fleet database provides each aircraft's build year, order date, and delivery date, so I know when each aircraft was ordered, at least for brand new planes. Another concern is that the aircraft fleet is not partitioned into regional subcategories, posing a challenge when analyzing domestic data only. To address this concern I restrict my analysis to narrow-body jets, since wide-body jets are more often used to fly over-ocean routes. Another key piece of data is the financier, if present, for each aircraft, which allows me to measure how many parties (either lessors or secured creditors) with which a given carrier is contracted. Figure 3 demonstrates that fleet investment has fallen since BAPCPA was enacted (panel a), while demand for passenger air travel fails to explain the trend (panel b). Table I summarizes daily aircraft fleets for several large carriers.

FIGURE 3.—Fleet Investment and Demand over Time

(a) Median Change in Fleet Size (b) Median Investment and Implied Demand

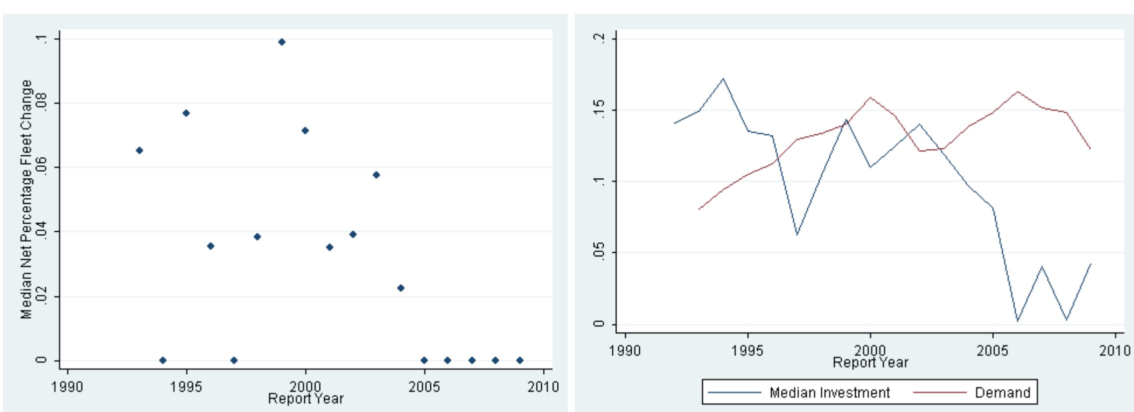


TABLE I

SELECTED CAPACITY STATISTICS

(in thousands of seats)

Player	Mean	Median	Min	Max
American (AA)	99.8	105.4	23.8	186.1
Continental (CO)	46.8	47.1	5.0	77.6
Delta (DL)	87.5	92.0	32.5	160.8
Northwest (NW)	61.0	69.5	20.9	97.2
United (UA)	85.0	88.2	28.9	188.3
US Airways (US)	46.3	52.3	8.0	87.0
Southwest (WN)	45.9	42.7	2.1	124.2
America West (HP)	59.7	36.8	0.1	141.5
Overall	66.8	66.4	0.1	188.3
Observations	98,448 carrier-days			

5.2. *Bankruptcy Events*

Evaluating firms' decisions to enter and exit bankruptcy requires data on the timing and circumstances of these decisions. I extend and cross-check Ciliberto and Schenone (2012)'s list of pre-2008 bankruptcies using news and trade journal reports, court dockets, Lynn LoPucki's Florida-UCLA Bankruptcy Research Database, and data from Airlines for America (A4A), the U.S. airline industry's primary trade organization. While nearly 200 airline cases have been filed since 1978, many of those involved small and/or cargo carriers. I focus on the filings of passenger airlines with at least 20 aircraft who provide service on their own routes, as opposed to regional carriers who primarily operate as feeder airlines to larger companies. After imposing those restrictions and combining mutually owned companies, I end up with 41 bankruptcy filings matched to capacity data.[52]

[52] If that figure seems a bit small, recall that the model is not just estimated off of transitions between states. Every daily observation of a firm's bankruptcy state provides information on the hazard of state transition, so knowing that American Airlines was bankrupt on January 1, 2013 is just as important as knowing that the firm was not bankrupt on March 3, 2005.

5.3. *Demand and Flow Profit*

Airline demand is typically estimated using publicly available price and quantity data. I used quarterly data from the DOT to construct such a measure and found that it was no better at predicting profit or investment than a measure of real GDP growth. Moreover, using real GDP allows me to credibly treat my demand measure as exogenous, while also sidestepping the need to account for demand estimation error when reporting final results. Therefore, I proxy for industry demand using year-over-year quarterly growth in real GDP. I define the demand state as good if growth was above the linear trend, and bad otherwise. This definition amounts to about 20 demand changes over the course of my data, consistent in both number and direction with results from estimating demand with price and quantity data.

The DOT's Form 41 Financial Data, Schedule P-1.2 provides an abundant source of financial information, including operating revenue and categorized expense data for reporting carriers in the U.S. Moreover, each accounting category is broken down by region, allowing me to link domestic operating profits to domestic demand. In order to convert accounting data into economic profits, I assume that operating cash flow (as measured by EBITDA) is proportional to economic profit. Table II summarizes this value for several large carriers.

6. RESULTS AND CONCLUSIONS

I now present the results of each empirical analysis. My difference-in-differences test shows that an increase in bankruptcy cost tends to discipline capital investment. My structural estimation points to a very large downward capacity adjustment cost outside of bankruptcy and suggests that BAPCPA roughly doubled the all-in cost of Chapter 11. My counterfactual simulations demonstrate that rescinding BAPCPA would increase industry capacity by about 5%, while completely eliminating the reorganization option would reduce industry capacity levels by as much as 20%.

6.1. *Difference-in-Differences Results*

The changes made by BAPCPA were more likely to affect the behavior of the most complex firms, for which Chapter 11 typically represents a multi-year process. Following

TABLE II

SELECTED PROFIT STATISTICS

(in millions of $2009)

Player	Mean	Median	Min	Max
American (AA)	1274	1551	-4509	4267
Continental (CO)	548	538	-1467	2104
Delta (DL)	1486	1169	-1475	6111
Northwest (NW)	801	879	-1348	3132
United (UA)	1019	1186	-4307	4638
US Airways (US)	255	255	-3646	2349
Southwest (WN)	1000	960	62	2253
America West (HP)	377	393	-2499	1529
Overall	846	737	-4509	6111
Observations	696 carrier-quarters			

the empirical literature on bankruptcy, I proxy for complexity using firm size. I measure firm size as the average number of seats available in the fleet during the quarter, and I split the sample in half by size as of the fourth quarter of 2004, using 5,000 seats as the cutoff. Investment is the percent change in fleet size from the same quarter of the previous year. Table III shows that BAPCPA reduced overall investment of sufficiently large firms by about 14% relative to small airlines.

6.2. *Structural Model Estimates*

Table IV illustrates that BAPCPA more than doubled the cost of emerging from Chapter 11, raising it from $799 million to $1.7 billion. Upward adjustment costs are estimated to be around $170 million outside of bankruptcy and $631 under bankruptcy protection. Downward adjustment costs are about $1 billion outside of bankruptcy and $145 million under bankruptcy protection. However, it should be noted that other than the downward adjustment cost outside of bankruptcy, capacity adjustment costs are not tightly estimated. To put these figures in context, note that the median annualized cash flow across carriers is about $700 million. Note also that adjustment costs in my model are based on a change

TABLE III

DIFFERENCE-IN-DIFFERENCES RESULTS

Dependent Variable = Year-over-Year % Change in Fleet Size

Large	0.068
	(0.039)
Post BAPCPA	0.108
	(0.051)
Large X Post BAPCPA	-0.135
	(0.046)
Moving Average of Demand Growth	0.141
	(0.086)
Seasonal Fixed Effects	Yes
Type-Specific Fixed Effects (LEG, LCC, Other)	Yes
Type-Specific Linear Time Trend	Yes
Number of Observations	1,982

Note: Standard errors clustered at firm level and reported in parentheses below estimates.

of between 20 and 40 aircraft. Given a rough estimate[53] of $10 million per aircraft for early lease termination fees, adjustment costs in the hundreds of millions appear sensible, especially for downward adjustments outside of bankruptcy.

6.3. *Counterfactual Simulations*

Using the structural model estimates, I solve for two counterfactual equilibria. In the first, I simulate what would have happened had BAPCPA never been passed. In that scenario, I find a modest increase in industry capacity of about 5%, representing an estimate of the contribution of BAPCPA to observed capacity discipline. Though small in magnitude, the presence of any effect at all should give pause to bankruptcy law reformers. In his 2013

[53] per AMR Corporation's 2010 10-K

TABLE IV

STRUCTURAL PARAMETER ESTIMATES

(costs in millions of $2009)

Baseline Bankruptcy Emergence Cost	799
	(345)
BAPCPA Incremental Bankruptcy Emergence Cost	906
	(330)
Upward Adjustment Cost, Non-Bankruptcy	170
	(260)
Downward Adjustment Cost, Non-Bankruptcy	1061
	(285)
Upward Adjustment Cost, Bankruptcy	631
	(305)
Downward Adjustment Cost, Bankruptcy	145
	(523)
Scale Parameter	0.47
	(2.6)
Number of Observed Events	1184

Note: Bootstrapped standard errors in parentheses below estimates.

testimony before the American Bankruptcy Institute's Commission to Study the Reform of Chapter 11, bankruptcy expert and law professor Daniel Keating stressed policymakers to respect the potential for unintended consequences from tweaking the U.S. Bankruptcy Code.[54] As Congress considers future reforms to bankruptcy law, the influence of Chapter 11's non-financial provisions on investment behavior should be considered.

The second counterfactual simulates industry evolution through 2014, the final year of my capacity sample, as though the expected cost of Chapter 11 is infinite, effectively precluding reorganization as a downsizing option. I find that eliminating the Chapter 11 option reduces overall capacity by as much as 20% relative to its actual level, suggesting that the

[54] Wiese Niemeyer, Kelly. Kansas City infoZine, June 24, 2013. http://www.infozine.com/news/stories/op/storiesView/sid/56281/

malleability of contracts in bankruptcy has a significant inflationary effect on capacity. Given the steep adjustment cost associated with downsizing outside of bankruptcy, this result is not entirely surprising. That is, by reducing the level of commitment otherwise engendered by long-run contracts in the industry, the Chapter 11 option leads to greater equilibrium capacity.

6.4. *Conclusion*

The key takeaway of this paper is that bankruptcy law, specifically the provisions of Chapter 11, can influence oligopoly investment behavior. Moreover, this effect is distinct from the limited liability and strategic bankruptcy effects of Brander and Lewis (1986, 1988) and any capital-structure-related investment effects. I have developed a realistic, dynamic model that predicts capacity discipline as an outcome of stricter bankruptcy policy, and I have provided support for that prediction with rigorous, multifaceted empirical analysis and counterfactual simulation.

As the first paper to link the investment and reorganization decisions in a strategic setting, this work has a number of interesting extensions. Understanding how the airline industry has responded to bankruptcy reform is valuable in its own right, yet the framework used herein applies to any industry with heavily contractual investment and volatile demand. Steel, auto manufacturing, telecommunications, and even retail conform to this pattern. The capacity discipline engendered by a more creditor-friendly Chapter 11 should correlate positively with an industry's demand volatility and prevalence of long-term contracts. The degree to which this relationship applies beyond the airline industry is an open question, and one that would seem highly relevant for the study of industry dynamics, both within each relevant industry and in the broader macroeconomy.

From a policy perspective, this work and its extensions have important implications for bankruptcy lawmakers around the world. In the United States, bankruptcy reform is an area of active interest and policy discussion.[55] Understanding how BAPCPA has influenced

[55]For example, from 2011 to 2014, the American Bankruptcy Institute's Commission to Study the Reform of Chapter 11 heard testimony from legal experts in a variety of fields regarding whether and how the current U.S. Bankruptcy Code should be amended. Since that time, a number of legislative proposals addressing various aspects of insolvency policy have been brought forth in both houses of Congress, including the Small Business

equilibrium investment in capital should inform future legislative actions, especially those affecting large companies. Looking beyond the U.S., Halliday and Carruthers (2007), in their study of the globalization of corporate insolvency regimes, document a convergence in bankruptcy law over the previous two decades. The authors explain how international institutions, with significant U.S. support, have forged global norms, consequently influencing the lawmaking processes of transitional and developing countries. To the extent that U.S. practitioners and policymakers continue to contribute to global norm making, they must recognize how those norms may impact firm behavior, especially given the crucial role of capital investment for economic growth in developing economies.

Reorganization Act of 2019, which made Chapter 11 considerably more feasible as a tool for small businesses in financial distress, as well as a number of reforms to consumer bankruptcy.

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