Predatory pricing happens when a dominant firm prices its goods below cost with the purpose of driving out competition. This paper assesses the impact of price predation on consumers in the American airline market, using Spirit Airlines Inc. v. Northwest Airlines Inc. as the case study. Northwest Airlines was found guilty of conducting price predation against Spirit Airlines in 1996 for the routes Detroit-Boston and Detroit-Philadelphia. I find that Northwest's price predation lowers consumer surplus by driving competition out of the market, which reduces consumer choice and allows the surviving dominant company to raise its prices to recoup losses. I also predict that Northwest Airlines would be found guilty in other jurisdictions such as in New Zealand, Australia, the UK, and finally the US, after researching and summarising their legislations surrounding price predation and abuse of market power. I came to these conclusions by firstly calculating the total and variable costs of the airlines affected by the price predation with data publicly available from the Transtats database. I then estimated a demand model for the airline market. I also computed counterfactual Bertrand equilibrium prices for the two routes of interest. Finally, I calculated the changes in consumer surplus due to the price predation.

I. Introduction

Predatory pricing is a tactic used by dominant firms in a market to drive out competition. It has a long history; instances of the practice have been recorded in court for over a hundred years, starting with *Standard Oil Co. of New Jersey vs. United States* ("Standard Oil Co. of New Jersey vs. United States," 1911). In essence, the definition of predatory pricing is when a dominant firm prices its goods below cost with the purpose of driving out competition. It is generally agreed upon that price predation, by driving out competition, is detrimental to consumers in the long term. The event can also be used to scare other potential entrants from entering the market. With less competition, the surviving companies can then increase their prices and make supernormal profits. The consumers then are worse off after the price war ends because their consumer surplus reduces and deadweight loss in the market increases (Leslie, 2013). Predatory pricing is therefore illegal in most, if not all, countries. However, this is where the various legislatures diverge. The definition of dominant firm for example could emphasise market power or share or presence. The appropriate measure of cost could mean variable or total cost. Who has the burden of proving the purpose of the price cutting also changes according to the legislature. Because of this, it is important to know how price predation laws change around the world to get a deeper understanding of its definition and the circumstances that make up the situation.

The legal case that makes the core of this paper is *Spirit Airlines Inc. vs. Northwest Airlines Inc.* (*Spirit vs. Northwest*, with the parties referred to as Spirit and Northwest respectively henceforth). This case was between the two eponymous airlines. Spirt accused Northwest of predatory pricing during 1996 for the Detroit-Boston and Detroit-Philadelphia route markets ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005). This essay is split in several parts to explore this case and the effect of this price predation event on the consumer. First, the various definitions of predatory pricing are explored through the perspective of different jurisdictions. This includes a study of the legislation of New Zealand,

Australia, the United Kingdom, and finally the United States. Second, a regression is run, and consumer surpluses are calculated to evaluate the effect of the price predation. Data ranging from 1994 till 1998 in the Transtats database are compiled and analysed, especially the itinerary data from the DB1B database. Third, counterfactuals that help deepen understanding of the situation are investigated. Two counterfactuals are of note: the Bertrand equilibrium counterfactual, which assumes that all the airlines priced their fares according to the Bertrand equilibrium price, and the No Spirit Airlines counterfactual, which assumes that Spirit never entered the route markets in question. This paper comes to several conclusions. First, Northwest could be found guilty of price predation in all the jurisdictions studied, though there are variations in when and how. Second, the lack of competition in the routes before Spirit's arrival allowed the airlines in the routes to exploit customers by charging above competitive fares and make supernormal levels of profit. Third, by driving Spirit away, Northwest's price predation behaviour was detrimental to consumers in the long term as it allowed them to raise fares back to above competitive levels.

II. Literature review

A. Market reactions to entries

New firms entering a market often pose a threat to established companies, especially in markets that were not particularly competitive. This is because competition can lower the market price and reduce established companies' market share, number of customers, and therefore profitability. Predatory pricing is then one of many reactions and strategies employed by established companies to mitigate their losses. The method they choose are dependent on a few factors. For example, Ailawadi et al. (2010) found that the salient factors that determined an incumbent retailer's reaction to a Wal-Mart entering their area include their vulnerability and size, how valuable the market is, and whether the incumbent can successfully retaliate.

In general, according to Gatignon et al. (2018), incumbent firms have three possible strategies against new entrants: fight back, withdraw, or change nothing. Incumbents fight back because of two reasons: they focus more on market share than profitability, or they were underperforming, and the entrant company made them realise that. Withdrawal happens when the incumbents do not know how to fight back, know they cannot fight back, or because it is the profit maximising move for them. Incumbent firms might do nothing if they do not see the newcomer as a threat. The authors also suggest that the incumbent's reactions are predictable, based on the elasticity of their marketing strategies such as offering discounts. If the marketing strategy is elastic (a small effort will have a big effect), the firm will fight back. If the marketing strategy is inelastic (a big effort will have a small effect), the firm will withdraw.

There is also a fourth strategy, as pointed out by Paul Klemperer. Instead of making it expensive for the entrant to enter the market, the incumbent makes it expensive for their customers to switch

providers. For example, a bank or a telecommunications company might charge cancellation fees or a technology company might create an 'ecosystem' where it is difficult to integrate a product from a different firm. Other ways firms can increase switching costs include making the software very convenient to use or so difficult to use and learn people become afraid to learn how to use another one. This strategy is somewhat risky. If a company makes it too costly for consumers to switch, it could scare off potential customers. The company is then heavily reliant on repeat customers and their goodwill. For a company to use this strategy, they must be a vast company with an extremely big customer base and become the industry standard. This strategy works best in a monopoly scenario (Klemperer, 1987).

In scenario where a company is trying to enter a monopoly market, Miguel Ropero identified two further strategies incumbents can use to discourage market entry. First, the incumbent might reduce the quantity supplied to what it would be if entry was not profitable. This scenario works if information on market price is noisy, the cost of entry high, and the products the two firms make are substitutes. That way, the incumbent tricks the new company into thinking they would lose money entering the market. Second, the incumbent might increase the price to reduce the quantity sold to hide market information. This scenario tends to happen when the firms' products are differentiated (Ropero, 2020).

There is also specific literature regarding the reaction to entries and exits in the airline industry. A case study that has been of particular interest to economists has been Southwest Airline's entry into Washington Dulles International Airport (Dulles). Many perspectives were investigated. For example, Austan Goolsbee and Chad Syverson found that incumbents at Dulles dropped their fares even before Southwest entered. They classed this as a response to a threat and they theorised the airlines did it to reduce market share loss (Goolsbee & Syverson, 2008).

Chao Ma added to their study by focusing on the behaviour differences between airlines that are financially heavily leveraged (or in debt) versus those who are not as leveraged. Ma found that companies change their tactics to new entrants in the market in different ways depending on their debt levels. An airline with low financial leverage or debt levels, for instance, would cut fares as soon as a threat is detected because they have the means to do so and maintaining customer loyalty is the higher priority. Airlines with high financial leverage, on the other hand, could not afford to cut into profitability until they must because of their interest payments. A threat of entry did not take away their customers nor affect their market share, so they did nothing. Once Southwest entered and took away their market share. However, the highly indebted airline behaved far more aggressively. They did this to increase cash flow so they can fulfil their debt obligations (Ma, 2019).

John Kwoka and Birzhan Batkeyev also pointed out that the reduction in price can be used as a threat in and of itself. Incumbents, even those who are not going to directly compete with Southwest, might reduce their prices to discourage Southwest from directly competing with them. However, legacy airlines (airlines that was founded before the Airline Deregulation Act of 1978 came into effect) did not

see each other as major threats, so incumbent legacy airlines tended to accommodate each other (Kwoka & Batkeyev, 2018).

It is then easy to see that if the incumbent feels particularly threatened by an entry into the market, they would be particularly aggressive in cutting prices. If the price cuts become unlawfully aggressive, it enters the realm of predatory pricing.

B. Predatory pricing

Economic studies on predatory pricing tend to focus on law cases. This is not surprising. Instances of predatory pricing are hard to detect until it is actively brought up in the courts due to the lack of availability of public data on private companies. Indeed, the lack of actual instances of predatory pricing economists can study has led to people wondering just how often predatory pricing happens. Kenneth Elzinga for instance once asked the American Bar Association in a speech whether predatory pricing was, "rare like a unicorn." (Wright & Stone, 2012). The answer is unknown, with the most obvious reason for that being not all predatory companies are taken to court. However, some, like Ho Cheng, also believe that predatory pricing happens more often than most people suspect, and that the current laws on predatory pricing do not capture enough instances (Cheng, 2020).

Two famous economists that studied price predation are Phillip Areeda and Donald Turner. They are the people that gave their name to the Areeda-Turner test: if a company is pricing a product below average variable cost (AVC), it is a strong indicator of a predatory pricing scheme. This is because AVC is a good substitute for marginal cost and when price is at marginal cost, there is a competitive market. If the price is any lower, then the company would make a loss for every product sold. As detailed later in this paper, their test proved very popular in courts, especially in the United States. Areeda and Turner's 1975 paper is also unique in that they explain using economic models the market conditions that would encourage predatory pricing. They believe that monopolistic conditions provide fertile ground for predatory pricing for two reasons. First, high cost of entry means it is difficult for new firms to enter a market. Incumbents in a monopoly market have often entered back when the market was small enough not to have competition or had government help. Once they reach a certain size, it then becomes harder for newcomers to raise enough capital to compete. Second, established companies in monopoly markets tend to have low variable, or running, cost compared to total cost. This means it becomes cheaper to drive away competition than for competition to stay in the market and the reward for successfully driving away competition is higher compared to other market conditions. If a dominant company can drive competition away from the market, they can then charge supracompetitive prices afterwards (Areeda & Turner, 1975).

C. Predatory pricing and airlines

Airlines are particularly conducive to predatory pricing practices. As pointed out by Brady and Cunningham, airlines have a particularly high fixed cost to variable cost ratio. This means it becomes much easier for incumbents to drive out newcomers. While the incumbents only need to worry about meeting variable costs in the short term, as they have already paid the fixed costs needed to run the company, newcomers must quickly earn revenue to pay for costs such as new planes. Incumbents also usually have other routes they are servicing, which means they can offset losses by raising the prices of the other routes. The incumbent can therefore set their prices in a way that it makes it unviable for newcomers to stay in the market. They can then, with reduced competition, set the airfares much higher to recoup losses. This explains why there are many court cases for price predations in the airline industry (Brady & Cunningham, 2001).

There are two cases of note for predatory pricing in airlines in the United States: *US v. AMR Corporation* ("U.S. vs. AMR Corp.," 2003), and *Spirit v. Northwest* ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005). Both cases support the Areeda-Turner test because it is difficult for an outsider to calculate marginal cost; however, it is possible to calculate AVC from a detailed enough financial statement (Areeda & Turner, 1975). Furthermore, as John McGee has pointed out, predatory intent is difficult to confirm (save for the rare instance the motive was clearly recorded) so motive must be inferred from the action (McGee, 1980).

Papers that use economic models to calculate the impact of an airline price predation case are rare, one of which is written by Snider (2009), which focuses on *US v AMR Corporation*. In that paper, the author proposes an alternative to the Areeda-Turner test due to the difference in cost structures between incumbent and newcomer airlines as discussed above. The paper also simulates a scenario where Department of Transportation's "fair competition guidelines" were in place at the time of the predatory pricing, and from there, calculates the loss of consumer surplus and the damages to the driven-out newcomer caused by the predatory practices. This paper aims to do something similar, except focused on *Spirit vs. Northwest.*

III. Predatory pricing: a legal definition

Before studying a case of price predation, it would be useful to understand what exactly price predation is. It would come as no surprise then that many countries have taken steps to limit price predation and each of them have done so in subtly different ways as they try to balance between protecting smaller companies and allowing highly competitive behaviour. However, the courts must be careful when defining what predatory pricing is. Too broad, and the courts would be in an anti-competitive manner protecting companies that are failing due to its own faults (McGee, 1980). Too strict, and genuine price predation would be missed. (Cheng, 2020). This is where economics comes in. One of the jobs of the economist is to promote and quantify social welfare, by extension, the wellbeing of consumers. Predatory pricing, as mentioned above and elaborated below, is detrimental to consumers as it reduces competition and consumer surplus in the long term. Therefore, many of the economists above have taken an interest in the legislation surrounding predatory pricing. Legislators also take an interest in the economics surrounding the issue, as it is in their interest to know whether the law is working as intended. Economics, despite being considered a separate sphere of knowledge from law, plays a not insignificant part in helping shape competition law.

This section intends to provide a summary of legislation surrounding predatory pricing worldwide. It helps provide context to the economic analysis afterwards, as it defines the exact triggers and scenarios that labels an event a 'price predation event'. It will however not critique the effectiveness of the legislations using economic models, as that is outside the scope of the paper.

A. Australia and New Zealand

New Zealand

New Zealand does not have legislation against predatory pricing per se. Rather, it falls under s 36 of the Commerce Act 1986. That section, summarised, states that no parties may take advantage of their market power to prevent competitive behaviour. This includes, "Eliminating a person from that or any other market." The courts in New Zealand have interpreted predatory pricing to fall under this section. The main cases are *Carter Holt Harvey Building Products Group Ltd v. The Commerce Commission* ("Carter Holt Harvey Building Products Group Ltd vs. Commerce Commission," 2006) (CHH case) and *Port Nelson Ltd v. Commerce Commission* ("Port Nelson Ltd v. Commerce Commission," 1996) (Port Nelson case).

In summary, both cases deal with companies that have significant market power. Carter Holt Harvey (CHH) was the dominant supplier of housing insulation in New Zealand and Port Nelson Ltd ran commercial operations in Port Nelson. Both companies had offered significant discounts to their customers in response to a competitor entering the market, with CHH doing below variable cost pricing on wool insulation and Port Nelson 5% discounts for all services. CHH had also entered into distribution agreements, in which they are the preferred supplier, with major chain stores. The judges did not find price predation against CHH, but they did find it with Port Nelson.

From the two cases, it can be discerned what is needed to be found guilty of price predation in New Zealand. First, the claimant needs to prove that the defendant is a dominant company in the market. The definition of a dominant company is defined in the Port Nelson case as a company that has a, “dominant influence over production, acquisition, supply or price of goods or services in that market.” ("Port Nelson Ltd v. Commerce Commission," 1996) CHH for instance was the dominant company due to its overwhelming market share for general housing insulation ("Carter Holt Harvey Building Products Group Ltd vs. Commerce Commission," 2006) and Port Nelson being the administrative body of the port ("Port Nelson Ltd v. Commerce Commission," 1996).

Second, the claimant needs to prove that the defendant abused their market power. The Privy Council ultimately did not find CHH to have conducted predatory pricing because they were not convinced they were abusing their market powers, with acts such as raising prices to supracompetitive levels after the competition had left. They emphasised that just because anticompetitive behaviour was present it does not mean the company was using their dominate market power to facilitate the behaviour. In the same case, they applied a test from *Telecom Corporation of New Zealand Ltd v. Clear Communications Ltd* (Telecom case) to see if the company was improperly using their market power: would the dominant firm act in the same way if they were a non-dominant firm in a competitive market? If yes, then the firm is said to not have used their market power. They also stated that there must be a direct and causal link between market power and the conduct of the dominant party ("Carter Holt Harvey Building Products Group Ltd vs. Commerce Commission," 2006).

With the Port Nelson case, on the other hand, the judges have found that Port Nelson did use their market power to deliberately reduce competition in the market via price predation. This was because Port Nelson used their situation as a company that can provide all the necessary services to an incoming ship to offer substantial discounts to anyone who used all of their services. In addition, their piloting charges was set below cost, subsidised by Port Nelson’s other activities. Their competition on the other hand could only offer piloting and tugging services, and therefore cannot entice customers

like Port Nelson can. Furthermore, Port Nelson denied their competition use of their tugboats while mandating that any ships above a certain length that come into port must be tugged in. Their competition had to then get low-capacity tugboats from another supplier, which then denied them entry into the market for higher capacity ships. These acts were seen as an abuse of market power ("Port Nelson Ltd v. Commerce Commission," 1996).

Australia

For Australians, the keystone case for predatory pricing is *Boral Besser Masonry Ltd (now Boral Masonry Ltd) vs. Australian Competition and Consumer Commission (ACCC)* (Boral case). In this case, Boral Besser was accused of predatory pricing behaviours in the block laying market. The High Court of Australia stated that the elements for predatory pricing is evidence of market power and proof that the party used said market power to drive away competition through a price war. The High Court then did not find Boral to have conducted predatory pricing because they were not convinced Boral Besser had substantial market power. They were quick to also point out that, "Financial strength is not market power." They defined market power as, "absence of constraint from the conduct of competitors or customers," with "the ability to target an outsider without fear of competitive reprisals from an established firm, and to raise prices again later." In other words, a company with market power is not influenced by their rivals' or customers' behaviours, and if they conduct a price war, other companies will not join in, and they can increase prices later to recoup their losses without losing market share ("Boral Besser Masonry Ltd (now Boral Masonry Ltd) vs. Australian Competition and Consumer Commission (ACCC)," 2002).

Australia has more recently refined how price predation is defined in the legislation. A recent amendment for example is section 46 of the Competition And Consumer Act 2010. That section states that "A corporation that has a substantial degree of power in a market must not engage in conduct that has the purpose, or has or is likely to have the effect, of substantially lessening competition…" (Australian Government, 2021) This legislation was then applied in a more recent predatory pricing case: *B&K Holdings (Qld) Pty Ltd vs. Garmin Australasia Pty Ltd*. In short, B&K was the exclusive distributor of Garmin, a large company with a substantial degree of market power, products in Australia. This relationship broke down. B&K later accused Garmin, amongst other things, of price predation because Garmin started selling their products directly to B&K's former customers at a price lower than what they were selling them at to B&K. This case only had a summary judgement and it concluded that B&K had a probable case of predatory pricing against Garmin. This was because Garmin could not conclusively prove that they were not trying to drive B&K out of the market with their actions ("B&K Holdings (Qld) Pty Ltd vs. Garmin Australasia Pty Ltd.," 2019).

It is important to note that Australia legislators had a debate on what the definition of dominant firms is. Prior to the Competition and Consumer Act, Australia had the Trade Practices Act 1974 which for a time contained the infamous 'Birdsville Amendment'. That amendment added subsection 46 (1AA) to the Trade Practices Act. The subsection expressly forbade any firms with "substantial share of a market" from supplying goods and services below cost for an extended period for the purpose of lessening competition. In other words, in the context of price predation, the definition of dominant firms was for a time extended to include consideration of market share (Australian Government, 2010). Whether the definition of dominant firm will change again in Australia is unknown, but it seems the Competition and Consumer Act is stable for the moment.

The difference between Australia and New Zealand

Due to the closeness of the trans-Tasman relationship, there is specific legislation dealing with abuse of market power, and by extension predatory pricing, between the two countries. In New Zealand, trans-Tasman predatory pricing is covered by s 36A of the Commerce Act 1986 (New Zealand Government, 2022), while in Australia it is s 46A of Competition and Consumer Act 2010 (Australian Government, 2021). Despite this, there is a slight difference between how the different jurisdictions treat predatory pricing.

It must be noted that Australia's threshold for finding predatory pricing behaviour is lower than New Zealand's. First, the position of the company in the market must be stronger in New Zealand than in Australia. In New Zealand, the company must be powerful enough to have a dominating influence in the market, such as being able to set the market price. In Australia, it is merely sufficient that the company itself is not influenced by market forces. They do not need to be able to set the market price. Second, New Zealand has the test as stated above from the CHH case (would the dominant firm act in the same way if they were non-dominant in a competitive market?). Australia on the other hand only needs to find if market power has been abused. It is therefore possible to have a case where predatory pricing is found in an Australian court but not in a New Zealand one. For example, the CHH case. It would be reasonable for any competitive company to enter a price war and use any market advantage and relationship it has. However, what is a reasonable price war in New Zealand could become predatory pricing in Australia *because* of the company's dominant market power.

As the dissenting judgement in the CHH case has noted, CHH was able to do below-cost pricing in wool insulation because wool insulation was not their main business. CHH's main business was fibreglass insulation (called Pink Batts), which heavily dominated the New Zealand insulation market. They entered the price war with their wool-based competition because their competition was threatening

the fibreglass insulation business. The dissenting judges then concluded CHH entered the price war with the explicit purpose to drive out their wool-based competitors. It also explained to them why CHH did not raise the price of wool insulation after their competition has left the market, as CHH essentially sacrificed their wool insulation business to save their fibreglass insulation business ("Carter Holt Harvey Building Products Group Ltd vs. Commerce Commission," 2006). Tellingly, CHH's Wool Line no longer exists on the market and any internet results related to the product relates back to the case.

The line from the judgement stating that CHH did not abuse its market powers because it did not intend to charge "supracompetitive prices at a later date on that or any other of its products," is also somewhat problematic. This is because, as noted by Professor Lattimore in the case, CHH was already charging supracompetitive prices for insulation before the price war. CHH had put a high profit margin on their fibreglass insulation well before the price war happened and said margin did not change throughout the events in the case. Wool Line only existed to defend Pink Batt's market share so that CHH can continue charging supernormal profit margins on it, and CHH did not need to change Pink Batt's profit margins to recoup losses ("Carter Holt Harvey Building Products Group Ltd vs. Commerce Commission," 2006).

CHH's behaviour might not be as well received in the Australian courts, as it can be seen a use of market power to drive competition out. CHH at the time was almost the monopoly company in the house insulation market, so they had market power. The Court of Appeal did note that CHH may have used the sales from their fibreglass insulation, of which they are getting supernormal profits *because* of their market power, to fund the price war. Therefore, it can be argued that CHH used their market power to subsidise a price war that would not have gone for as long as it did had they not had market dominance with another product bringing in supernormal profit. It is then more likely than not CHH would be found guilty of predatory pricing in Australia.

It must be noted that due to the strong trans-Tasman business community, and the fact that Australia has been working on predatory pricing legislation far more recently than New Zealand, the New Zealand courts might change their stances on how predatory pricing is treated to better match Australia.

B. United Kingdom and United States

How New Zealand treats cases from the United Kingdom and United States

The next two subsections deal with predatory pricing in the United Kingdom and United States. They are added to this dissertation because, besides *Spirit v. Northwest* being an American law case, both jurisdictions' cases on competition law are actively considered in New Zealand courts. A good example is the case *Telecom Corporation of New Zealand Ltd v. Commerce Commission*. In that case, Telecom was accused of price squeezing, or charging too much for services their competition required. As Telecom owned the telecommunications network at the time for the whole of New Zealand, any telecommunications company that wish to operate in the same country must buy services from them.

For part of that case, the Court of Appeal considered whether price squeezing falls under predatory pricing. Telecom submitted the arguments that following American cases, price squeezing is a type of predatory pricing and their behaviour did not fit the definition of predatory pricing. The Court decided that price squeezing was not predatory pricing for the following reasons. First, United States legislation does not specifically cover price squeezing under competition law for telecommunication companies because they have specific industry regulation for it, and the courts there do not feel the need to apply general competition law on top of the regulations. When Telecom was conducting their price squeeze, they had no regulation concerning wholesale prices to competition. This made applying American law to the case problematic. Second, they agreed with the European Union in that price squeezes are more of an investment issue rather than a competition issue. Price squeezes prevent outside competition from investing in the market properly because they are not able to provide the services needed to their customers at a competitive price. As a result, the competition cannot gain enough customers to justify infrastructure investment to no longer rely on Telecom. By overpricing their wholesale services, Telecom was setting up competition for guaranteed failure, even if they were just as or more efficient than Telecom. However, the Court acknowledged they also cannot blindly follow European Union law because the market conditions are different. For example, European monopolies have an obligation to assist their competitors, while New Zealand monopolies do not. If the competition failed because they were less efficient than the monopoly, New Zealand courts will not help them. This case however does not comment whether competition law would still apply in conjunction with industry regulation (following the European Union) or not (following the United States) ("Telecom Corporation of New Zealand Ltd vs. Commerce Commission," 2012).

Considering that both the United Kingdom and the United States have developed their predatory pricing regulation and legislation more than New Zealand has, it is highly likely that the next New Zealand predatory pricing case will rely heavily on the other two countries' guidance. It is therefore important to understand how predatory pricing is treated in those two jurisdictions, as they indicate the direction New Zealand might go.

The United Kingdom context

Pre-Brexit in 2020, the United Kingdom followed the EU's regulations and rulings regarding predatory pricing. This was reflected in Chapter II section 18 of the Competition Act 1998. That section states that parties in a dominant position cannot, "directly or indirectly [impose] unfair purchase or selling prices or other unfair trading conditions." There have not been any major developments in competition law as of writing since then. The two recent predatory pricing cases of note are *Napp Pharmaceutical Holdings Ltd and others vs. Director General of Fair Trading* ("Napp Pharmaceutical Holdings Ltd and others vs. Director General of Fair Trading," 2002) (Napp case) and *Royal Mail plc vs. Office of Communications and another* ("Royal Mail plc vs. Office of Communications and another," 2021) (Royal Mail case). Both focused heavily on abuse of market power by the dominant firm.

Napp Pharmaceutical Holdings Ltd (Napp) was a manufacturer of a sustained release morphine tablet (SRM). Because Napp held the patent of the sustained release mechanism of the tablet, they were the dominant supplier of morphine tablets. They supplied two distinct markets: chemists and hospitals. Due to the nature of the markets, Napp was able to impose significant profit margins on chemists while giving hospitals a marked discount. This was because doctors were reluctant to prescribe a different pain-relieving drug due to Napp's perceived superiority and the fact that patients were already taking Napp's SRM whilst in hospital. If the patient was already taking one pain-relieving drug and it is shown to work, the doctors are usually reluctant to change the drug regime. This makes the chemist market price insensitive. Meanwhile, Napp was able to use the surplus profits from their chemist market to subsidise the discounts given to hospitals, who are by contrast extremely price sensitive. As a result, Napp was accused of predatory pricing in the hospital market. The Court of Appeal held that Napp did abuse its market powers and had conducted predatory pricing. It then affirmed a definition for abuse of market power: a company is guilty if they, "reap trading benefits that would not have been available to it in conditions of normal competition." ("Napp Pharmaceutical Holdings Ltd and others vs. Director General of Fair Trading," 2002)

The Royal Mail was a state-owned postal service. They enjoyed statutory monopoly regarding the postal service until competition was finally allowed in 2006. Whistl was one of their first competitors. Whistl had to initially rely on the Royal Mail for some of their deliveries. The Royal Mail in response decided to inflate the price of the service Whistl was relying on. Internal documents indicated that the Royal Mail was planning the new pricing model to drive Whistle out of the market, and afterwards hired an economic consulting firm to find reasons to justify the price increase. The judges did find the Royal Mail guilty of margin squeezing. Although this case is not about predatory pricing per se, it did have some important statements regarding the as-efficient competitor (AEC) test. The AEC test is applied to see if a dominant company abused their market power. If it can be determined

that a non-dominant company with the same costs could not have offered the same prices as the dominant company, the dominant company has abused their market powers and have most likely committed price predation ("Royal Mail plc vs. Office of Communications and another," 2021).

The United States context

Predatory pricing has been an issue in the United States for over a century now. This is a situation where a company with dominant market power deliberately under-prices with the intent of driving market entrants out. When the entrant has left the market, the remaining dominant company is then able to raise prices and recoup its losses. One of the earliest instances of a price predation court case was recorded in 1911, with the state of New Jersey prosecuting Standard Oil ("Standard Oil Co. of New Jersey vs. United States," 1911). Since then, other large companies have also been accused of this anti-competitive practice. All these cases culminated with the case *Brooke Group Ltd v Brown & Williamson Tobacco Corp*. In this case the judges have set down the test of which other predation cases are to be measured against: that the "plaintiff must prove (1) that the prices complained of are below an appropriate measure of its rival's costs and (2) that the competitor had a reasonable prospect of recouping its investment in below-cost prices" ("Brooke Group Ltd. vs. Brown & Williamson Tobacco Corp.," 1993). Predatory pricing is made illegal under section 2 of the Sherman Act 1890. The section states that it is illegal to, "monopolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce among the several States, or with foreign nations…"

Background to *Spirit vs. Northwest*

Spirit Airlines is a budget carrier which was founded in 1990 in Michigan. Its target market are leisure travellers who are very price sensitive. As such they offer parred down services with many restrictions on their tickets, such as having no first class, refunds, or loyalty programmes, in exchange for the low fare. With an operating revenue of approximately $53.6 million in 1995 (Bureau of Transportation Statistics, 2021a), it was back then considered a small player, especially in the Michigan area. Northwest was in many ways the opposite to Spirit. It was founded in 1926, before the Airline Deregulation Act was passed, which made it a legacy carrier. It also provided a full range of services, but as a result, its fares were consistently more expensive than Spirit's. It was also significantly bigger, with an operating revenue of $8.91 billion in 1995 (Bureau of Transportation Statistics, 2021a) and considered the fourth largest passenger airline in the United States ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005).

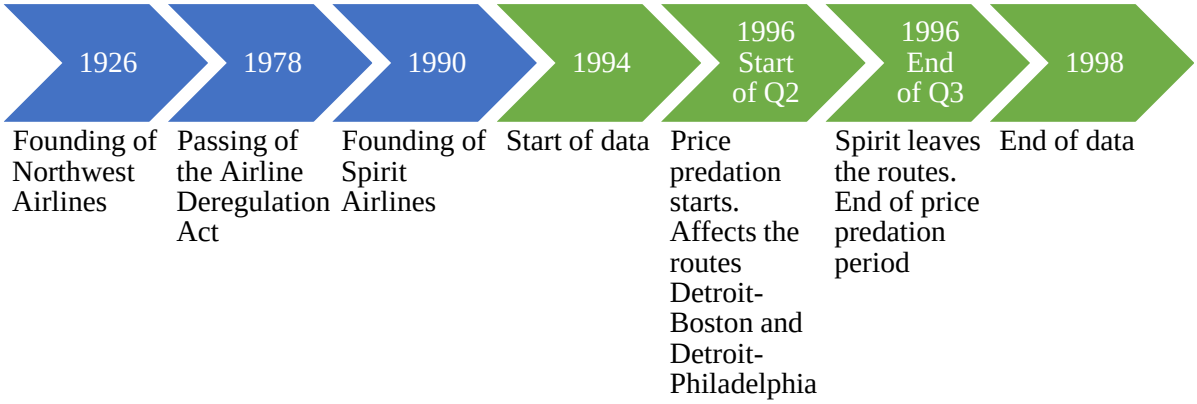
Before Spirit entered those routes, Northwest's lowest restricted fare for the Detroit-Philadelphia route was $125 and the Detroit-Boston route $189 each way. This was in line with their main competitor US Airways. They also had the biggest market share for the routes: 72% and 89% respectively. This quickly changed in April 1996. Spirit had by then entered the market and was achieving 88% load factor; that is, 88% of their seats in those routes were being sold. Northwest then started to drastically lower their fares to compete. They first discounted the Boston-Detroit route until it bottomed out at $69 each way. They then did the same to the Philadelphia-Detroit route, with fares reaching as low as $49 each way. Unable to compete, Spirit left the Philadelphia-Detroit route at the end of September 1996. Northwest then proceeded to increase their lowest fare for that route, first to $139 at the end of October 1996 and then to $208 each way in April 1998. Spirit also left the Boston-Detroit route at the start of September 1996 due to its losses. ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005).

Spirit Airlines eventually took Northwest Airlines to court for predatory pricing. Initially, Spirit lost in the District Court because the District Court did not think that Spirit gave enough evidence to prove that the price-sensitive passenger market existed. As a result, they were unable to prove that Northwest failed the Areeda-Turner test because the average fare included those who were not price sensitive. In the Court of Appeals however, the judges were convinced of the existence of the price sensitive passenger market and therefore found Northwest guilty of price predation. The case also supported a modified version of the Areeda-Turner test from *D.E. Rogers Associates, Inc vs. Gardner–Denver Co.* As stated by Judge Boyce F. Martin, "If the defendant's prices were below average total cost but above average variable cost, the plaintiff bears the burden of showing defendant's pricing was predatory. If, however, the plaintiff proves that the defendant's prices were below average variable cost, the plaintiff has established a prima facie case of predatory pricing and the burden shifts to the defendant to prove that the prices were justified without regard to any anticipated destructive effect they might have on competitors.*"*("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005)

To investigate the effect of the price predation event, the years 1994 till 1998 are investigated. The predatory pricing event essentially spanned the second and third quarter of 1996; the two years prior and after are used as baselines. All of the data has come from the Transtat website, which is run by the Department of Transport in the United States.

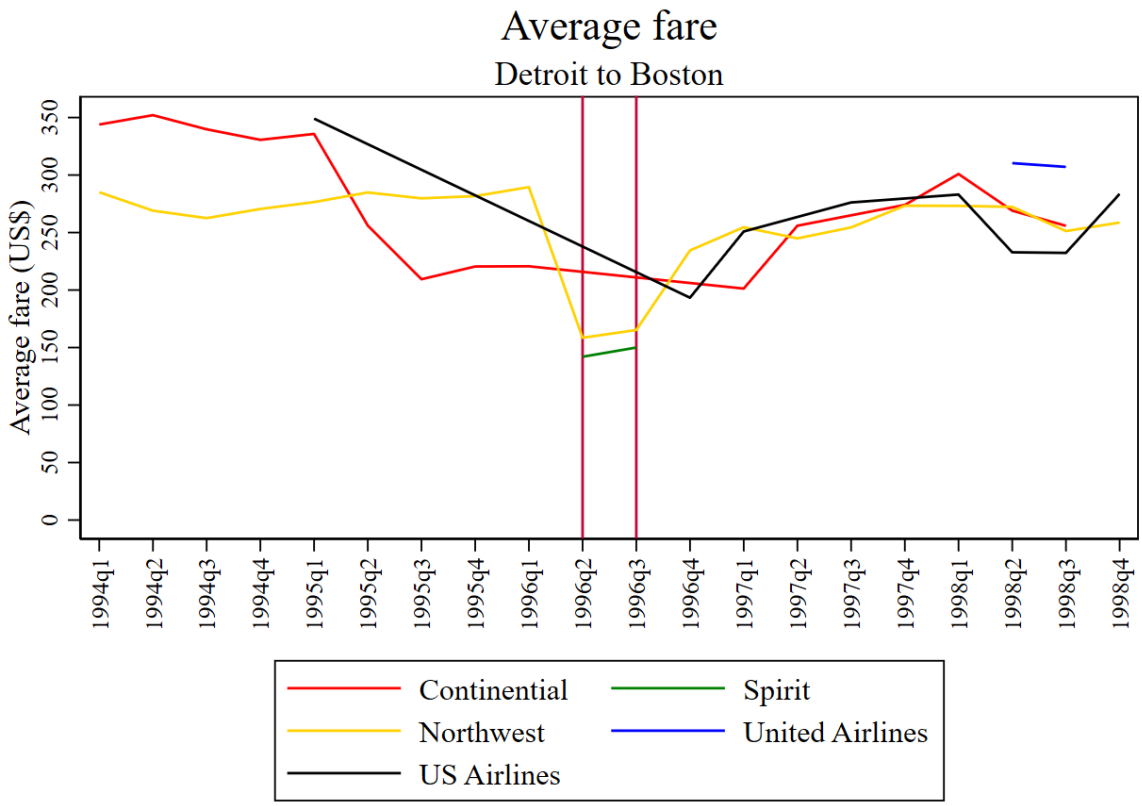
IV. Empirical study

A. Timeline of events



The data for the graphs below is completely taken from the Airline Origin and Destination Survey (DB1B) dataset. This dataset is a 10% random sample of all the airline itineraries in America every quarter. It includes details of each itinerary, such as origin and destination airports, fare, and fare class (Bureau Of Transportation Statistics, 2021c). The dataset was first downloaded, and then any fares that was more than $450 roundtrip was deleted. This is because economist and expert witness Dr Kaplan had worked out in *Spirit vs. Northwest* that the fare was the line between price sensitive passengers and other passengers. These passengers are unique in that they have little to no brand loyalty and their biggest concern is price. They do not care which airline they fly, as long as it is the cheapest seat and they get to their destination safely and on time ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005). Any itineraries that are free (e.g. bought with air miles) are also deleted as they in theory have infinite demand. Only economy fares and roundtrips are kept for consistency of the market, unless it is Spirit as they only do one-way itineraries, in which case their fares were doubled. Finally, the flights were aggregated by route, ticketing airline, number of coupons (how many flights it took to get to its destination) (coupons), and year and quarter. Any airline that had less than 0.05% share of any given route is deleted.

The graphs below give a summary of the situation prior to, during, and after the price predation period. 'Total passengers' is calculated by adding up all the price sensitive passengers in a route during a quarter for an airline. 'Average fare' is the airline's average fare for the route in the quarter. The red vertical lines indicate the price predation period as set out by the case. Graphs for the reverse routes can be seen in Appendix A1.


Average fare
Detroit to Boston
Average fare (US$)
0
50
100
150
200
250
300
350
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
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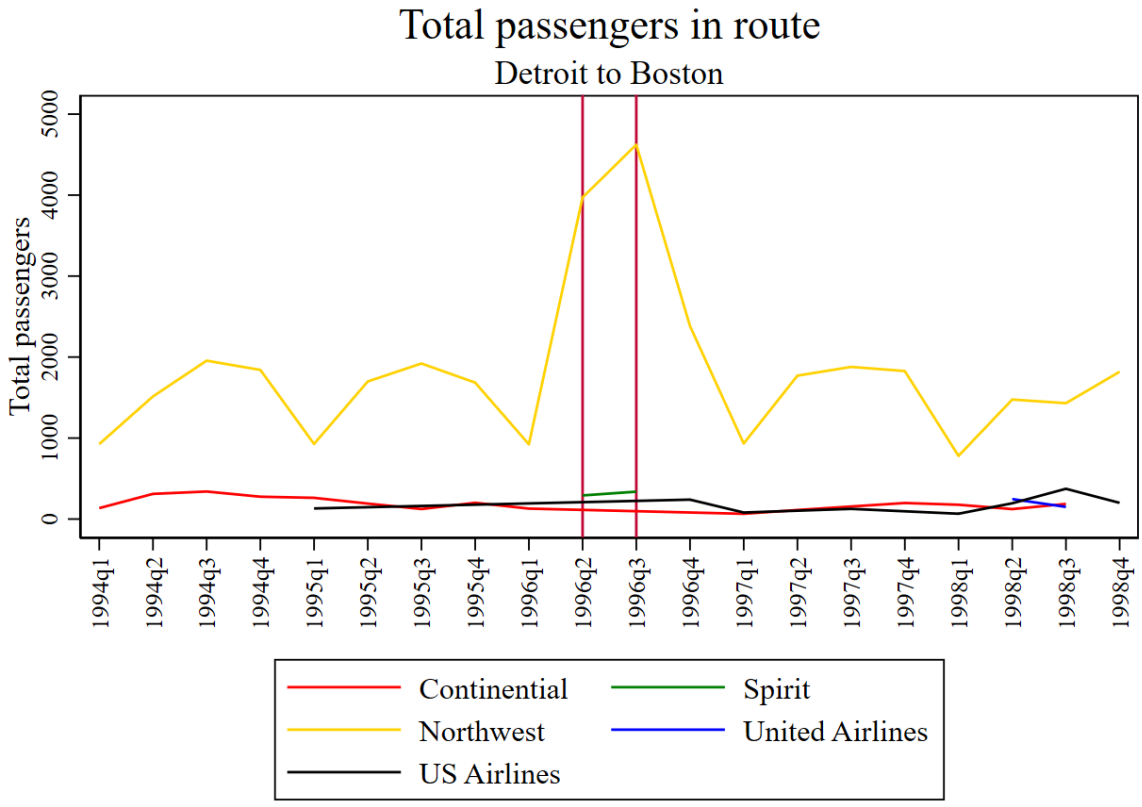
1998q1
1998q2
1998q3
1998q4
Continential
Northwest
US Airlines
Spirit
United Airlines


Total passengers in route
Detroit to Boston
Total passengers
0
1000
2000
3000
4000
5000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
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1998q1
1998q2
1998q3
1998q4
Continential
Northwest
US Airlines
Spirit
United Airlines

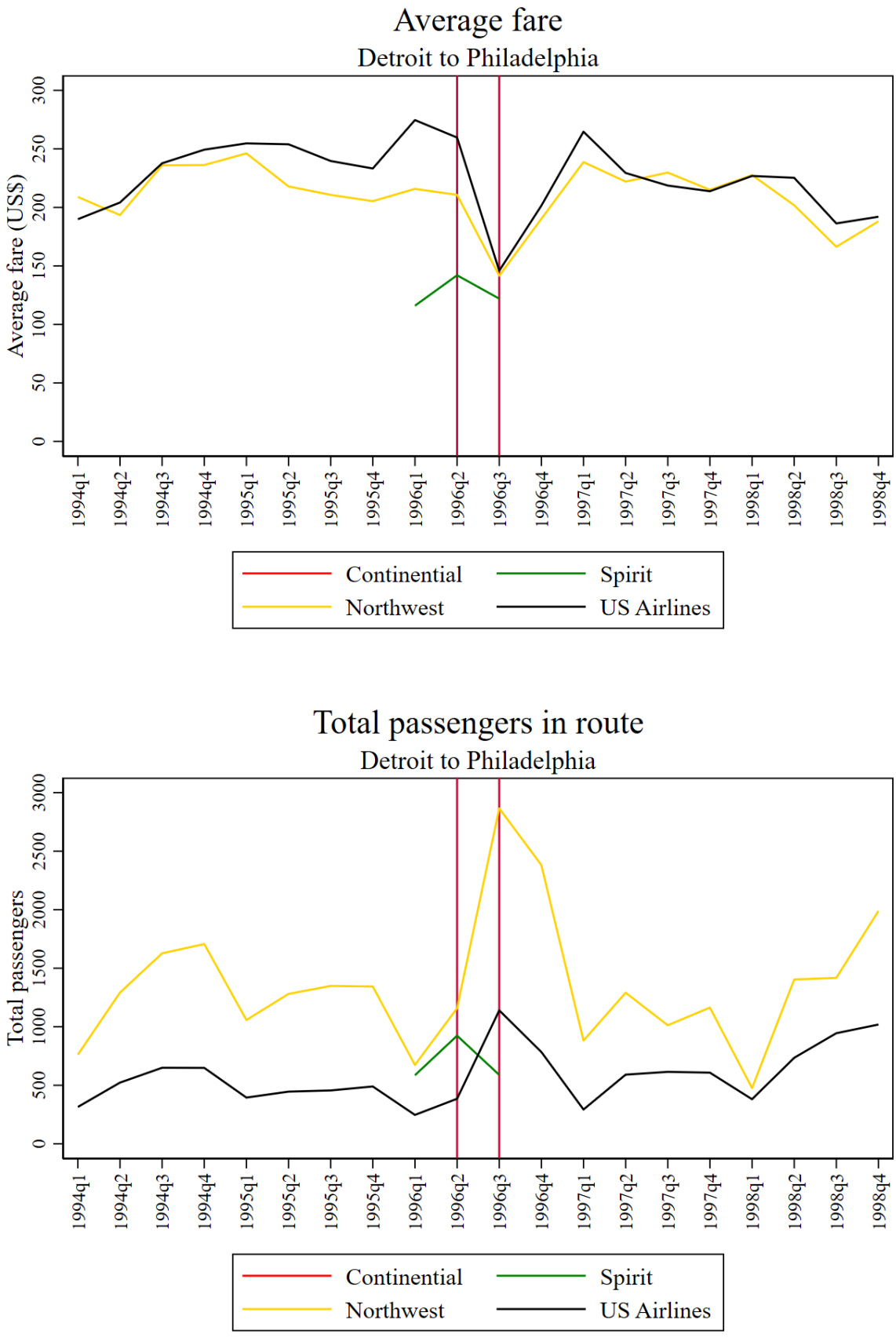


Figure 1. summary graphs for Detroit-Boston and Detroit-Philadelphia routes.

B. How variable cost was calculated

Variable cost is defined in this paper as operating costs: additional expenses the airline must spend to put up one more flight. This includes salaries, landing fees, and maintenance costs. The data comes from schedule P6 from Transtats (Bureau Of Transportation Statistics, 2021b). Total variable cost for the airline is calculated by adding up all the operating costs, and then divided by number of revenue (paid for seat) miles the airline has flown in that quarter to find the average variable cost per mile (Bureau Of Transportation Statistics, 2022). Variable cost per route is then derived by multiplying average variable cost per mile by the number of revenue miles in that route.

C. How total cost was calculated

In this paper, total cost is calculated using schedule P1.2 from Transtats (Bureau of Transportation Statistics, 2021a) and is defined as total operating cost plus total non-operating costs in that quarter. Non-operating costs encompasses indirect expenses, including building maintenance and debt servicing. Average total cost per mile is then calculated by dividing the total cost by the total number of revenue miles flown by the airline in that quarter. Total cost per route is then derived as multiplying average total cost per mile by the number of revenue miles in that route.

D. Major costs assumption

A major assumption made in the paper is that the costs per mile for an airline is the same across all their routes. This can be problematic as some routes are more expensive per mile than others. For example, some airports charge higher landing fees than others. Spirit only offers one-way tickets while roundtrip tickets (the dominant type of tickets) are used for all other airlines. To make the costs of one-way and roundtrip tickets comparable, Spirit's costs per route is doubled.

E. How the demand curve was estimated

This paper uses the logit demand model following Berry (1994). This is derived from a discrete choice model. The general equation for average utility is

$$\bar{u}_{ij} = x_j\bar{\beta} - \alpha p_j + \xi_j + \epsilon_{ij}$$

with i representing the consumer and j the product (airline and route), $x_j\bar{\beta}$ and αp_j observable product characteristics, and ξ_j unobservable product characteristics. It is assumed that all consumers of a product (the itinerary) have the same utility in a given time period .

This paper also assumes the utility specification

$$u_i = -\alpha price_j + \beta_1 year_{quarter} + \beta_3 coupons_j + \beta_4 distance_j + \epsilon_{ij}$$

The observable product characteristics in this case are average fare, coupons, and distance of the route. The time effects and quarters are also considered. As the same utility function is used for all periods, the subscript t is omitted for simplicity. ξ_j is dropped because as mentioned above, the passengers in this market do not care as much about the product characteristics as they do in other markets.

A logit model calculates the probability of something happening, which in this case is the probability of a consumer choosing an airline. The higher the probability, the higher the demand. The logit market share formula is (Belleflamme & Peitz, 2010)

$$s_j = \frac{\exp(x_j\beta - \alpha p_j + \xi_j)}{1 + \exp(x_k\beta - \alpha p_k + \xi_k)} = \frac{\exp(\delta_j)}{1 + \sum_{j=0}^{n} \exp(\delta_k)}$$

Using this equation above, one can easily derive mean utility from market shares[1]:

$$\ln(s_j) - \ln(s_0) = \delta_j \equiv x_j\beta - \alpha p_j + \xi_j$$

where s_j is the market share of itinerary *j* (defined by the number of people taking itinerary *j* divided by city population) and s_0 is the outside good's market share (calculated by one minus the sum of s_j). Thus, $\ln(s_j) - \ln(s_0)$ gives the mean utility of δ_j. The level of δ_j comes from the logit utility function, with $x_j - p_j + \xi_j$ being the observable product characteristics, such as price (p_j). β and α are the coefficients of x_j and p_j respectively.

Because itinerary fares are endogenous in the demand system, an instrumental variable (IV) had to be used to estimate the demand curve. In this case, as with most demand curves, the endogeneity is likely caused by supply factors. As the equation above only has demand factors, supply factors are not defined, and an OLS regression cannot separate supply shocks from demand shocks (Baum, 2007). For example, an increase in aviation fuel prices would increase average prices because cost per flight would have gone up and airlines cannot operate on a loss for long periods. Yet, because aviation fuel price is not a demand factor, it is captured by the regression's error term. It therefore causes a positive correlation between average price and the regression error term. The IV is then needed to separate the supply and demand shocks.

Data used to estimate the coefficient of the demand curve in the regression comes from the DB1B database. To limit the dataset to something that is workable, only routes that have the top 30

[1] Proof of derivation can be seen in Appendix A2.

airports as their origin and destination are used. Included in the dataset is information for over 800 routes. Data on population of the metropolitan area in which the airport is situated in is used as the stand in for the market population. Said population data is sourced from the 1990 US census (U.S. Bureau of the Census, 1998) and is assumed to be stable throughout the years studied. As noted above, the data is filtered to only include economy fares and fares under $450, per Dr Kaplan's instructions. However, this becomes filter becomes problematic when applied to different routes. For example, $450 roundtrip is almost too cheap when flying from one end of the United States to another and it would be reasonable for price sensitive passengers to happily pay more for such a trip. However, due to the limitations of the dissertation, it was not possible to identify the price ceiling for price sensitive passengers for each route. The $450 filter ensures that the vast majority, if not all, the itineraries in the data is bought by price sensitive passengers, even if it does exclude some of them.

The regression was decided as thus:

$$\delta_j = -\alpha price_j + \beta_1 year\_quarter_j + \beta_2 coupons_j + \beta_3 distance_j$$

The regression is applied to the price. Year and quarter and coupons are dummy variables. δ_j is the fitted value from the regression above, which stand for the observable differences in log market share.

The following table shows the results of the IV regression. Each subsequent column adds explanatory variables. The first regression column only has price in the regression equation, while the second one adds the time effect. The third one includes the coupons, while the fourth the distance. The full regression table is in Appendix A5.

Table 1- Regression results table for coefficients

Regression version	1	2	3	4
Dependent variable (difference in log market share)	$\ln(s_j) - \ln(s_0)$	$\ln(s_j) - \ln(s_0)$	$\ln(s_j) - \ln(s_0)$	$\ln(s_j) - \ln(s_0)$
Quarter fixed effects	No	Yes	Yes	Yes
VARIABLES				
Price coefficient	-0.0336***	-0.0331***	-0.0346***	-0.0150***
	-0.000814	-0.000791	-0.00122	-0.00163
Coupons			0.0471**	-0.0540***
			-0.0218	-0.0149
Distance of Route				-0.000248***
				-2.01E-05
Constant	-4.951***	-5.158***	-5.376***	-5.425***
	-0.0379	-0.0477	-0.0531	-0.0536
Observations	58,525	58,525	58,525	58,525

Note: Standard errors: *** p<0.01, ** p<0.05, * p<0.1

Notably, all the coefficients are negative and significant in the final regression (column 4). The price coefficient matters because it is the slope of the demand curve. Under the standard demand curve, the higher the price the lower the quantity demanded, so the negative coefficient is to be expected. Also, the higher the coefficient, the more consumer surplus is lost with a price increase. The effect of time is considered because as can be seen in Figure 1, there is a mild cyclical time effect on the fare, with prices peaking slightly at Q1 each year. This could be because January is still part of the Christmas break, and maybe people want to travel for a holiday. Meanwhile, coupons indicate the number of flights within one itinerary; its negative coefficient indicate that people dislike taking multiple flights for one journey and would pay more for a more direct flight. This is easily explained by the inconvenience multiple flights cause; often, it means the passenger needs to change planes. The negative distance coefficient, which becomes important because the data used for the regression has over 800 routes, indicate that

price sensitive passengers prefer shorter flights over longer ones. This could be because people who are price sensitive prefer shorter and more local trips. This coefficient is per mile, so the overall effect of distance on market share can add up very quickly. For example, the change in difference in log market share proportion due to distance for Boston to Philadelphia would be $-0.000248 * 453 = -0.112344$. The changes all the coefficients, especially for the price coefficient, is bigger between columns three and four than with previous columns is due to compensation for the effect of the distance coefficient.

After estimating the demand system, the price elasticities were calculated. Price elasticity is heavily influenced by the price coefficient α. The bigger α is the more elastic demand becomes. The formula for own-price elasticity is (Levin, 2009)[2]:

$$\eta_j = \frac{\delta s_j}{\delta p_j} * \frac{p_j}{s_j} = -\alpha p_j (1 - s_j)$$

The average price elasticity across all of the routes and time periods is calculated as 4.04, which is of the same order of magnitude as the elasticity of 2.47 (Snider, 2009). The higher price elasticity found here could be explained by the fact that the dataset focuses on economy class passengers, who, due to their limited budgets, are very price sensitive (InterVISTAS Consulting Inc., 2007). Snider's dataset, on the other hand, includes first and business class passengers, who are not as price sensitive.

F. Calculating the Bertrand model price

To decide whether there has been any price predation, it is necessary to know what the prices could have been if not for the predatory behaviour. The Bertrand model is used to calculate this. It assumes that suppliers choose the prices, but cannot control the quantity demanded, with the goal of maximising profit. It also assumes that rivals in the market chooses their prices independently (Khemani & Shapiro, 2003). The market share function for the logit model (Belleflamme & Peitz, 2010) is

$$s_j(p_j) = \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}$$

Which makes the profit function

$$\pi_j = \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)} * (p_j - c_j)$$

[2] Proof of derivation can be seen Appendix A3

With n the number of airlines in that route in that quarter and c_j the marginal cost, defined as variable cost here. For the purposes of this equation, it is assumed that marginal cost equals average variable cost, and that average variable cost is independent of quantity supplied.

The profit maximising equilibrium price (p_j^b) (Bertrand equilibrium) is found with the first order condition for profit maximisation.

$$\frac{\partial \pi_j}{\partial p_j} = -\alpha \left(1 - \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}\right)\left(p_{p_j^b} - c_j\right) + 1 = 0$$

p_j^b was calculated by solving these first order conditions as a set of simultaneous equations, including all the airlines in the same route and quarter. Airline average fare is the average share weighted fare of the itinerary. It is calculated by adding up the total revenue of all the airlines in that route for that quarter, and then dividing by the number of passengers in that route and quarter.

Detroit to Boston[3]

Table 2-Average fare and cost table for Northwest (Detroit to Boston)

Year and quarter	Airline	Variable cost (US$)	Bertrand equilibrium price (US$)	Airline average fare (US$)	Total cost (US$)
1996Q1	Continental	162.0197	228.9243	220.6899	174.5413
	Northwest	158.0895	225.0291	289.507	170.9437
1996Q2	Northwest	144.6658	211.757	158.5229	155.8911
	Spirit	127.2691	194.518	142	133.8911
1996Q3	Northwest	138.4396	205.558	165.2492	149.6653
	Spirit	154.5202	221.5785	150	164.4745
1997Q2	Continental	147.9711	215.0798	255.9375	158.1659
	Northwest	144.2383	211.4069	244.8961	158.3641

[3] Information regarding the reverse of the routes can be seen in Appendix A6.

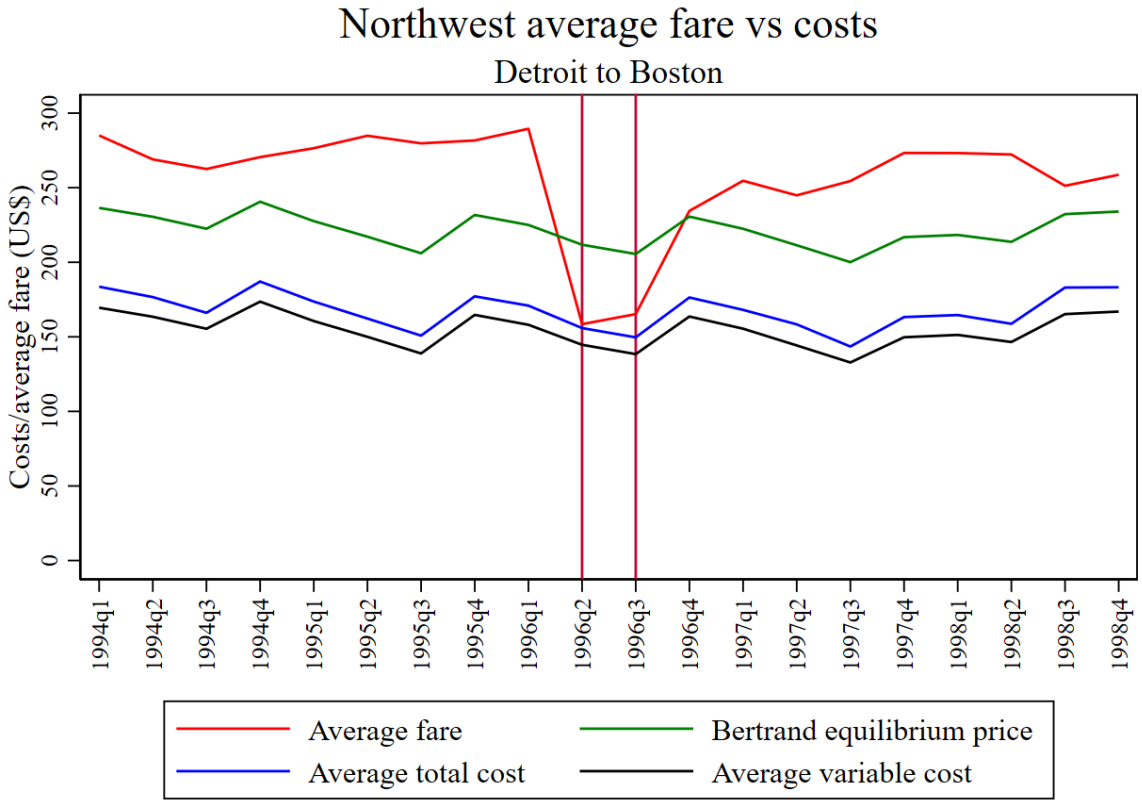


Figure 2. Average fare and cost graph for Northwest (Detroit to Boston)

This graph above indicates why Spirit was able to prove Northwest's price predation behaviour. Before Spirit entered the Detroit-Boston market, Northwest was pricing their roundtrip fares between $250 to $300. This was at least $50 above the competitive Bertrand price. However, as Spirit entered the market, Northwest immediately dropped their price below Bertrand equilibrium, with their average fare $3 above average total cost. It is then very likely a big portion of Northwest's fares were below total cost. Spirit was then able to prove that Northwest was able to recoup their losses by then raising their fares again back to pre-Spirit levels as soon as Spirit have left the market.

Detroit to Philadelphia

Table 3-Average fare and cost table for Northwest (Detroit to Philadelphia)

Year and quarter	Airline	Variable cost (US$)	Bertrand equilibrium price (US$)	Airline average fare (US$)	Total cost (US$)
1996Q1	Northwest	113.3142	180.4929	215.8531	122.5277
	Spirit	83.77718	151.2694	116	89.36411
	US	166.862	233.7726	274.6397	184.977
1996Q2	Northwest	103.6924	171.1474	210.7144	111.7384
	Spirit	91.22292	158.8913	142	95.96938
	US	149.0063	216.0791	259.7039	163.607
1996Q3	Northwest	99.22968	166.7192	141.6086	107.2759
	Spirit	110.7558	178.1667	122	117.8908
	US	150.3342	217.3994	145.9088	165.9308
1997Q2	Northwest	103.386	170.989	222.0581	113.511
	US	149.2693	216.4112	229.4332	162.4881

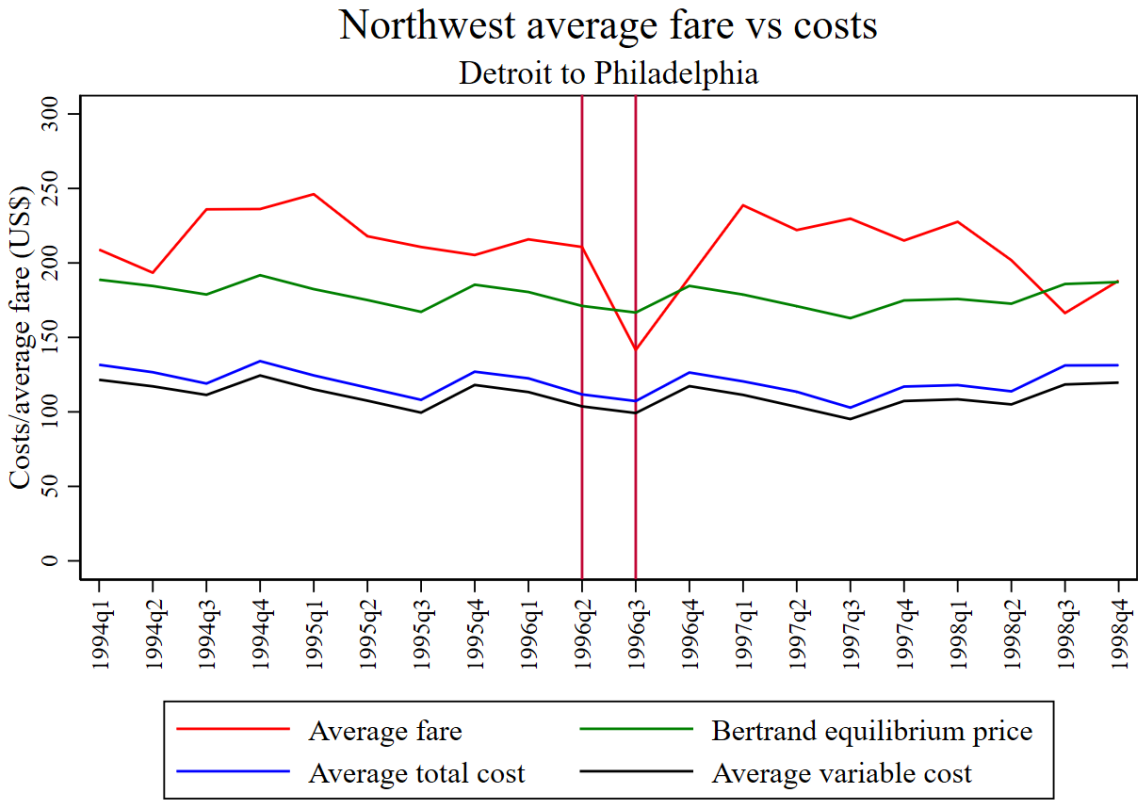


Figure 3. Average fare and cost graph for Northwest (Detroit to Boston)

The case for price predation in the Detroit-Philadelphia market is less clear here. First, Northwest's average fare is at least $50 above the total cost, even during the price predation period. Second, Northwest's average fare dipped once below the Bertrand equilibrium price outside the price predation period. Spirit would be able to prove the rapid price increase needed for price predation, but not the initial losses from pricing goods below total cost. If anything, the data for this route looks like a normal price war.

It may be noted that Northwest's average fare never went below the estimated total cost of the routes, yet they were found guilty of price predation under the modified Areeda-Turner test. This may be explained with two reasons. First, the court case and this paper use different data sources. The analysers in the court case have the benefit of discovery; that is, they would have a more complete dataset than the Transtats database for the route. The Transtats database on the other hand uses aggregated data that is not differentiated by route. This would bring down the average total fare because the cost of flying other routes is most likely lower, such as with lower landing fees. Furthermore, the Transtats databases relating to costs relies on the airlines submitting their numbers, so it is possible Northwest did not disclose everything publicly. This was seen in the case itself, in which Dr Kaplan estimates that Northwest was losing between $1.55 to $19.90 per price-sensitive passenger during the price predation period ("Spirit Airlines, Inc. v. Northwest Airlines, Inc.," 2003). The issue is more salient regarding average total costs, as Dr Kaplan estimates the average variable cost to be around $140 roundtrip for the Detroit-Boston route and $110 for the Detroit-Philadelphia route 1996[4]. Second, the DB1B database noted that Northwest was still selling a limited number of high fare itineraries during the price predation period (Bureau Of Transportation Statistics, 2021c). Within the case itself, it was stated around a quarter of Northwest's Detroit-Boston fares were sold above total cost during the price predation period, and the same for around 60% of Detroit-Philadelphia fares This would have raised the average fare.

G. Consumer surplus

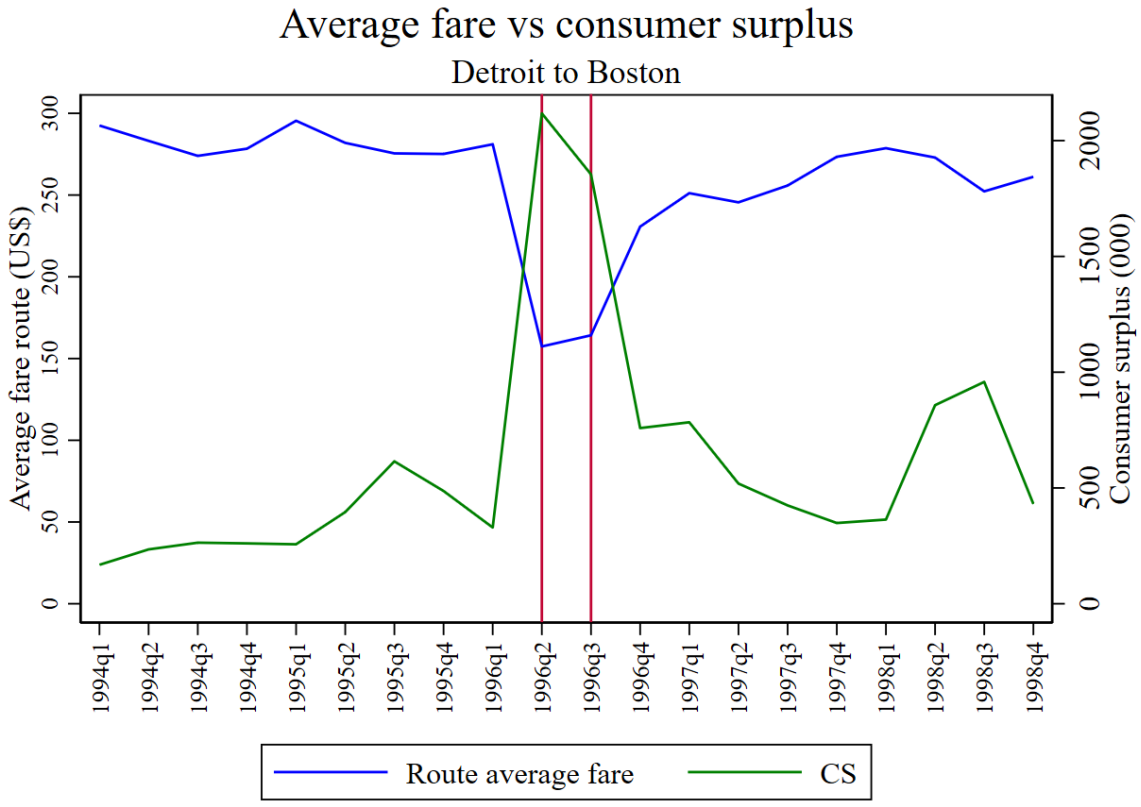
Consumer surplus is calculated using a modified version of the formula in Anderson and Palma (1992), who in turn derived it from a paper by Small and Rosen (1981):

$$CS = \frac{N}{\alpha} * \ln(1 + \sum_{j=1}^{n} \exp(\delta_j))$$

[4] Astute readers might note that Northwest's estimated average variable cost for Detroit to Philadelphia is underestimated according to the court documents. An attempt to rectify this can be seen in Section V counterfactual C.

Here N is the number of potential consumers in a particular market, approximated by the population of the city in which the origin airport is situated, and $n\ is$ the total number of airlines in the route market. The addition of the α (price coefficient) in the denominator is because Anderson and De Palma assumed their α was one. The adjustment allows for the effect α on the consumer surplus, with basic proof in Appendix A4. This equation calculates the total consumer surplus for all the consumers in the route in the quarter.

Under the logit model, it is assumed that the more choice the consumer has, the happier they are. It is also assumed that the lower the average fare across all the airlines, the happier the consumers are. To observe the latter correlation, the weighted average fare for the route and each quarter is calculated. The route-specific average fare is calculated across all relevant itineraries, weighted by the number of passengers in each itinerary. This is done by calculating the overall revenue of the route across all the airlines in one quarter, and then dividing by the total number of passengers for that route in that quarter. The correlation between the route's average fare and consumer surplus is around -0.9. Graphs for the reverse routes are in Appendix A7.



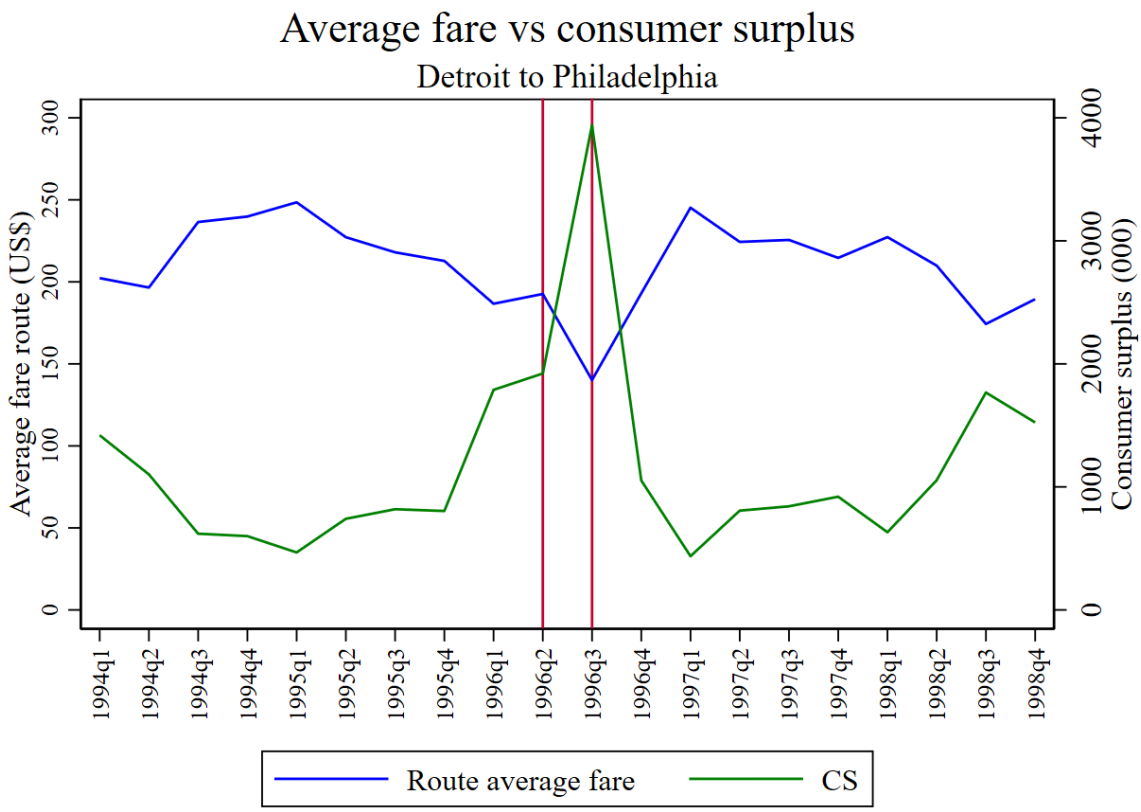


Figure 4. Average fare vs consumer surplus

Any significant peaks of consumer surplus that is outside of the price predation period can be attributed to additional airlines entering and exiting the market within the same quarter. For example, Spirit Airlines entered the Detroit-Philadelphia market early in 1996Q1, while United Airlines was temporarily in the Detroit-Boston route in 1998. As to be expected, the price predation did temporarily increase consumer surplus above normal ranges because consumers benefited from the artificially lowered prices. However, the peak is short lived, and as soon as the defeated competition leaves the market, consumer surplus rapidly drops due to the lessened choice and the increased prices. This graph therefore demonstrates that any benefits the consumers get from the price predation episode is short-term.

H. Further discussion of results

The graphs above show price predation activity by Northwest in the Detroit-Boston route. This is because during the price predation period, Northwest's average fare for the price sensitive passenger is almost at the total cost line, which indicates a major portion of their fares are priced below cost. The evidence of price predation in the Detroit-Philadelphia route however is much less clear. Even at their lowest, the average fare does not go near the total cost line. This is not surprising. As alluded above, only around 40% of fares for the Detroit-Philadelphia route during the price predation period were sold below cost.

I. Limitations of methodology

As with any dissertation, there are some limitations in the data and the analysis. First, the data in this paper is partially self-reported data. The airlines are the ones who report their expenditures. Because of this, costs may be underreported. If so, the Bertrand price will be underestimated, and Bertrand price counterfactual consumer surplus overestimated. Furthermore, as discussed above the data used to calculate costs is an aggregated average across all of the airlines' routes. This may have exerted a downward bias on the estimated average costs of the routes studied here. Second, the DB1B database only has ten percent of the flights (Bureau Of Transportation Statistics, 2021c). Ten percent of all the flights taken within the United States is still a large number of itineraries, but when dealing with only two routes, it becomes a much smaller sample size. Third, the data is done quarter by quarter. Although the events almost align perfectly with the quarters, with price predation starting at the beginning of April and ending at the end of September, doing it by quarters loses some of the details. It would be interesting, for instance, to see if the airlines changed the average prices month by month. Fourth, it is assumed that the overall market size, effectively the city's population, does not change throughout the 1990s. This is unrealistic. For example, according to US census, Detroit's population dropped from 1,027,974 in 1990 to 951,270 in 2000 (7.46% drop). In the same time period Philadelphia's reduced from 1,585,577 to 1,517,550 (4.29% drop) (Population Estimates Program, 2005) (U.S. Bureau of the Census, 1998). This change in the population affects several variables, such as the market share and consumer surplus.

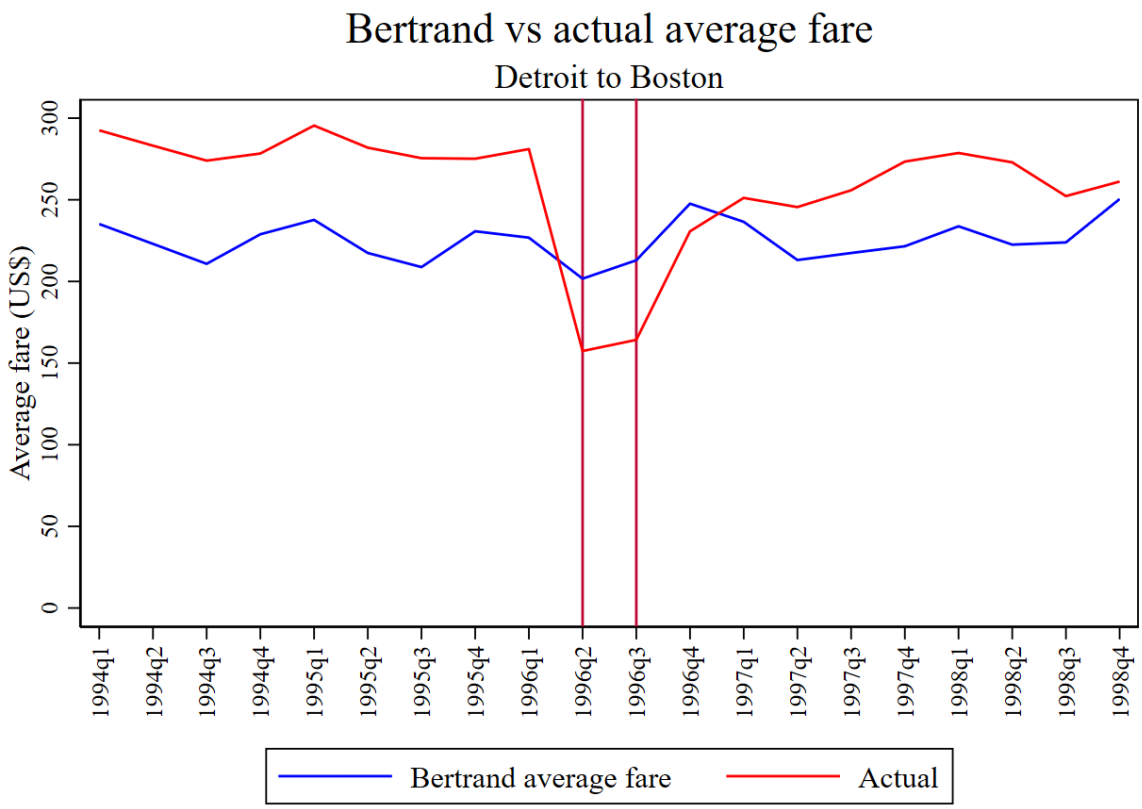
V. Counterfactuals

A. Counterfactual: what if the airlines used the Bertrand model price?

This counterfactual both assumes not only that price predation never happened, but that all airlines priced their products competitively. The average fares in Figures 5 and 6 are the Bertrand prices weighted by the Bertrand counterfactual market share. The Bertrand counterfactual market shares are calculated using the logit demand model:

$$s_{Bertrand} = s_0 * e^{\delta_{Bertrand}}$$

The graphs for the reverse of the routes can be found in Appendix A8.



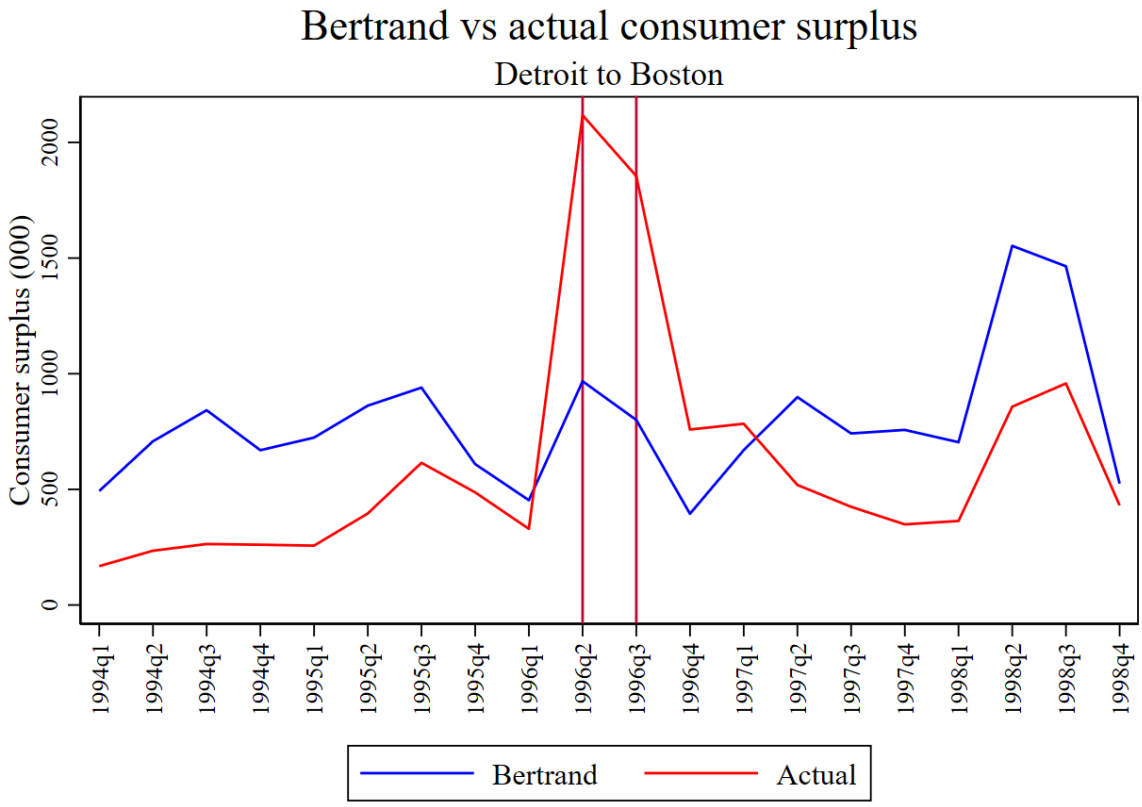
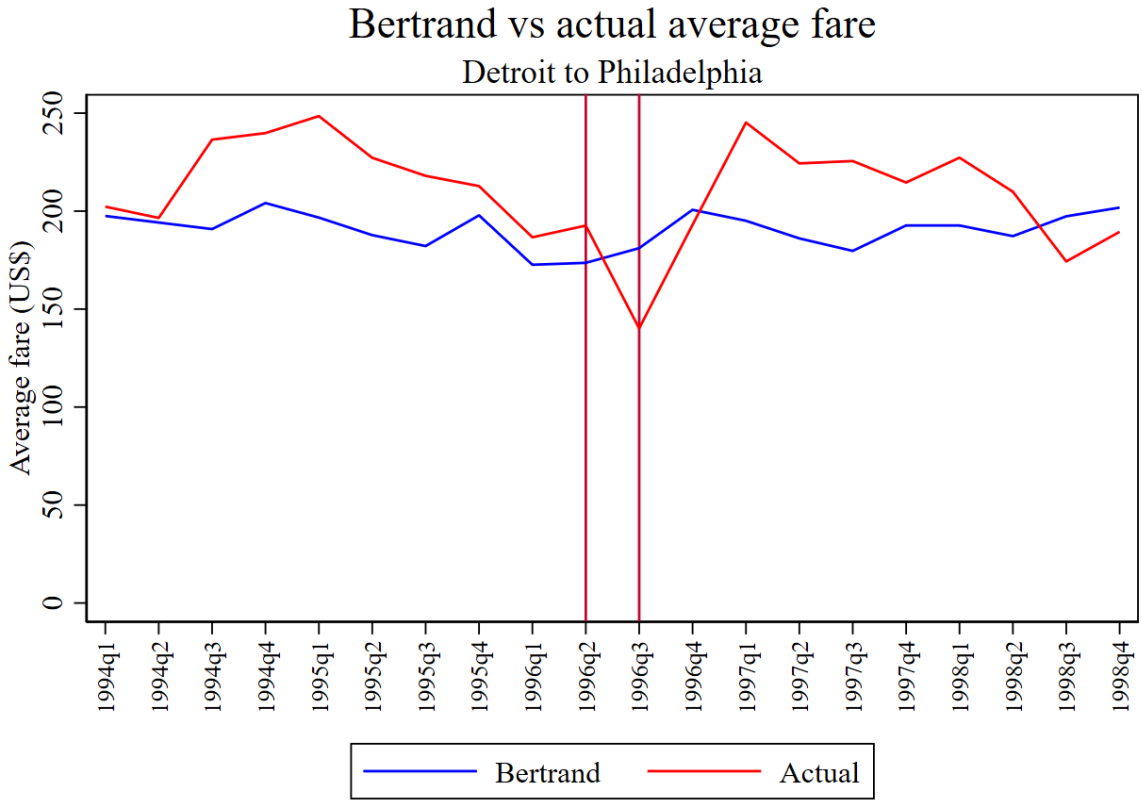


Figure 5. Detroit to Boston Bertrand counterfactual summary graphs



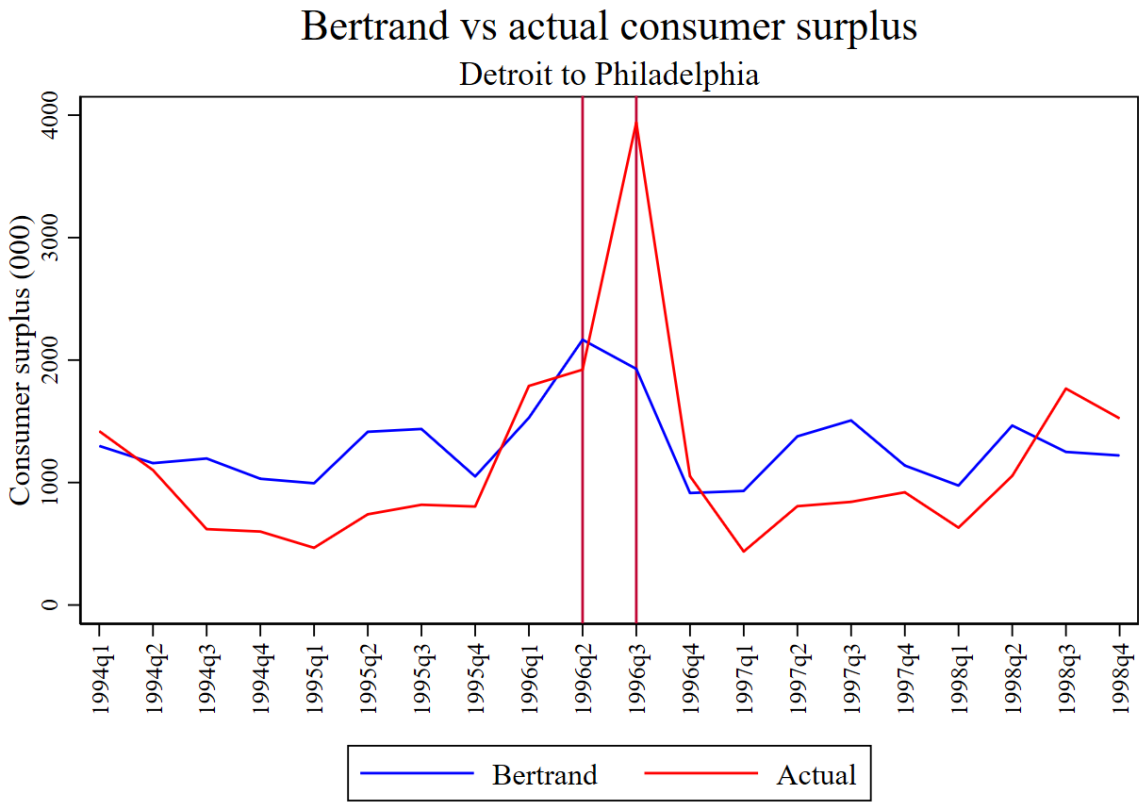


Figure 6. Detroit to Philadelphia Bertrand counterfactual summary graphs

For the most part, especially the Detroit to Boston route, average Bertrand fares are lower than the average actual fares. If the airlines chose to price their fares according to the Bertrand equilibrium, it significantly increases the number of customers due to the high price elasticity. This explains why the Bertrand price consumer surplus is usually higher than the actual consumer surplus. Any peaks in 1998 are due to the presence of a fourth airline in routes that usually only have two or three. From these graphs, it can be concluded that the airline's market lack of competition was hurting consumers. The airlines were able to make supernormal profit, which then depressed consumer surplus far lower than what it would have been in a truly competitive market. It also shows that even though price predation greatly benefits consumers in the short term, it is detrimental in the long term because competition is very short lived. After the competition leaves, consumer surplus then goes back to what it was pre-price predation, below what it should be with competitive pricing. Similar to what Snider has found, if the airline industry was forced to be fairer in their competition tactics, it would benefit consumers in the long run.

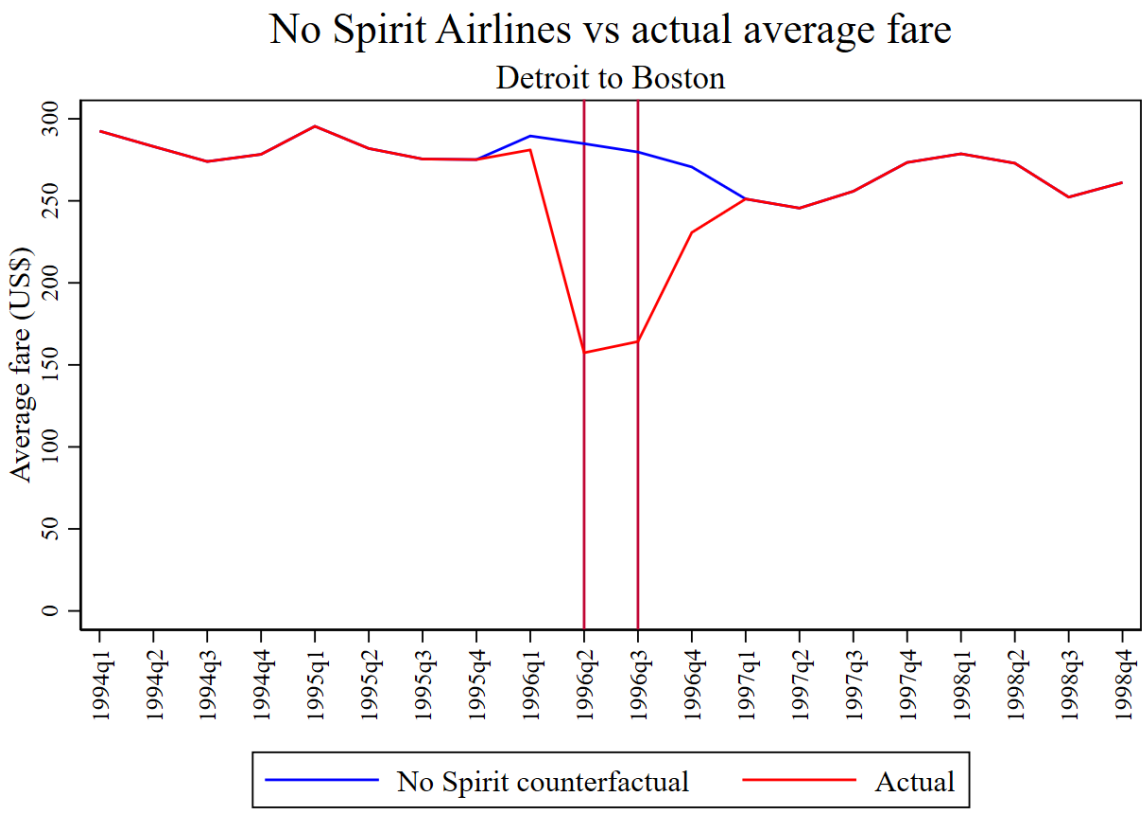
An interesting aspect about the data is just how closely airlines match their pricing behaviour to Northwest's. Except during the price predation period, all the airlines price their fares above Bertrand equilibrium competitive prices. There are three possible reasons for this. First, as noted above, it is possible that the costs have been underestimated, which would underestimate Bertrand prices. Second, as Northwest is a dominant company in the market, it is able to set the market price. If Northwest is able to set their prices above competitive market prices, then other companies feel they can do the same and also make supernormal profits. Third, this might be evidence of an unknown cartel.

It must be noted that the difference between counterfactual and actual CS is caused by the large elasticity. The large elasticity meant the drop in price not only considerably increased individual CS, it also increased the number of passengers taking the route. For instance, the number of price sensitive people who flew Detroit to Boston in 1994Q1 is 1233 (Bureau Of Transportation Statistics, 2021c). If the price was at Bertrand equilibrium, the number of estimated passengers in the same route and quarter jumps to 4819.

B. Counterfactual: what if Spirit never entered the market?

This counterfactual assumes that Spirit had never entered the market in 1996 and all the remaining airlines in the route in question charge the same prices in 1995 in 1996. In other words, what if the airline used the same supracompetitive prices in 1996 as they did in 1995 and Spirit never arrived? The pricing assumption is based on the cyclical nature of the fares, which the arrival of Spirit managed to disrupt. It is also assumes that the airlines in question had the same market conditions and costs in 1995 as they would have in 1996 if not for Spirit, including the same market shares. The last assumption made is that if an airline does not fly in 1996, it would also not fly in the 1996 counterfactual scenario. This is because it is unknown the exact reason why the airlines did not fly that year. Keep in mind,

however, that the average weighted price in the 1996 counterfactual is different to 1995's average weighted price because the number of airlines in the market changes. This counterfactual is therefore useful to understand what could have happened if Spirit had never entered the market, and therefore the full effect of Spirit's entrance.



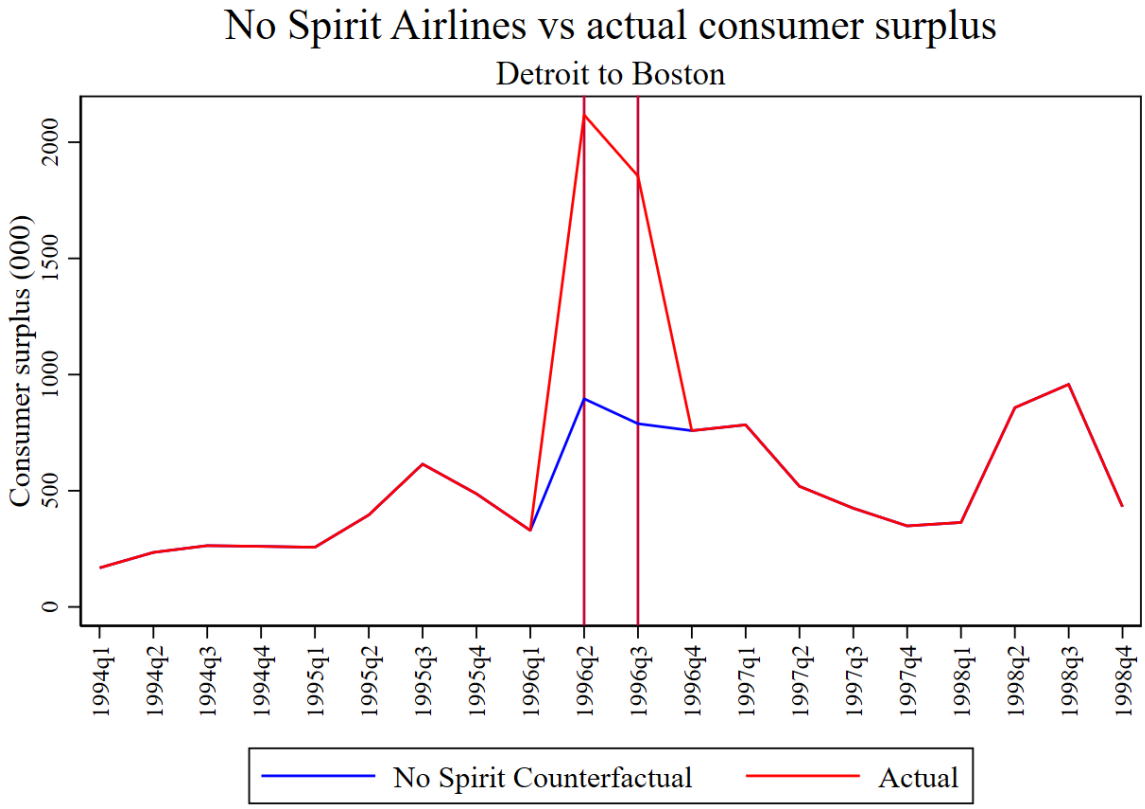


Figure 7. Detroit to Boston No Spirit Airlines counterfactual summary graphs

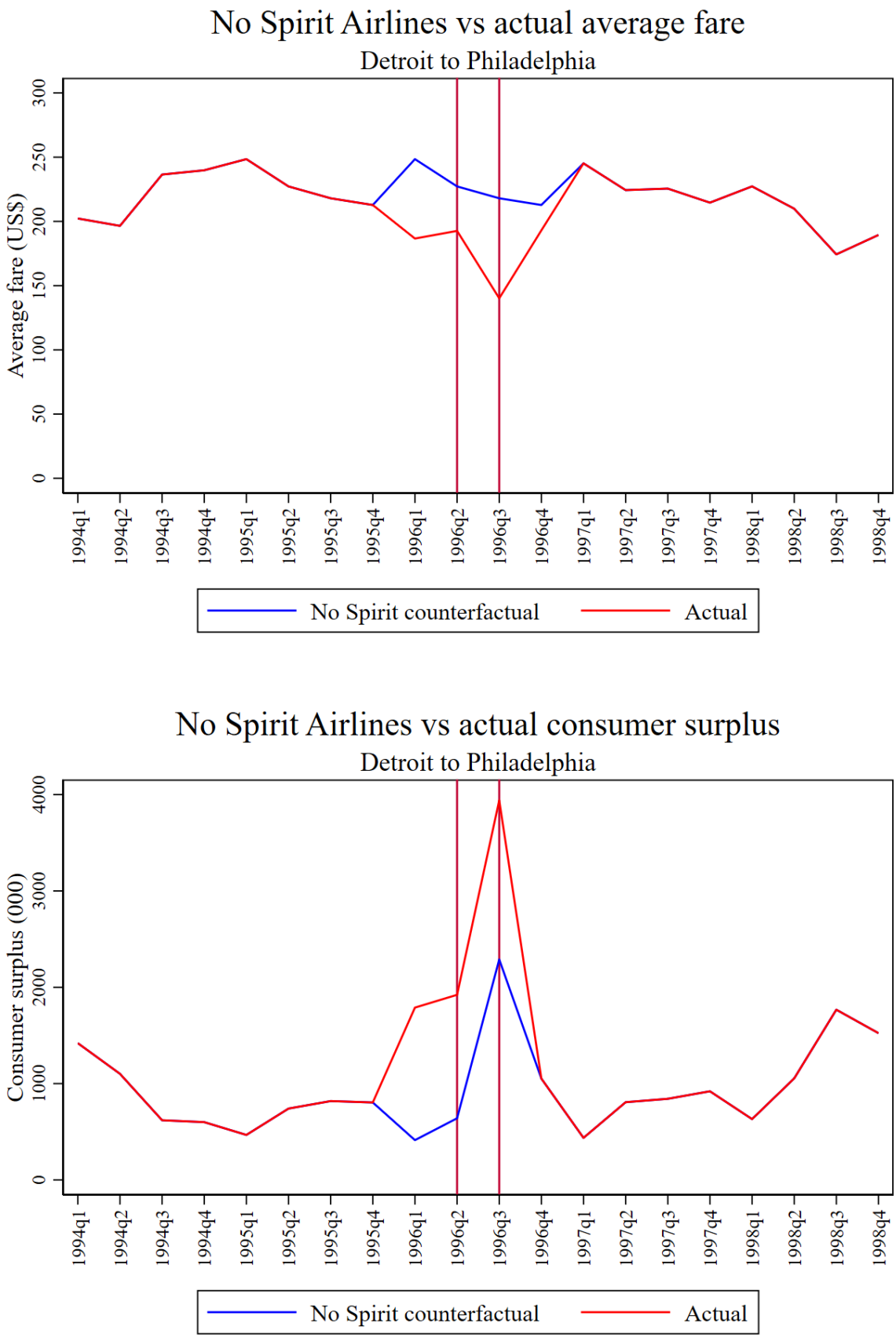
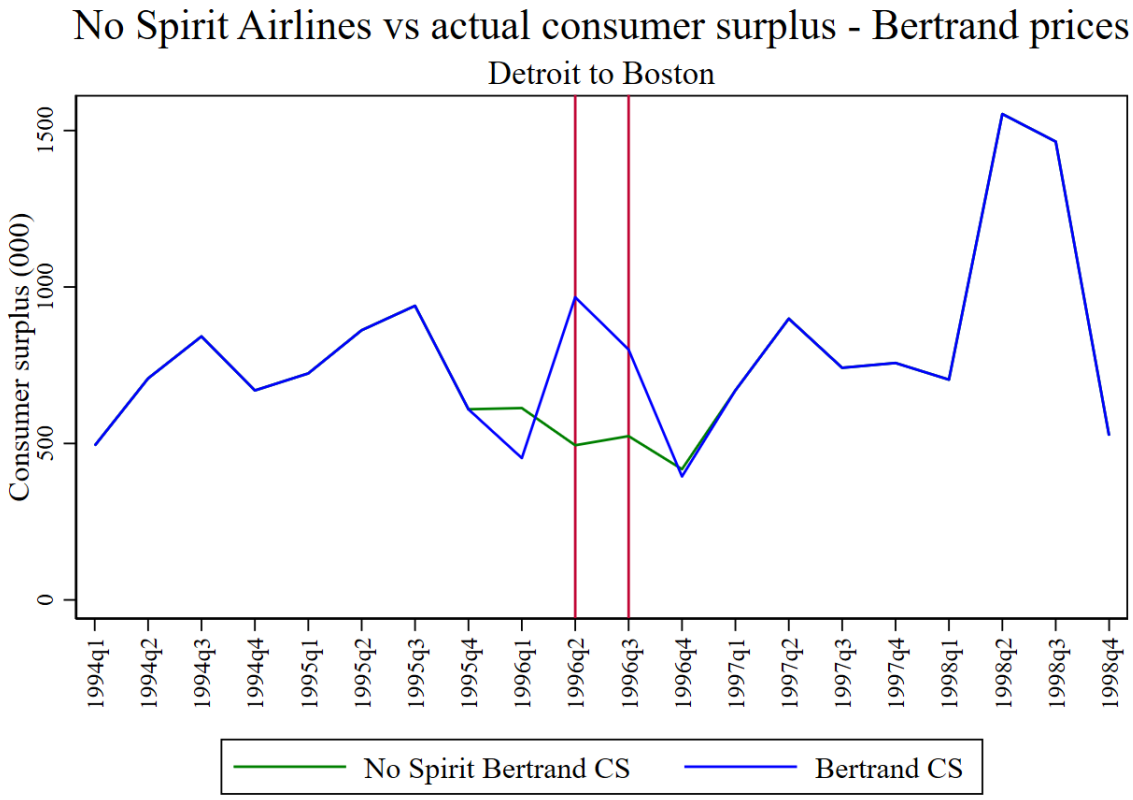


Figure 8. Detroit to Philadelphia No Spirit Airlines counterfactual summary graphs

Note: Spirit entered the Detroit-Philadelphia route in 1996Q1. The peak of CS in the Detroit-Philadelphia route in 1996Q3 is due to the presence of a third airline in the market for one quarter. Graphs of the reverse routes are in Appendix A9.

The effect of Spirit entering the market when all the airlines are using Bertrand equilibrium prices is also telling. Having an additional choice in the market benefits consumers even when prices are competitive. Comparison between Bertrand prices with and without Spirit airlines are not shown here as the difference between the two scenarios is within three dollars. Any changes in the CS is due to changes of variety of choice.



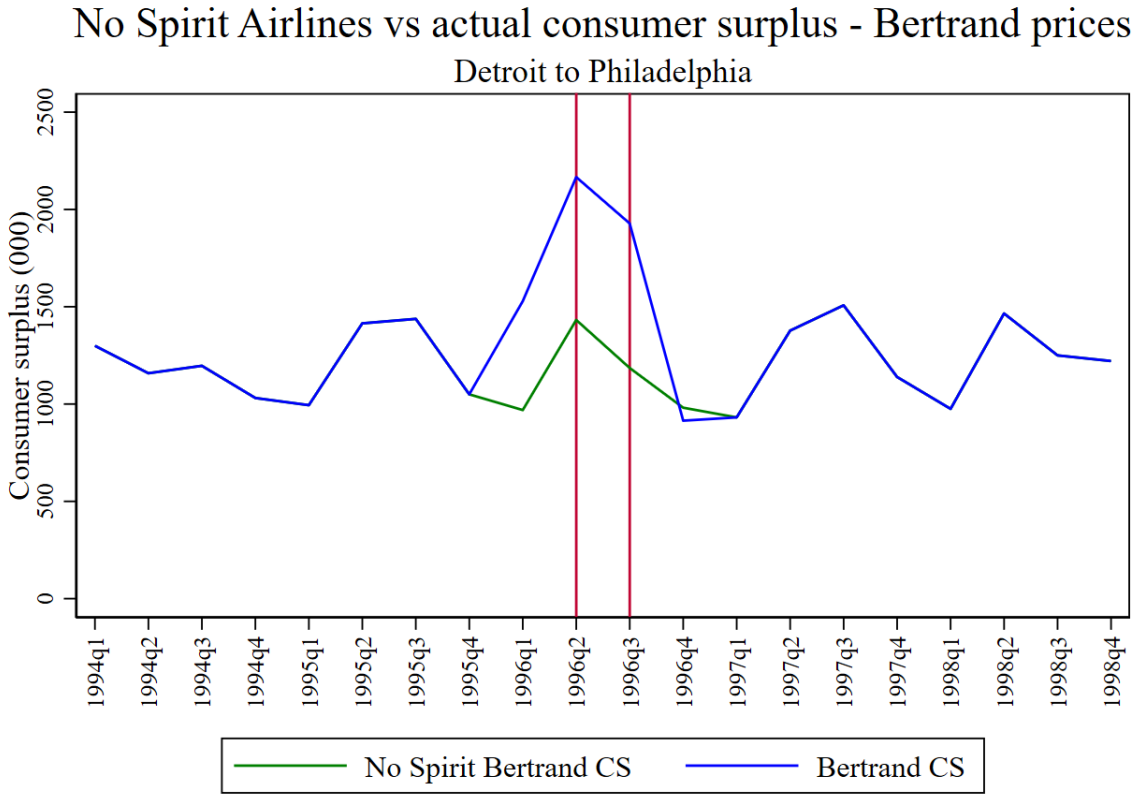


Figure 9. No Spirit Airlines Bertrand counterfactual summary graphs. Graphs for reverse of the routes can be seen in Appendix A9

The presence of Spirit Airlines in the market did have a big impact. It did so by not only pressuring the other airlines to lower their prices, but also giving consumers an additional choice in the market. As a result, the consumers had a massive benefit in having them in the market. However, a big limitation of this counterfactual is the assumption that the market conditions stay the same between 1995 and 1996. It is possible, for example, for another event in 1996 that would raise or lower airfare prices such as a change in petrol prices.

C. Counterfactual: an adjustment of costs for the Detroit-Philadelphia route

As noted above, the average total costs for both routes and average variable costs for the Detroit-Philadelphia route are lower than what they should be. This could explain why in none of the graphs the average fare line goes below the average total cost line. There are many reasons for the Detroit-Philadelphia route to have above average costs, such as an unusually high landing fee in one of the airports. For this counterfactual, to have the costs be more in line to what they have stated in the court case, the average variable cost and total cost per fare for all airlines in the Detroit-Philadelphia route is raised by $10. The Bertrand equilibrium price line was also recalculated with the increased variable cost.

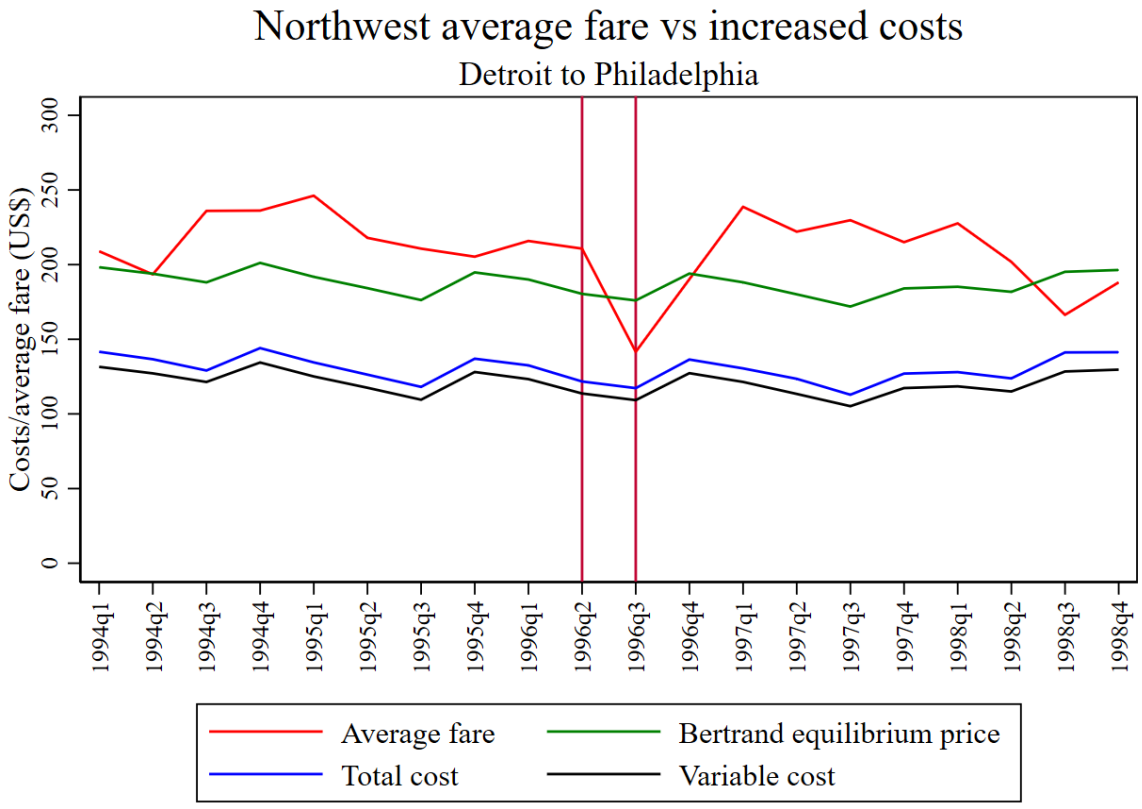


Figure 10. Northwest increased costs summary graph. Graph of the reverse route can be found in Appendix A10.

This graph seems a little bit more realistic than the average fare graph in Figure 3. Both the Bertrand equilibrium and total cost lines are a bit closer to the average fare line. With the Bertrand equilibrium line being closer, it means the average fare is now more believable. Total cost being closer to the average fare means evidence for predatory pricing for this route is now a little bit stronger. However, the evidence for predatory pricing for this route is still weaker than for Detroit-Boston route, as there is still a noticeable gap between the average fare and total cost lines.

Below are the graphs comparing the recalculated average weighted Bertrand fare to average actual fare, as well as the recalculated Bertrand consumer surplus with actual consumer surplus.

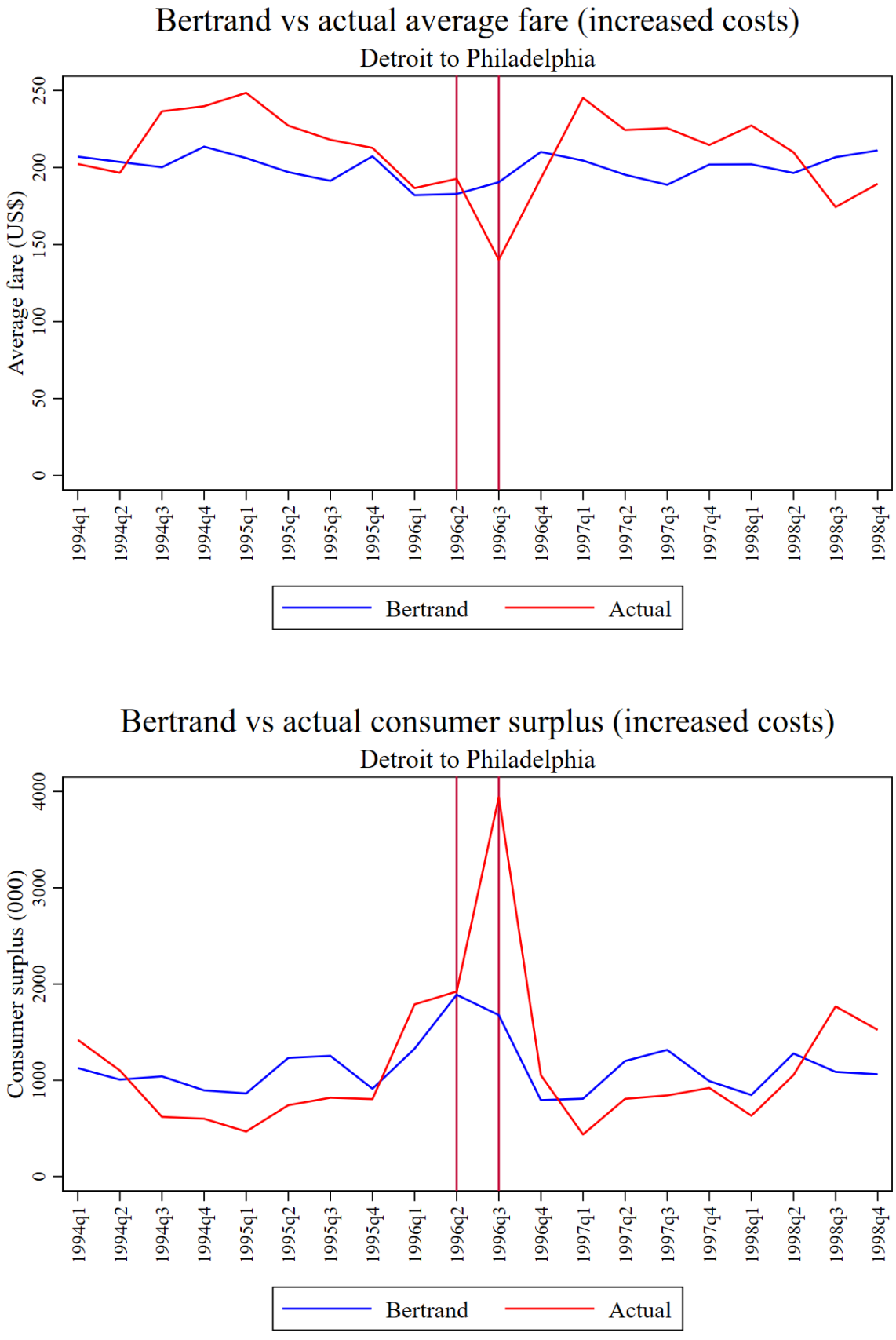


Figure 11. Bertrand summary graphs for higher costs in the Detroit-Philadelphia route. Graph of the reverse route can be found in Appendix A10.

D. Counterfactual: how could the case Spirit v Northwest play out in other jurisdictions?

Having 72% and 89% respective market share in the routes in question ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005), there can be no doubt that Northwest was the dominant player. They were able to charge airfares above the Bertrand equilibrium, indicating that they had enough power to at least set their own prices independent to any competition they might have at the time. The only matter in question is whether they have abused their market power according to the tests laid out, or they have merely used their financial power.

Under the New Zealand test, it would be likely the judge would find Northwest guilty. It would be reasonable, for instance, for Northwest to lower their prices in the event of a new competitor in the market. They would have done it even if they were not the dominate company. However, there is the issue of the massive increase in price after the price predation event. The only reason Northwest can increase their price significantly after Spirit leaves is due to their market power. If it was not for their dominant market power, it is highly unlikely they would be able to increase their price and still maintain their customer base. What Spirit needs to do is prove that after they left, Northwest immediately increased their prices to supracompetitive levels.

It would be easier for Spirit to prove their case in Australia. All that Spirit needs to prove is that Northwest used their market power, not just their financial power, in any way to price predate. Spirit has two ways they can argue this. Firstly, it was noted in the appeals case that Northwest used their market power over the business class passengers to charge them a higher fare to essentially subsidise their leisure passengers. This means in theory Spirit can start suing against Northwest before Spirit is forced to leave the market. Secondly, Northwest also used their market power to again, increase their price significantly after Spirit has left to recoup their losses ("Spirit Airlines, Inc. vs. Northwest Airlines, Inc.," 2005). This would play out similarly in the United Kingdom and the European Union. Spirit would need to conduct the AEC test: prove that if Northwest was not a dominant company ceteris paribus, they could not have cut the prices of their fares as low as they did.

VI. Conclusion

This paper studies the effect of predatory pricing on consumers through the lens of the case Spirit Airlines v Northwest Airlines. Predatory pricing is an anti-competitive pricing strategy that is detrimental to consumers in the long term for two reasons. First, it enables dominant companies to maintain above competitive prices. Second, consumers are left with less choices after the targeted company leaves the market. It is therefore no surprise that the practice is made illegal in most jurisdictions. However, different jurisdictions define price predation differently. Despite this, it is highly likely that Northwest Airlines would be found guilty of price predation in all the jurisdictions studied.

The paper also quantifies the effect of the predatory pricing incident on consumers. It observes that during the price predation period, there was a spike in consumer surplus, but the gains were lost as soon as Spirit exited the market. The paper also argues that due to the lack of competition, Northwest was able to charge above competitive prices on airfares when Spirit was not in the market. As a result, consumers were negatively affected. This was shown with the Bertrand price counterfactual. Lastly, the paper presents a No Spirit Airlines counterfactual which estimates what could have happened if Spirit never entered the market and compares it to what really happened. The conclusion from that study is that Spirit had greatly benefited the consumers in the short time they were in the market.

There is also the question of whether price predation should be stopped while it is happening. While companies can rightly point out that they might lower prices below cost for reasons other than driving out the competition, nevertheless waiting for companies to leave the market before prosecuting the predator allows for a lot of damage to be brought onto the consumer. However, if the predator can be forced to stop their price predation before their victim is forced to leave the market, the consumers will benefit in the long term through the preservation of competition in the market. This paper has shown, if somewhat imperfectly, that it is possible for computers to track a company's price and cost automatically and flag suspicious activity. This could be done via seeing how closely average fare meets the total cost. However, for it to work, costs need to be updated more regularly than just quarterly and be done in a way that does not increase administration costs for everyone. Regulators must be careful doing this. Airlines having the occasional fare below cost does not make for a predatory pricing case. There needs to clear rules laid out and laying out the explicit rules everyone can agree on will be very difficult indeed.

There are important questions raised by this paper for future research First, the counterfactual of if Spirit was not a budget airline. This would be useful to see what the effect of an additional airline in the market would be without the drop in price. Second, the economic effects of the different legislation regarding price predation should be studied. For example, which legislations is the most effective at promoting consumer surplus? Third and lastly, adding to that, it remains to be seen if predatory pricing can be automatically monitored for. In theory, if the definition of predatory pricing is known, and price and cost information is uploaded onto the internet, it should be possible for a computer to flag suspicious pricing activity. It might also be possible then to find instances of previously undetected predatory pricing, which can help protect the competitiveness of a market. If predatory pricing can be monitored for and stopped before the victims are forced to leave the market, it will prevent a lot of damage done by predatory pricing.

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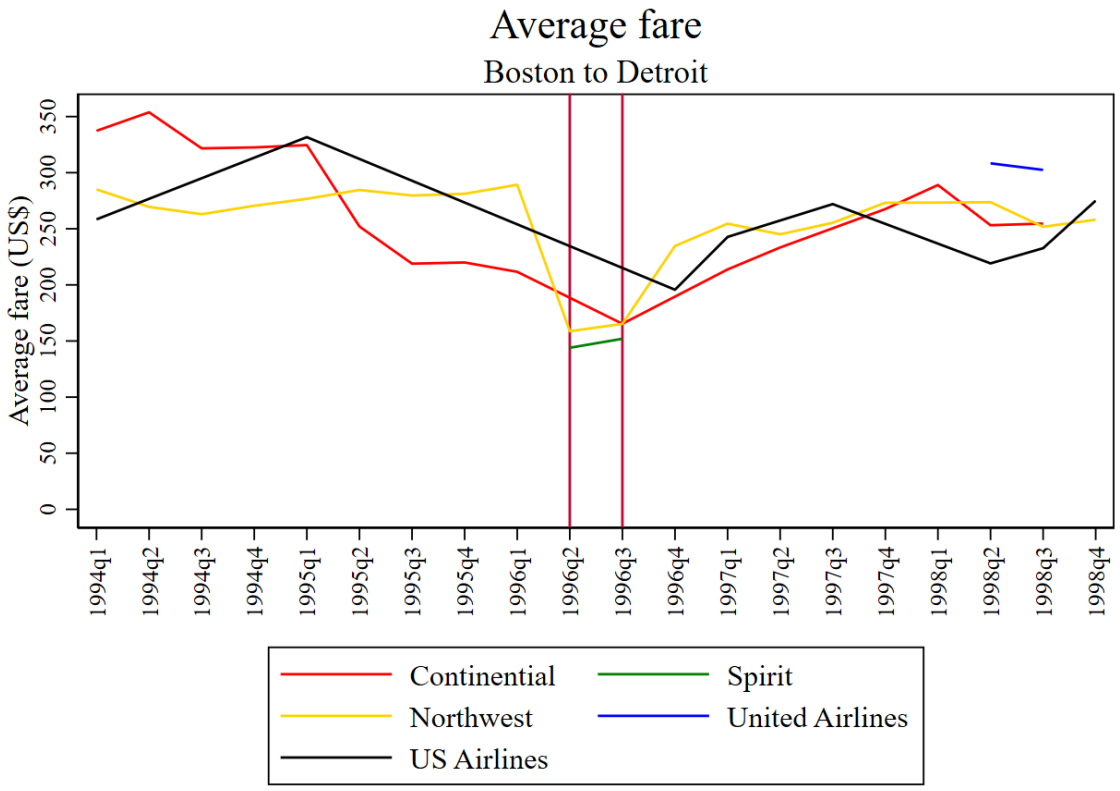
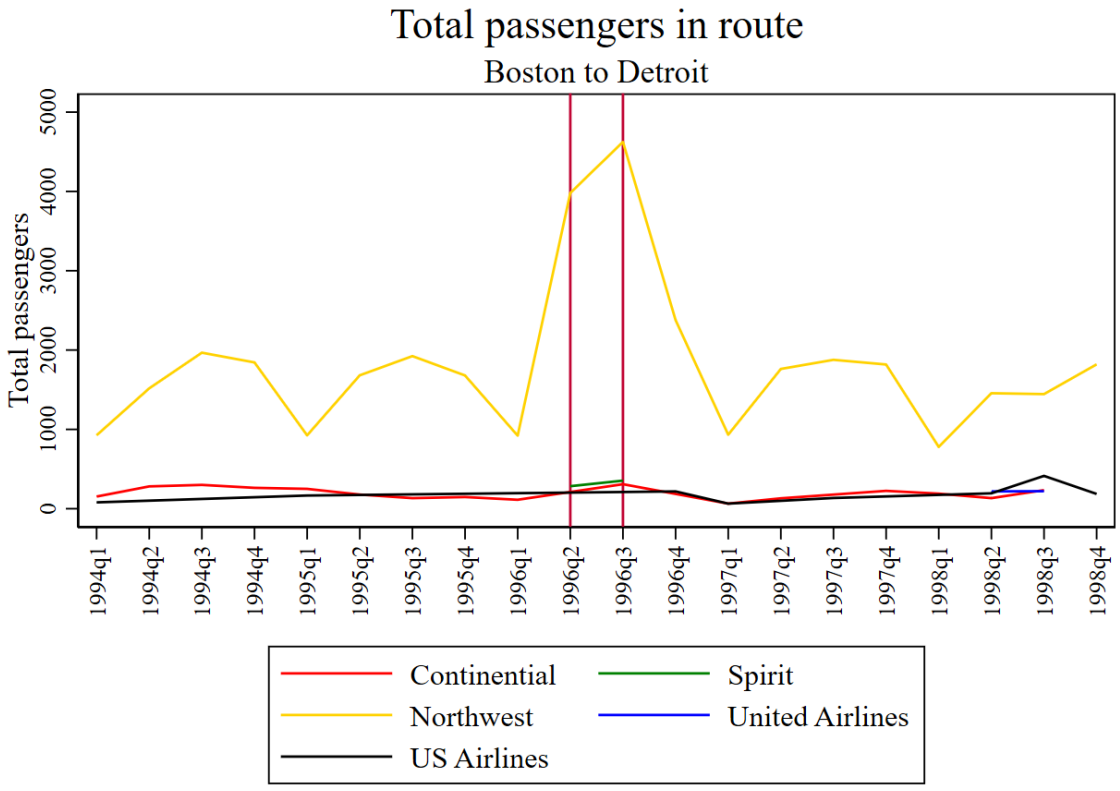
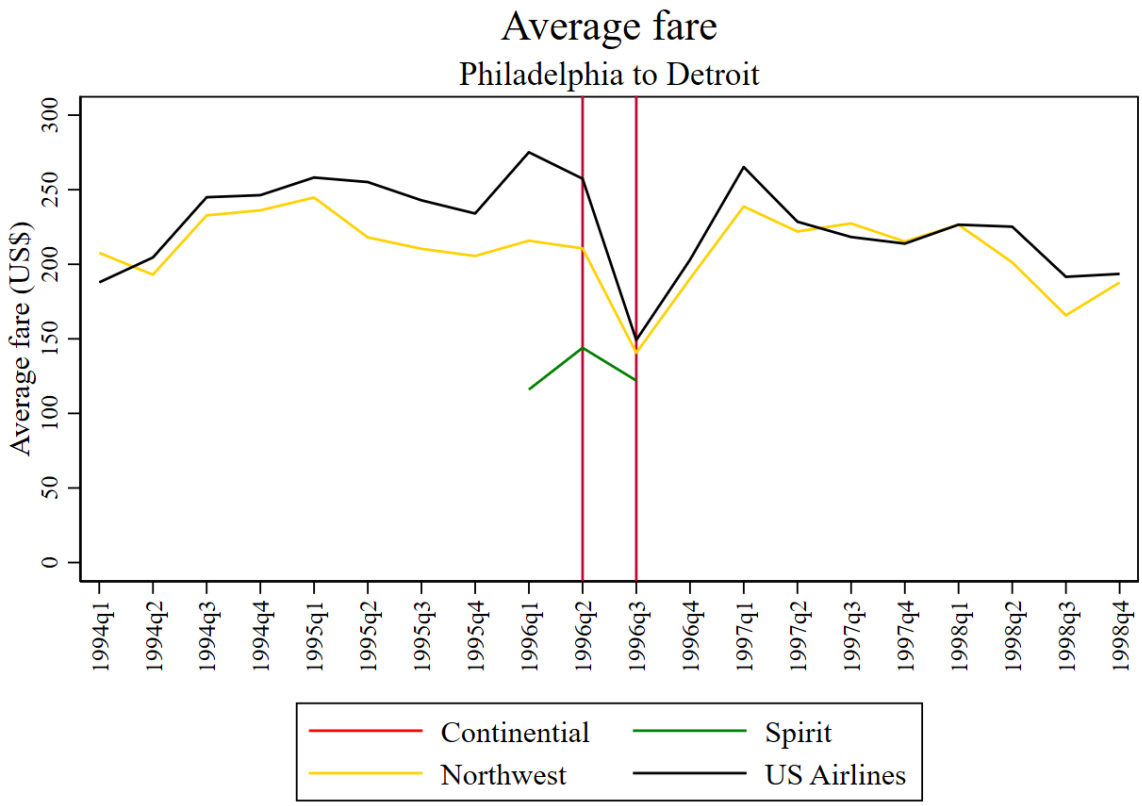
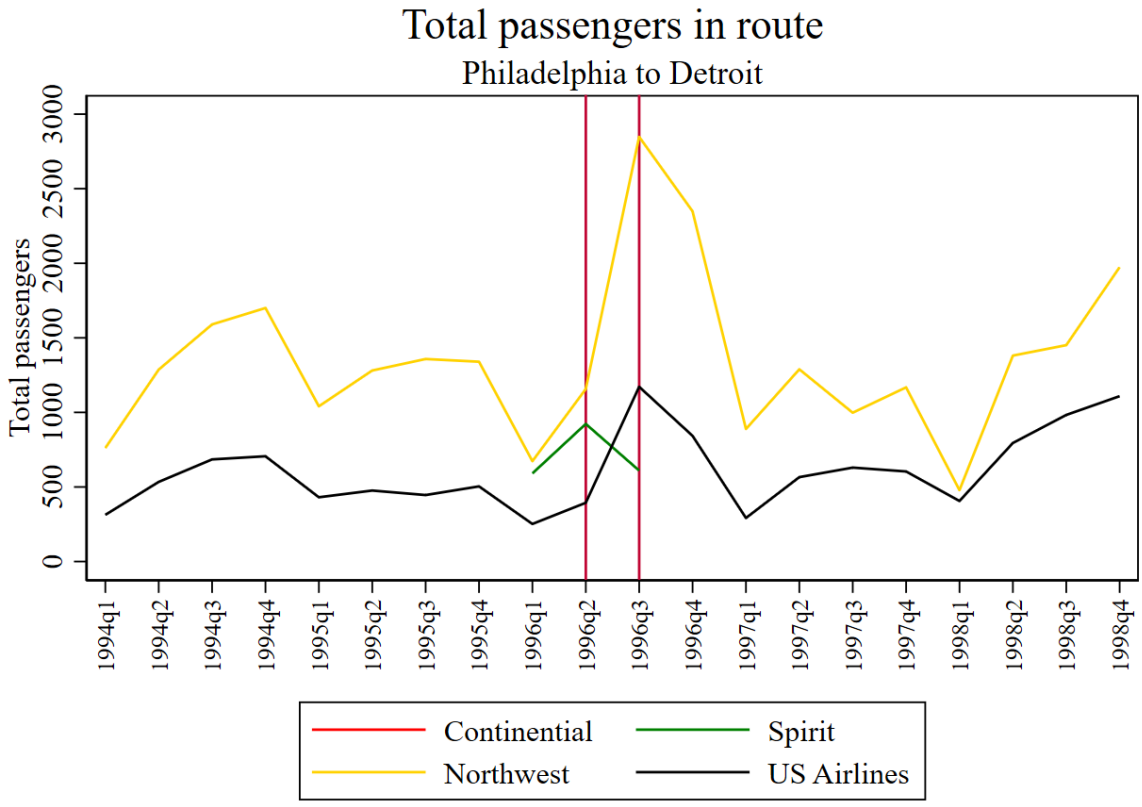
Appendix

A1. Average fare and passenger graphs






Average fare
Philadelphia to Detroit
Average fare (US$)
0
50
100
150
200
250
300
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Continential
Spirit
Northwest
US Airlines


Total passengers in route
Philadelphia to Detroit
Total passengers
0
500
1000
1500
2000
2500
3000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Continential
Spirit
Northwest
US Airlines

A2. Derivation for logit market share

$$s_0 = 1 - \sum_{j=1}^{n} s_j$$

$$\delta_j \equiv x_j\beta - \alpha p_j + \xi_j$$

$$s_j = \frac{\exp(x_j\beta - \alpha p_j + \xi_j)}{1 + \sum_{k=1}^{n} \exp(x_k\beta - \alpha p_k + \xi_k)} = \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}$$

$$s_0 = 1 - \sum_{k=1}^{n} \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}$$

$$\frac{s_0}{s_j} = \frac{\left[1 - \sum_{k=1}^{n} \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}\right]}{\left[\frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}\right]}$$

$$\frac{s_0}{s_j} = \frac{1}{\frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}} - \frac{\sum_{k=1}^{n} \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}}{\frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}}$$

$$\frac{s_0}{s_j} = \frac{1 + \sum_{k=1}^{n} \exp(\delta_k)}{\exp(\delta_j)} - \frac{\sum_{k=1}^{n} \exp(\delta_k)}{\exp(\delta_j)}$$

$$\frac{s_0}{s_j} = \frac{1}{\exp(\delta_j)}$$

$$\frac{s_j}{s_0} = \exp(\delta_j)$$

$$\ln\left(\frac{s_j}{s_0}\right) = \delta_j$$

$$\ln\left(\frac{s_j}{s_0}\right) = (x_j\beta - \alpha p_j + \xi_j)$$

$$\ln(s_j) - \ln(s_0) = \delta_j \equiv x_j\beta - \alpha p_j + \xi_j$$

A3. Derivation for logit own price elasticity formula

$$\eta_j = \frac{\delta s_j}{\delta p_j} * \frac{p_j}{s_j}$$

$$s_j = \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{n} \exp(\delta_k)}$$

$$\frac{\delta s_j}{\delta p_j} = \frac{-\alpha(1 + \sum_{k=1}^{n} \exp(\delta_k)) + \alpha(\exp(\delta_j))}{(1 + \sum_{k=1}^{n} \exp(\delta_k))^2}$$

$$\frac{\delta s_j}{\delta p_j} = \frac{-\alpha[(1 + \sum_{k=1}^{n} \exp(\delta_k)) - (\exp(\delta_j))]}{(1 + \sum_{k=1}^{n} \exp(\delta_k))^2}$$

$$\frac{\delta s_j}{\delta p_j} = \frac{-\alpha[(1+\sum_{k=1}^{n}\exp(\delta_k))]}{(1+\sum_{k=1}^{n}\exp(\delta_k))^2} - \frac{-\alpha[(-\exp(\delta_j))]}{(1+\sum_{k=1}^{n}\exp(\delta_k))^2}$$

$$\frac{\delta s_j}{\delta p_j} = \frac{-\alpha[(1+\sum_{k=1}^{n}\exp(\delta_k)) * \exp(\delta_j)]}{(1+\sum_{k=1}^{n}\exp(\delta_k))^2} - \frac{-\alpha[(-\exp(\delta_j)) * \exp(\delta_j)]}{(1+\sum_{k=1}^{n}\exp(\delta_k))^2}$$

$$\frac{\delta s_j}{\delta p_j} = \frac{-\alpha\exp(\delta_j)}{1+\sum_{k=1}^{n}\exp(\delta_k)} - \frac{-\alpha(\exp(\delta_j))^2}{(1+\sum_{k=1}^{n}\exp(\delta_k))^2}$$

$$\frac{\delta s_j}{\delta p_j} = -\alpha\left[\frac{\exp(\delta_j)}{1+\sum_{k=1}^{n}\exp(\delta_k)} - \frac{(\exp(\delta_j))^2}{(1+\sum_{k=1}^{n}\exp(\delta_k))^2}\right]$$

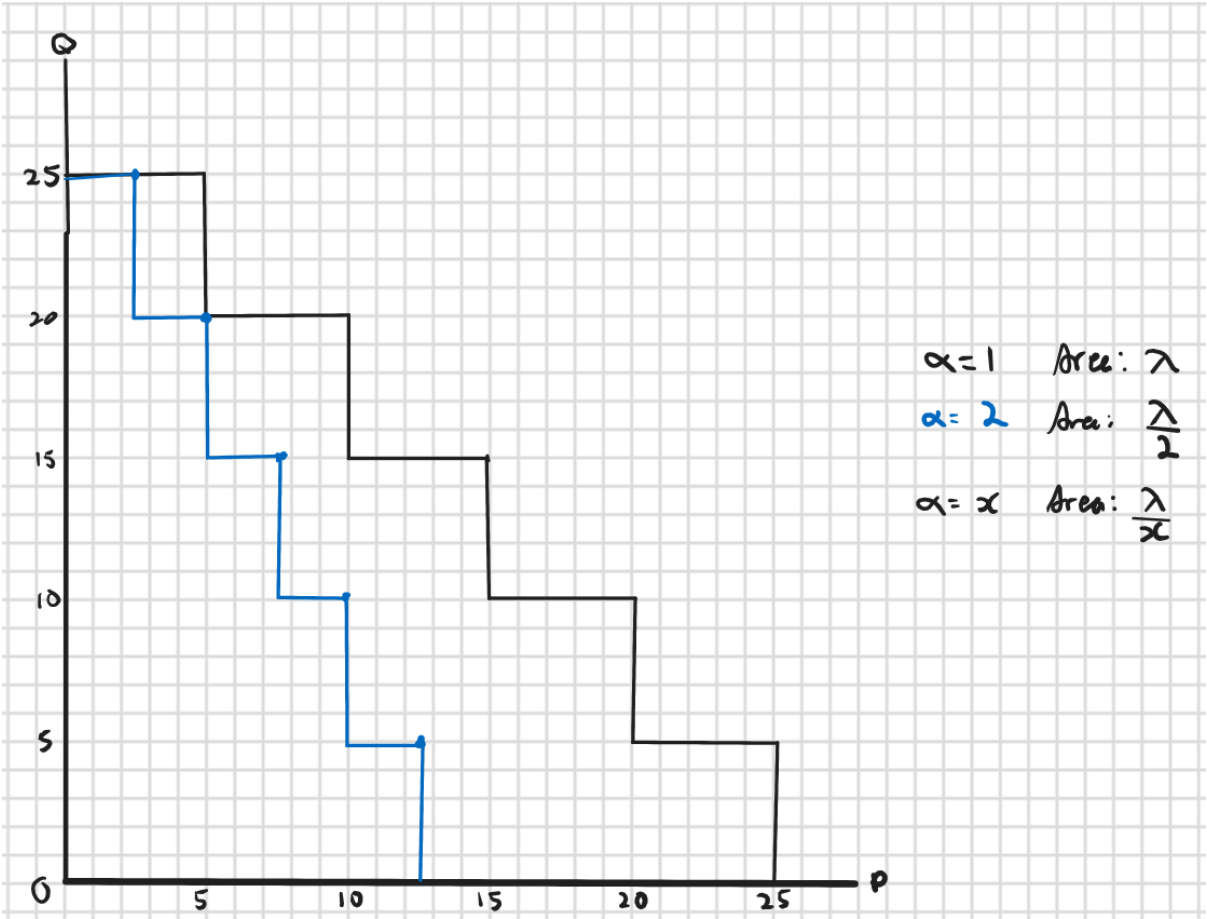
$$\frac{\delta s_j}{\delta p_j} = -\alpha(s_j - s_j^2)$$

$$\frac{\delta s_j}{\delta p_j} = -\alpha s_j(1-s_j)$$

$$\eta_j = \frac{\delta s_j}{\delta p_j} * \frac{p_j}{s_j} = -\alpha p_j(1-s_j)$$

A4. The effect of α on equations

This hand drawn graph below shows the effect of the gradient on the area of the graph. The higher the gradient (price coefficient in the context of the demand curve), the smaller the area underneath the graph.



A5. Full regression coefficient table

Versions	1	2	3	4
Dependent variable	$\ln(s_j) - \ln(s_0)$	$\ln(s_j) - \ln(s_0)$	$\ln(s_j) - \ln(s_0)$	$\ln(s_j) - \ln(s_0)$
Independent variable				
Average fare	-0.0336***	-0.0331***	-0.0346***	-0.0150***
	-0.000814	-0.000791	-0.00122	-0.00163
1994Q1 (base)		0	0	0
1994Q2		0.0993	0.091	0.171***
		-0.0714	-0.074	-0.0468
1994Q3		0.0165	0.000311	0.176***
		-0.0715	-0.0745	-0.0485
1994Q4		0.0855	0.072	0.219***
		-0.0713	-0.0741	-0.0477
1995Q1		-0.0041	-0.0119	0.0867*
		-0.0719	-0.0744	-0.0473
1995Q2		0.302***	0.301***	0.296***
		-0.071	-0.0734	-0.0461
1995Q3		0.243***	0.242***	0.248***
		-0.0713	-0.0737	-0.0463
1995Q4		-0.0811	-0.101	0.144***
		-0.0716	-0.0749	-0.0504
1996Q1		-0.731***	-0.776***	-0.215***
		-0.0747	-0.0817	-0.0658
1996Q2		-0.284***	-0.317***	0.107*
		-0.0736	-0.0785	-0.0584
1996Q3		-0.302***	-0.336***	0.0876
		-0.0732	-0.0782	-0.0581
1996Q4		-0.373***	-0.411***	0.0775
		-0.0743	-0.0799	-0.0617
1997Q1		-0.346***	-0.376***	0.019
		-0.0743	-0.0789	-0.0574
1997Q2		-0.0568	-0.0841	0.269***
		-0.0732	-0.0774	-0.0551
1997Q3		-0.0486	-0.075	0.284***
		-0.0739	-0.0779	-0.0556

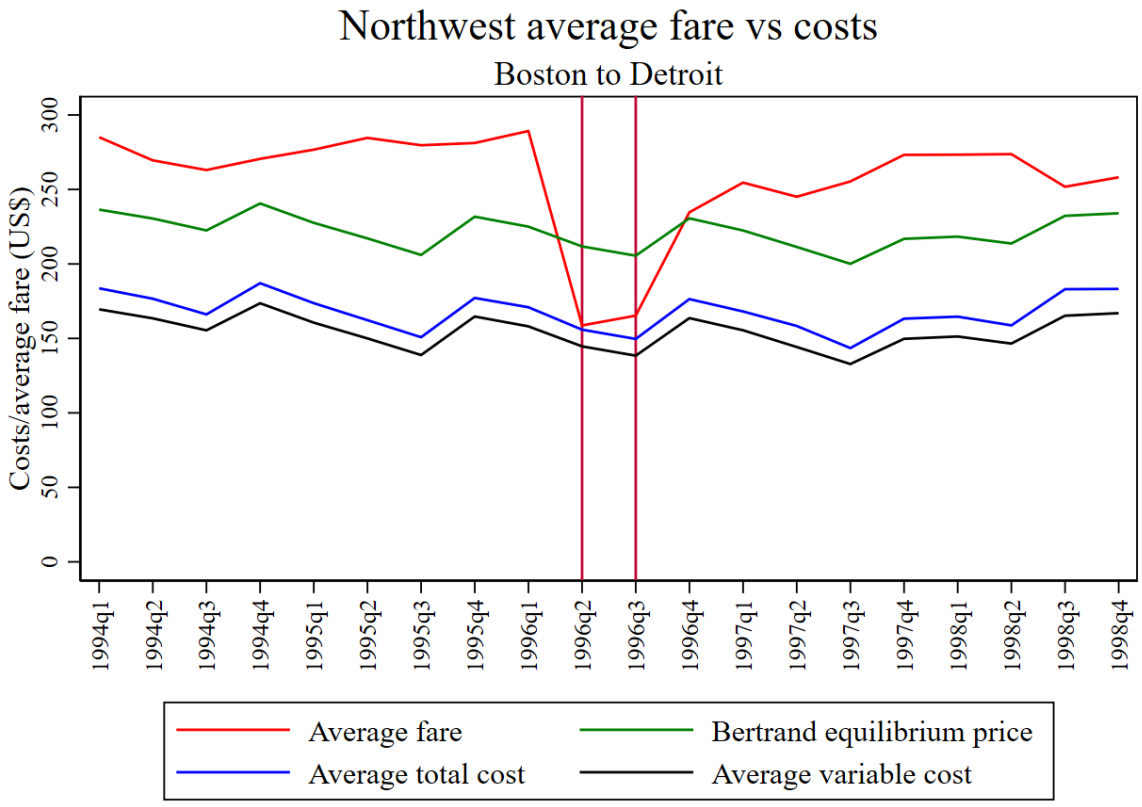
1997Q4		-0.084	-0.107	0.226***
		-0.0739	-0.0777	-0.0547
1998Q1		-0.240***	-0.266***	0.0414
		-0.0736	-0.0774	-0.0536
1998Q2		0.0572	0.0315	0.347***
		-0.0731	-0.077	-0.0536
1998Q3		0.00884	-0.0191	0.315***
		-0.0726	-0.0768	-0.0541
1998Q4		0.155**	0.137*	0.379***
		-0.073	-0.0762	-0.0511
Coupons			0.0471**	-0.0540***
			-0.0218	-0.0149
Distance				-0.000248***
				-2.01E-05
Constant	2.838***	2.770***	3.046***	-1.773***
	-0.221	-0.23	-0.298	-0.402
Observations	59,028	59,028	59,028	59,028

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

A6. Northwest average fares vs costs

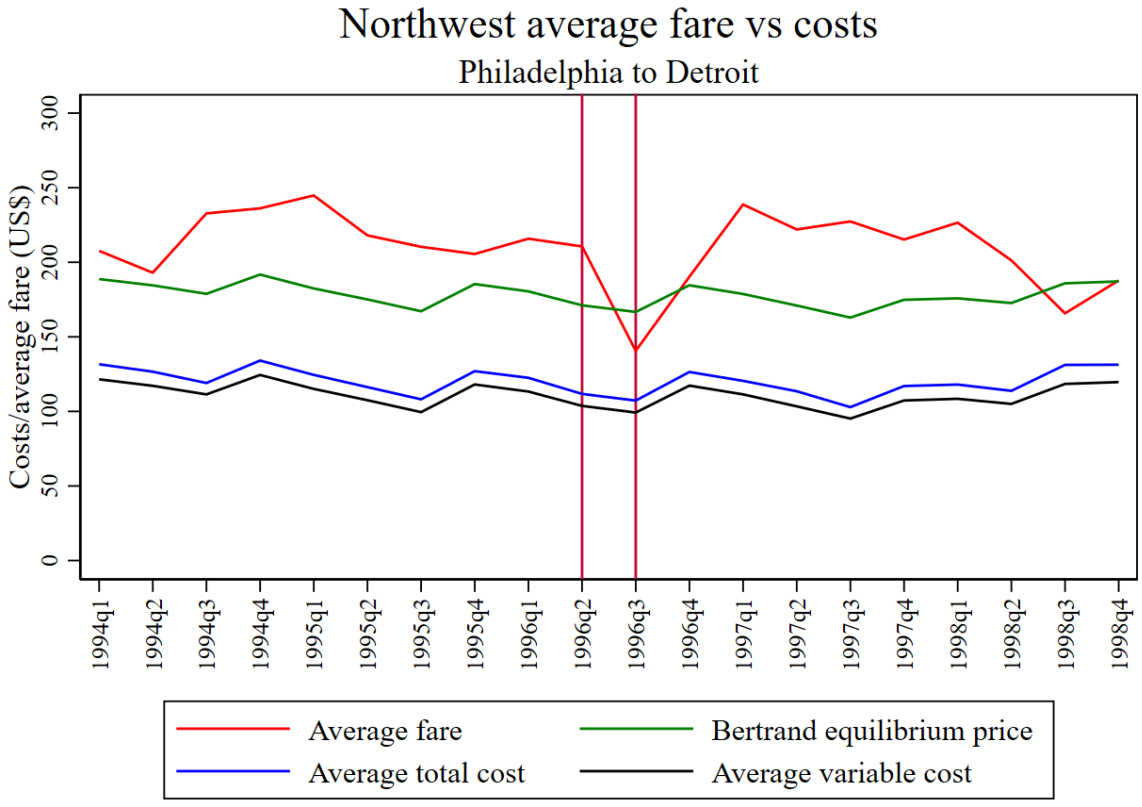
Boston to Detroit

Year and quarter	Airline	Average variable cost (US$)	Bertrand equilibrium price (US$)	Airline average fare (US$)	Average total cost (US$)
1996Q1	Continental	162.0197	228.9235	211.6726	174.5413
	Northwest	158.0895	225.0295	289.2291	170.9437
1996Q2	Northwest	144.6658	211.7577	158.7345	155.8911
	Spirit	127.2691	194.518	144	133.8911
1996Q3	Continental	166.1827	233.1378	165.3689	175.9792
	Northwest	138.4396	205.5565	165.2995	149.6653
	Spirit	154.5202	221.5771	152	164.4745
1997Q2	Continental	147.9711	215.0807	233.3664	158.1659
	Northwest	144.2383	211.408	245.1112	158.3641

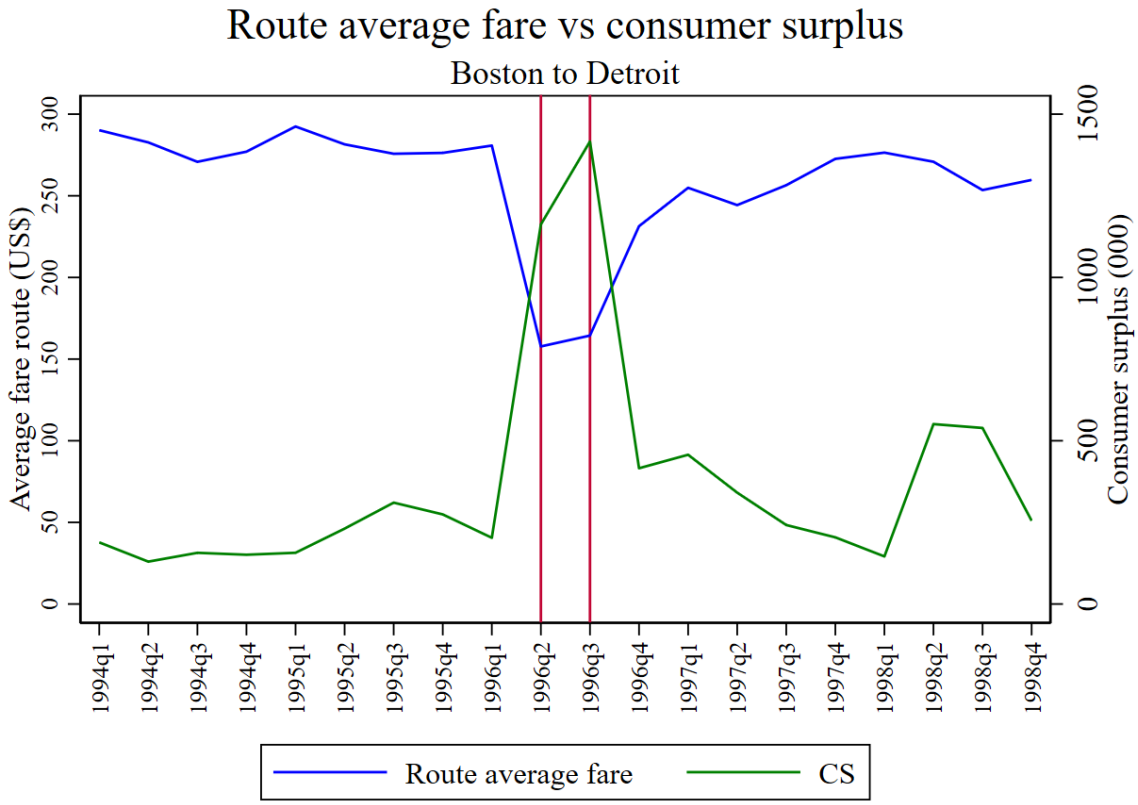


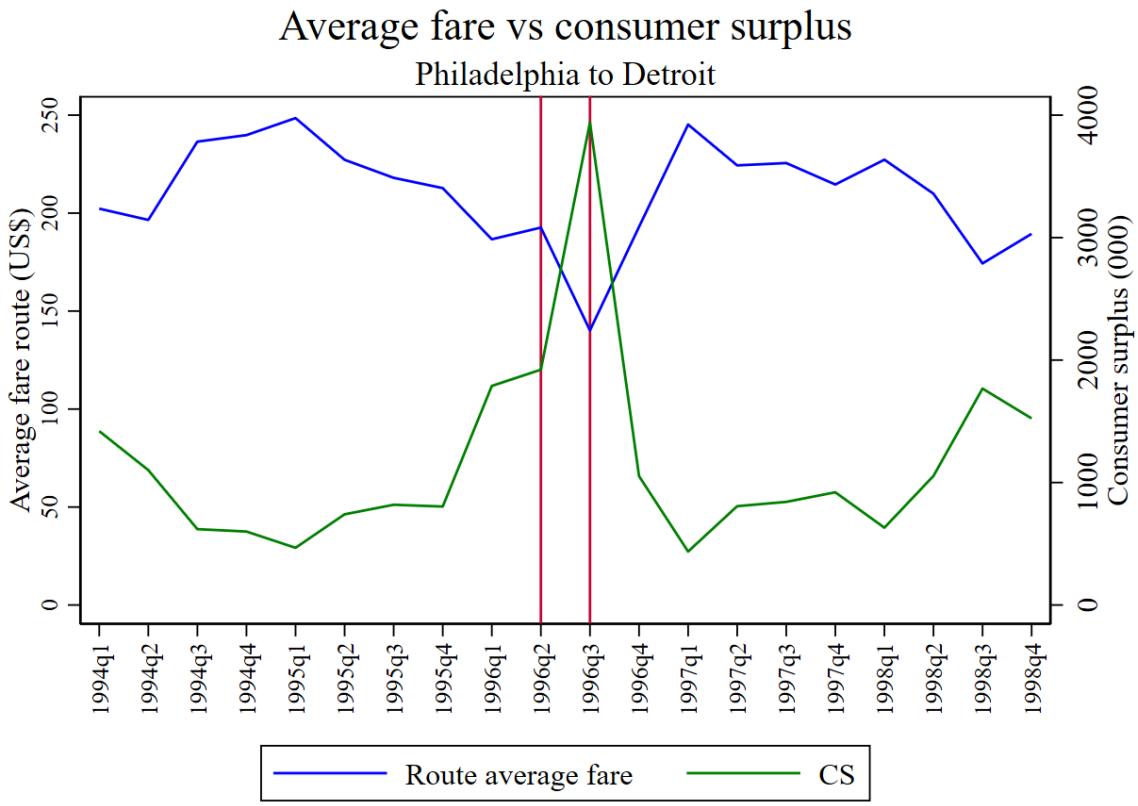
Philadelphia to Detroit

Year and quarter	Airline	Variable cost (US$)	Bertrand equilibrium price (US$)	Airline average fare (US$)	Total cost (US$)
1996Q1	Northwest	113.3142	180.4927	215.8247	122.5277
	Spirit	83.77718	151.2694	116	89.36411
	US	166.862	233.7728	275.131	184.977
1996Q2	Northwest	103.6924	171.1469	210.6361	111.7384
	Spirit	91.22292	158.8914	144	95.96938
	US	149.0063	216.0791	257.3807	163.607
1996Q3	Northwest	99.22968	166.7236	140.6303	107.2759
	Spirit	110.7558	178.1667	122	117.8908
	US	150.3342	217.3954	149.1843	165.9308
1997Q2	Northwest	103.386	170.9885	221.9814	113.511
	US	149.2693	216.4159	228.553	162.4881

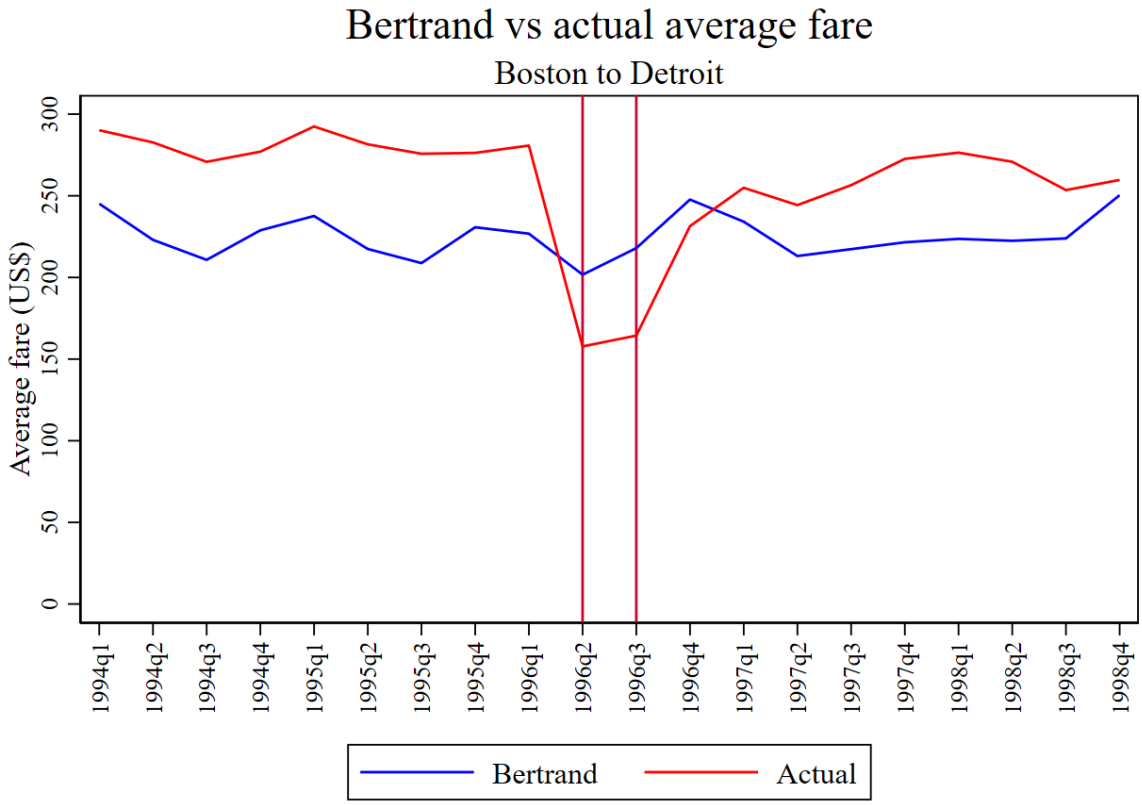


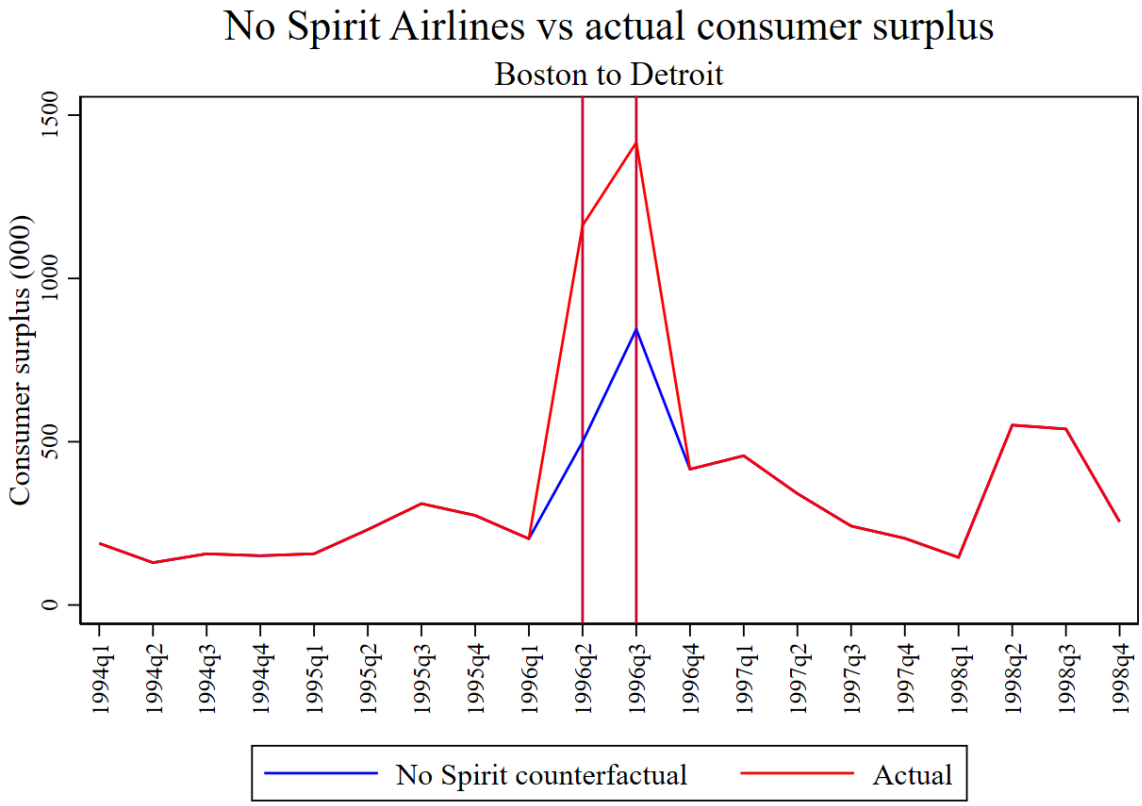
A7. Weighted average fare vs consumer surplus graphs

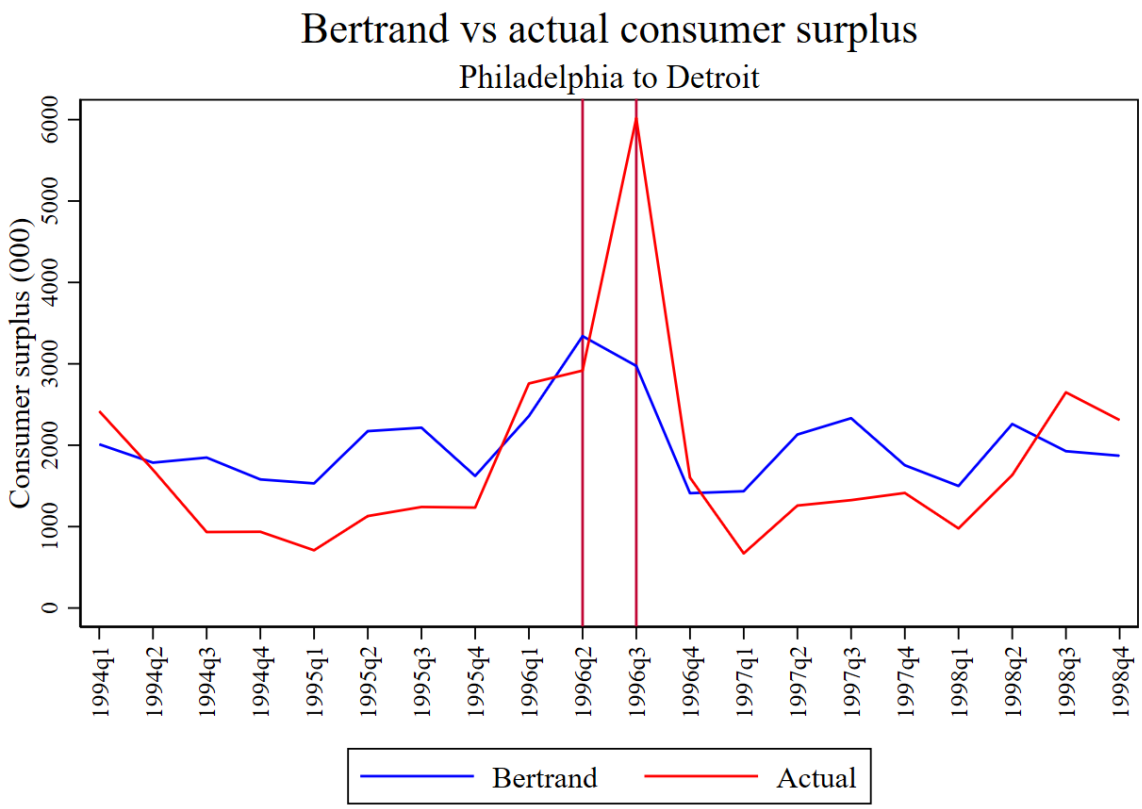


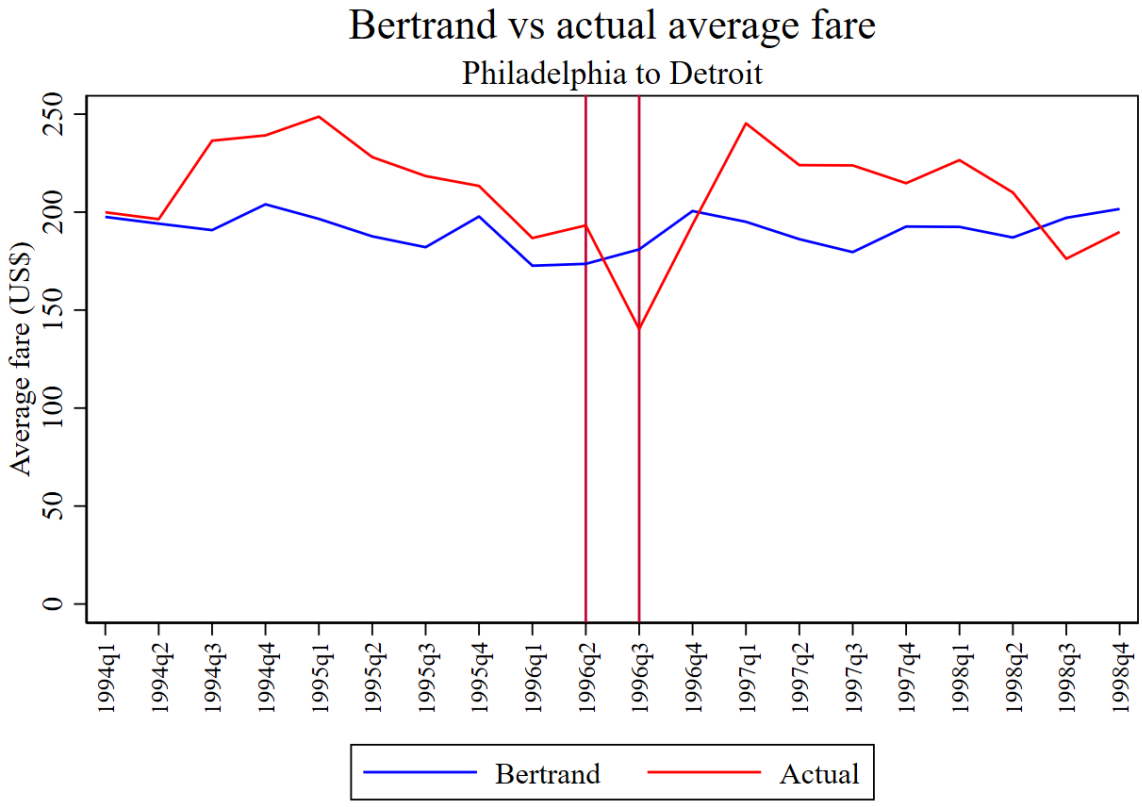


A8. Bertrand counterfactual

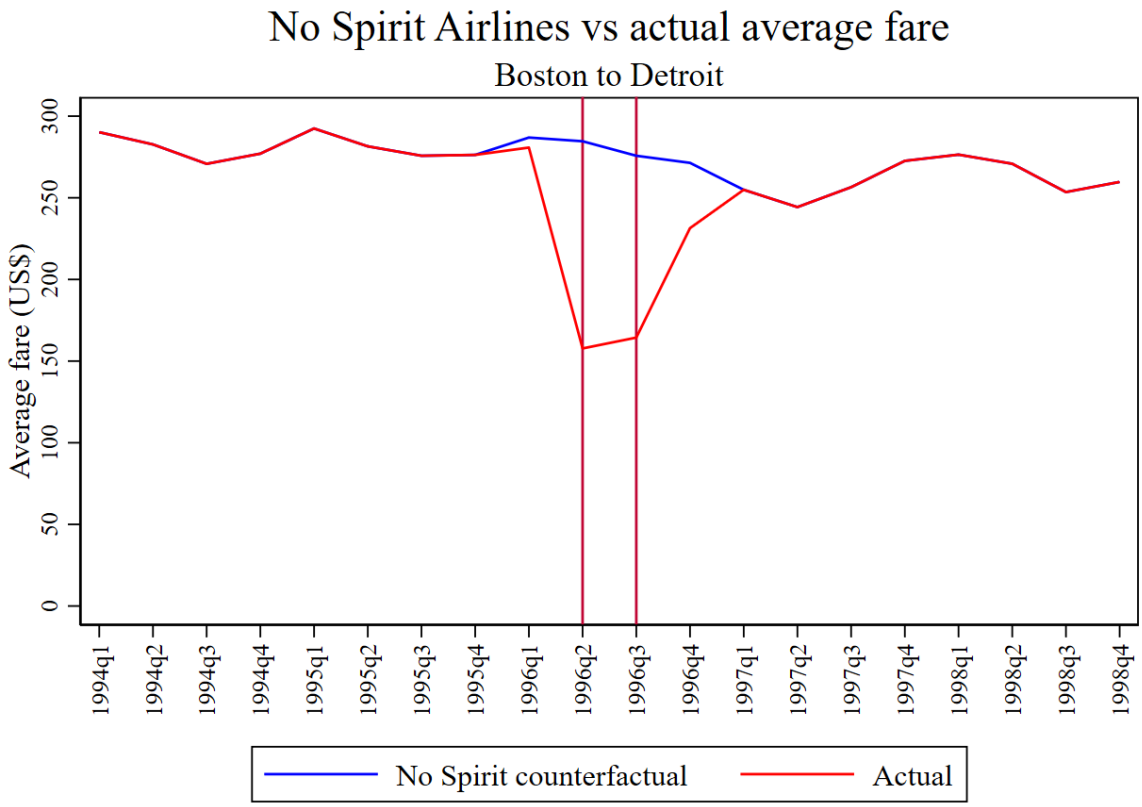


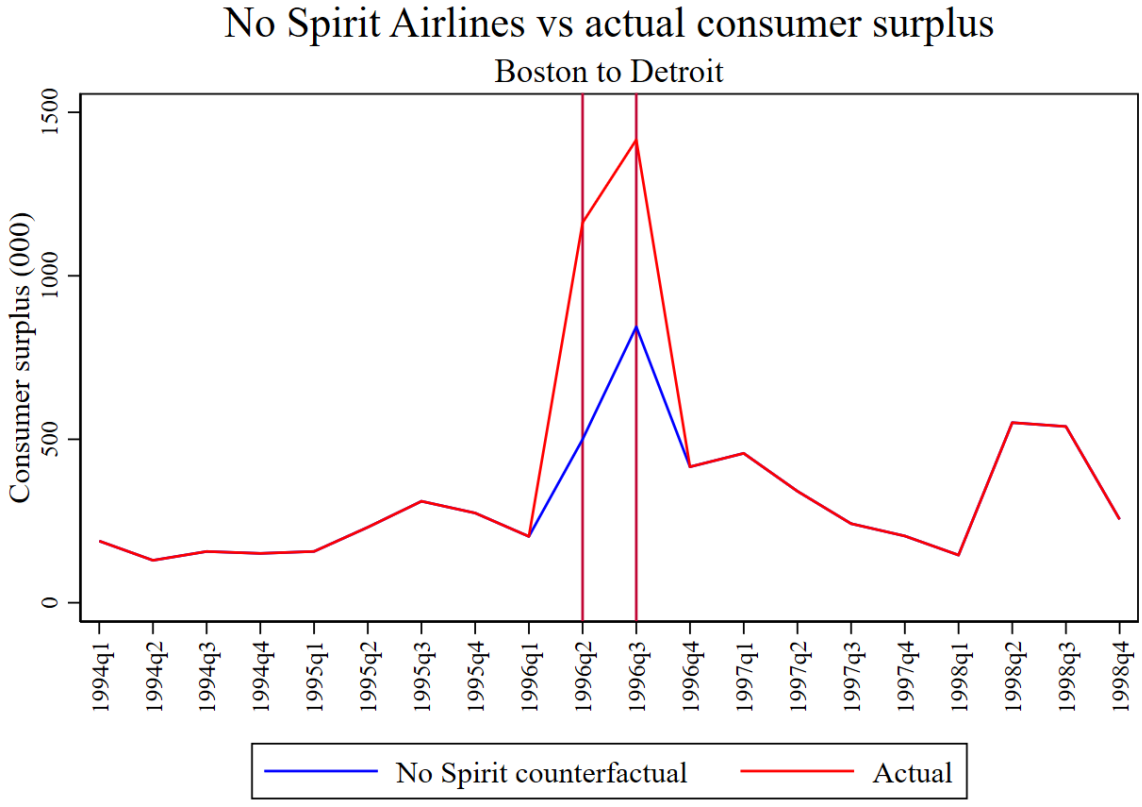


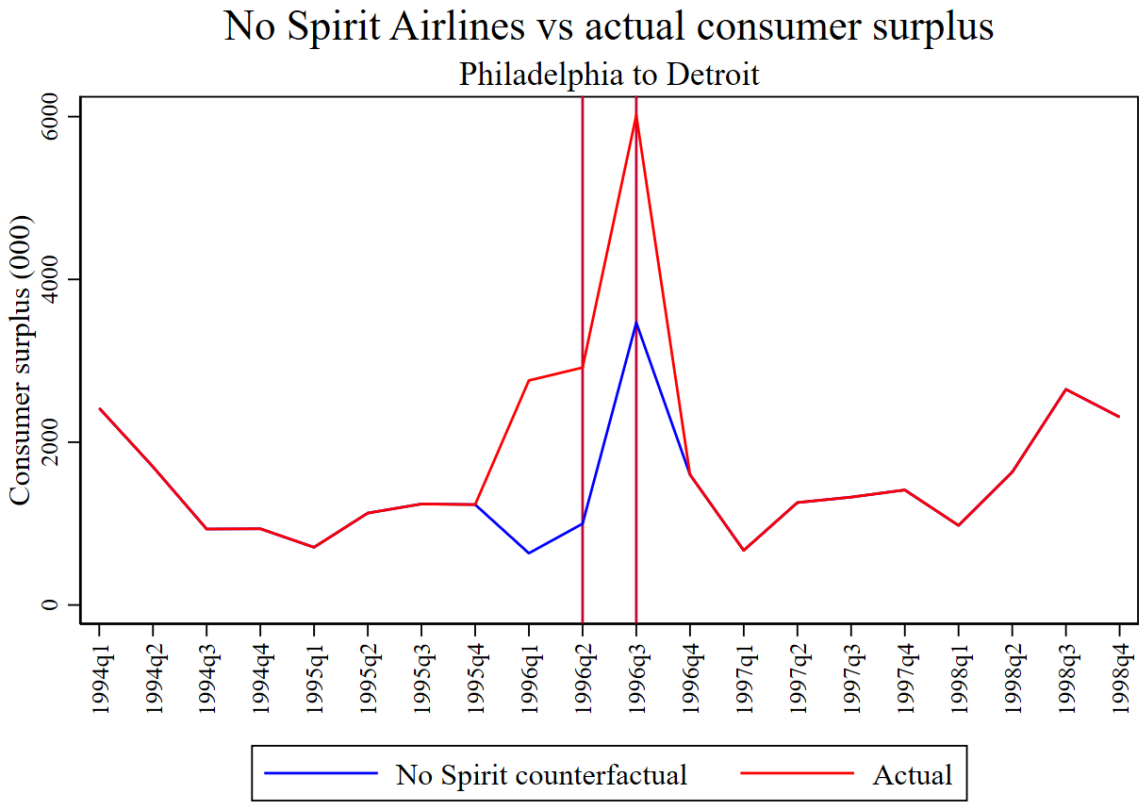

Bertrand vs actual consumer surplus
Philadelphia to Detroit
Consumer surplus (000)
0
1000
2000
3000
4000
5000
6000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Bertrand
Actual

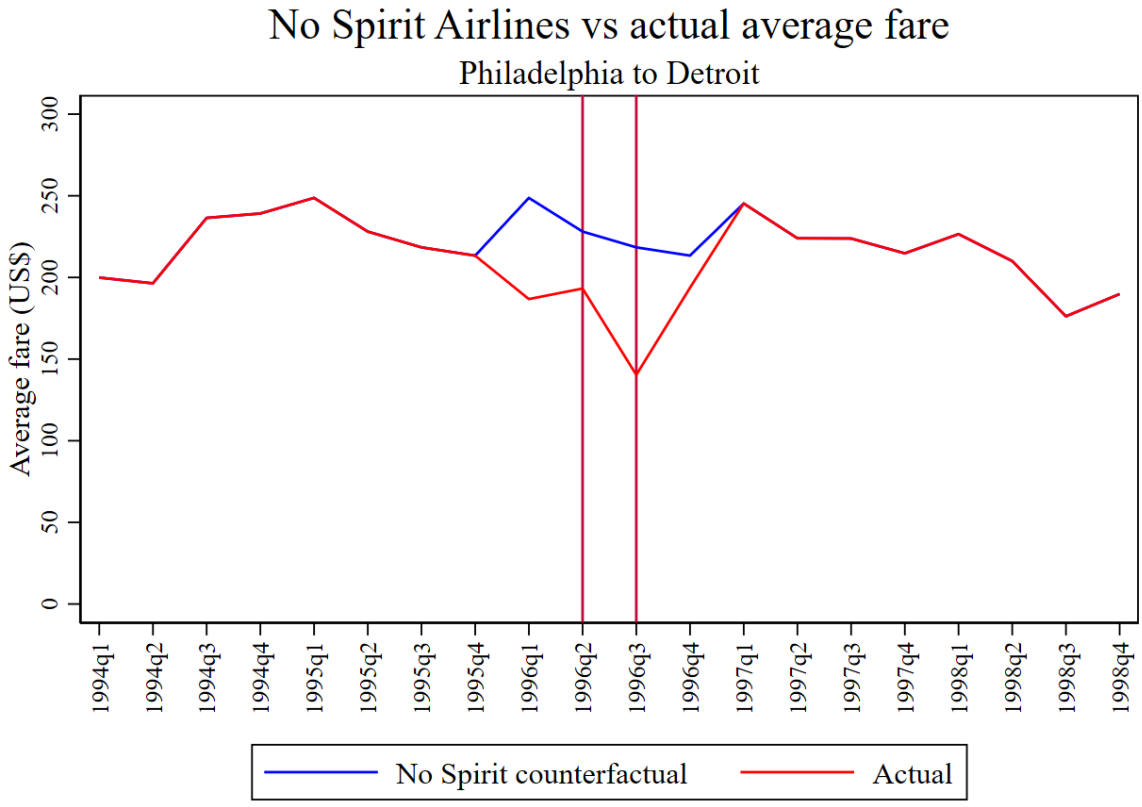

Bertrand vs actual average fare
Philadelphia to Detroit
Average fare (US$)
0
50
100
150
200
250
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Bertrand
Actual

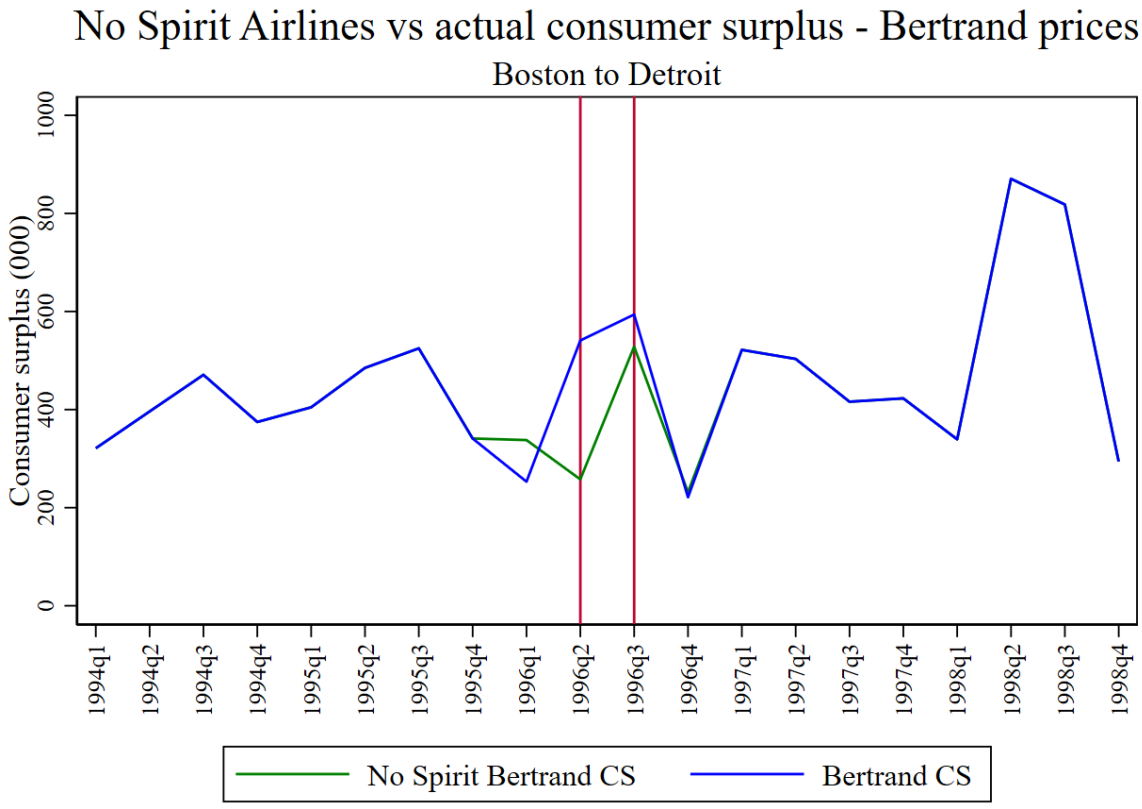
A9. No Spirit counterfactual

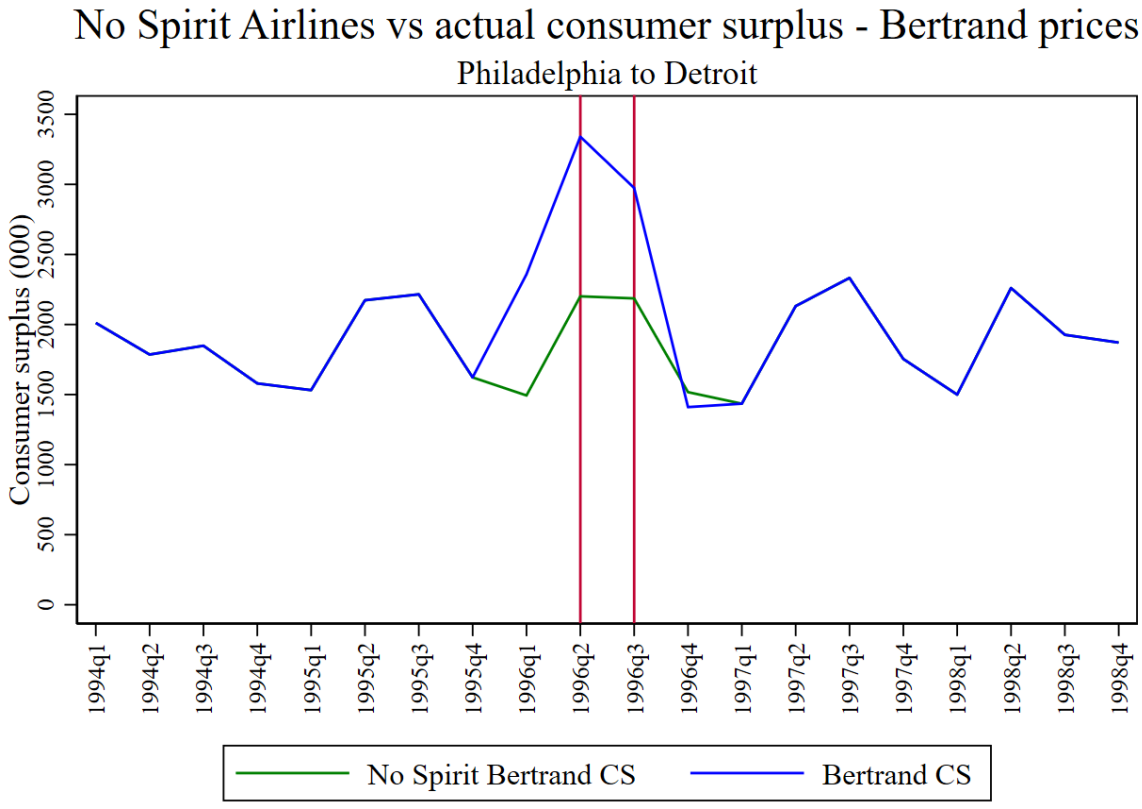




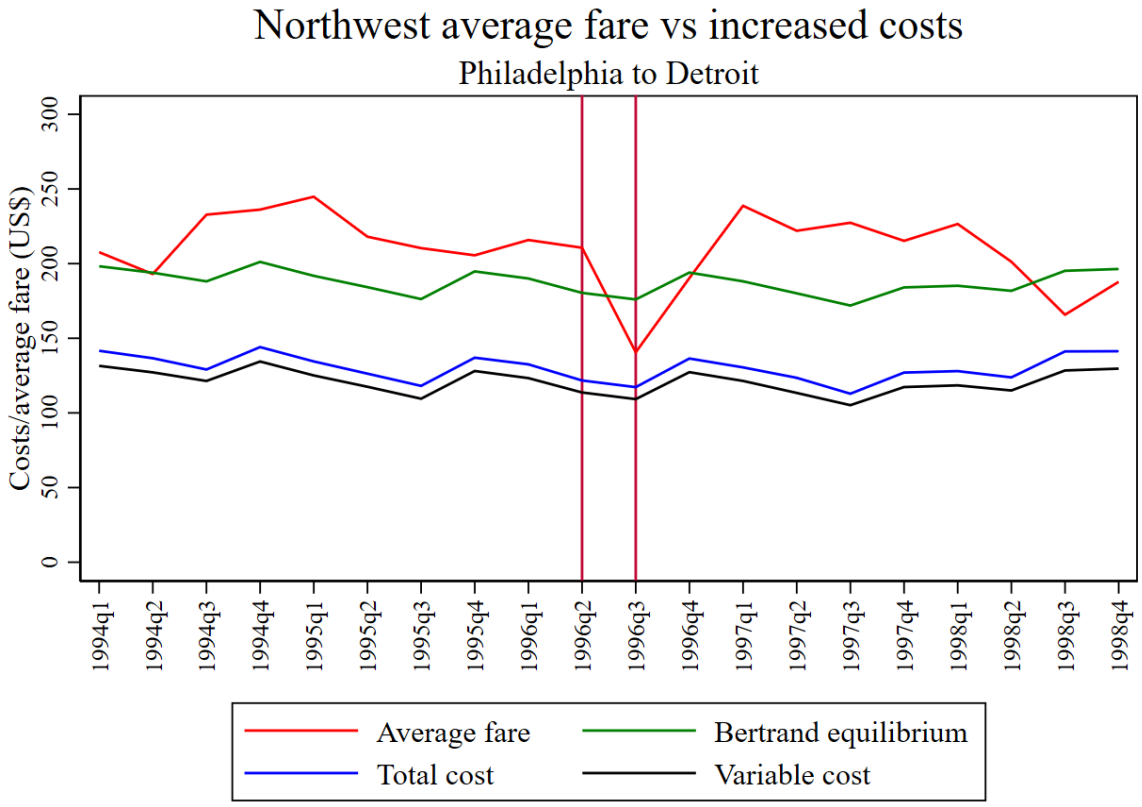

No Spirit Airlines vs actual consumer surplus
Philadelphia to Detroit
Consumer surplus (000)
0
2000
4000
6000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit counterfactual
Actual

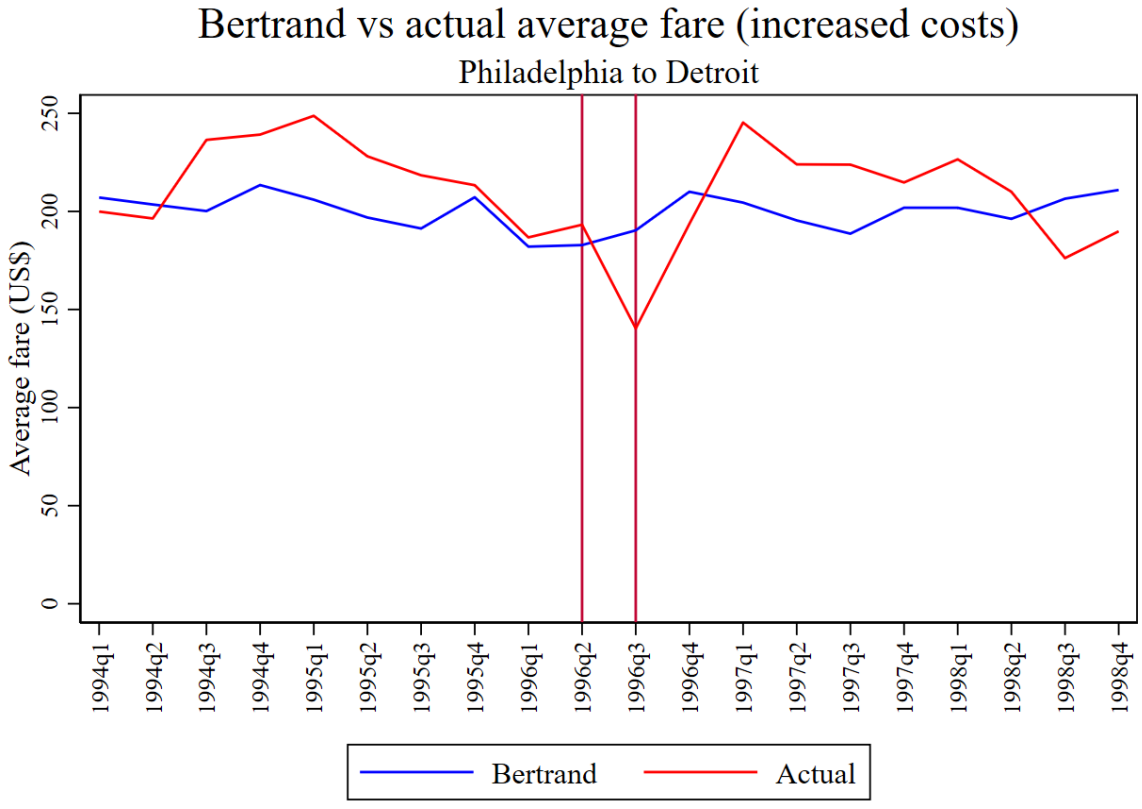

No Spirit Airlines vs actual average fare
Philadelphia to Detroit
Average fare (US$)
0
50
100
150
200
250
300
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit counterfactual
Actual

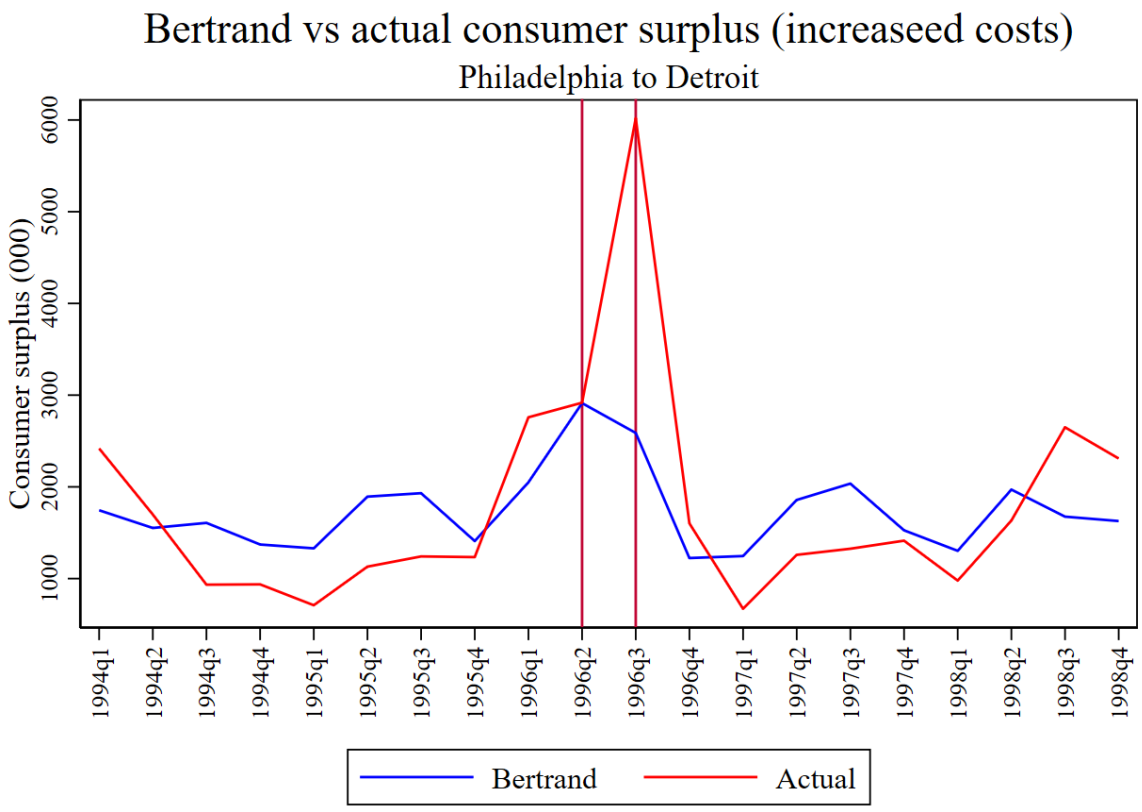

No Spirit Airlines vs actual consumer surplus - Bertrand prices
Boston to Detroit
Consumer surplus (000)
0
200
400
600
800
1000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit Bertrand CS
Bertrand CS


No Spirit Airlines vs actual consumer surplus - Bertrand prices
Philadelphia to Detroit
Consumer surplus (000)
0
500
1000
1500
2000
2500
3000
3500
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit Bertrand CS
Bertrand CS

A10. Increased cost for Detroit-Boston route

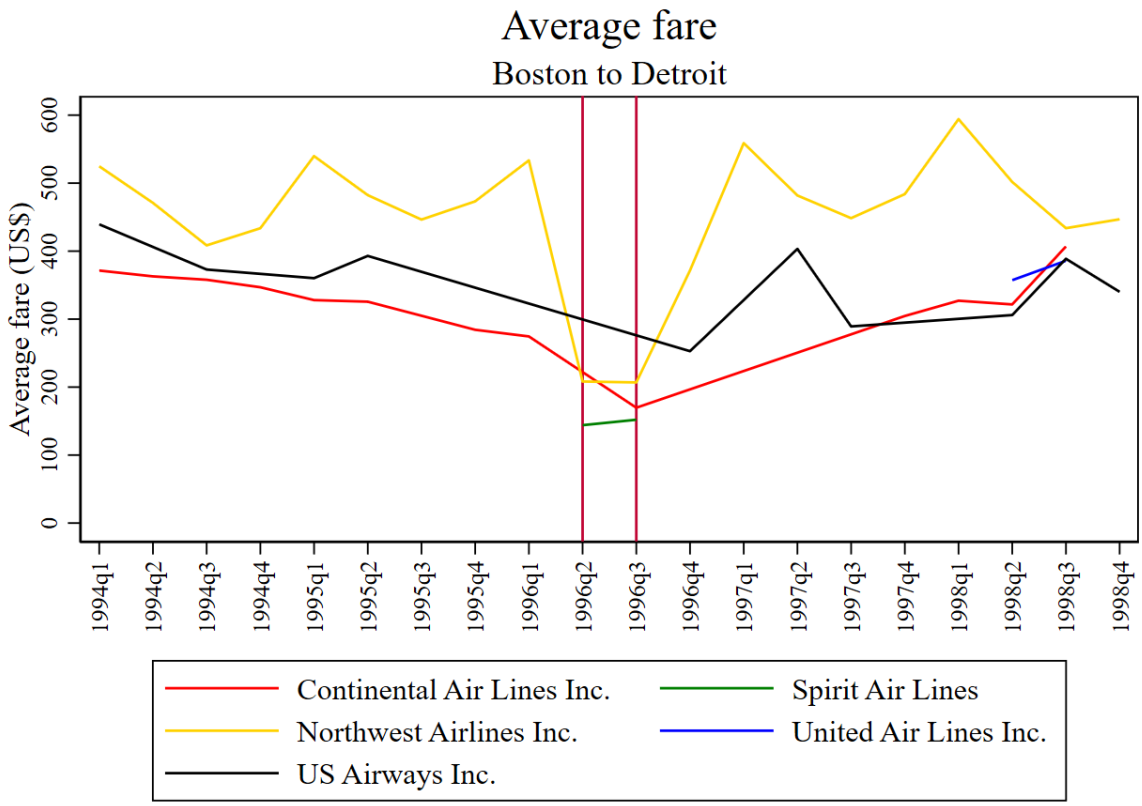


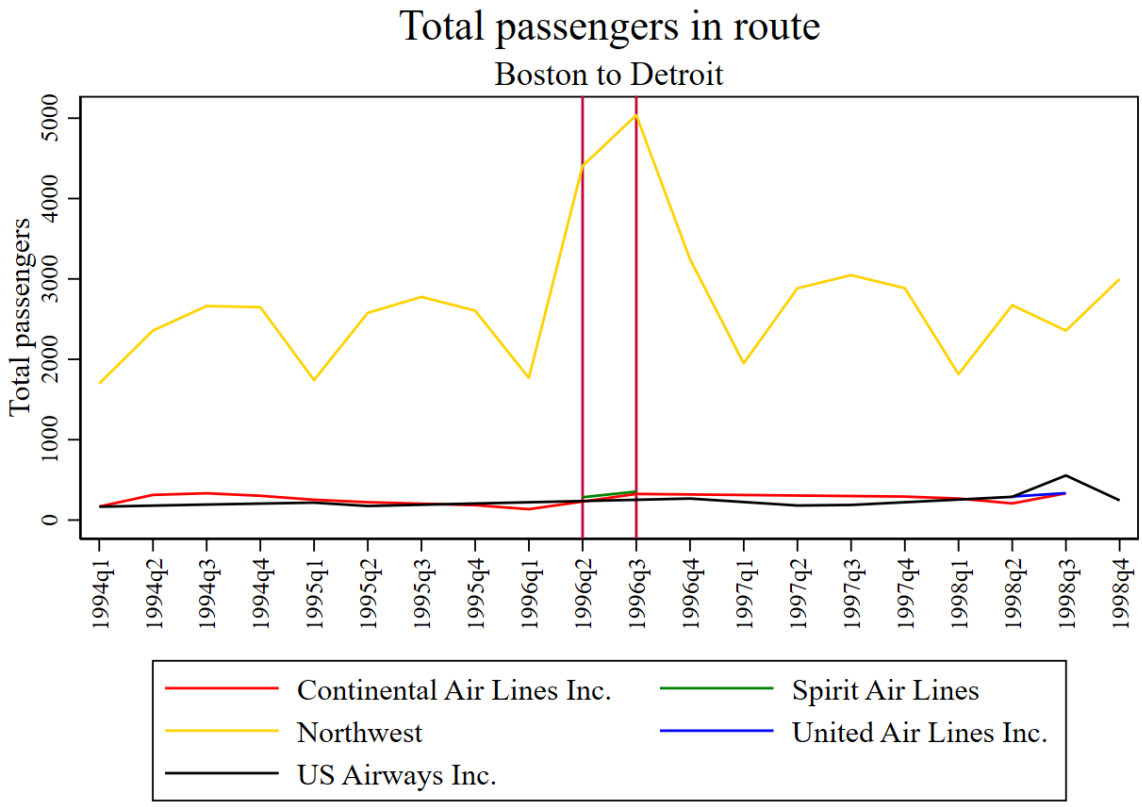


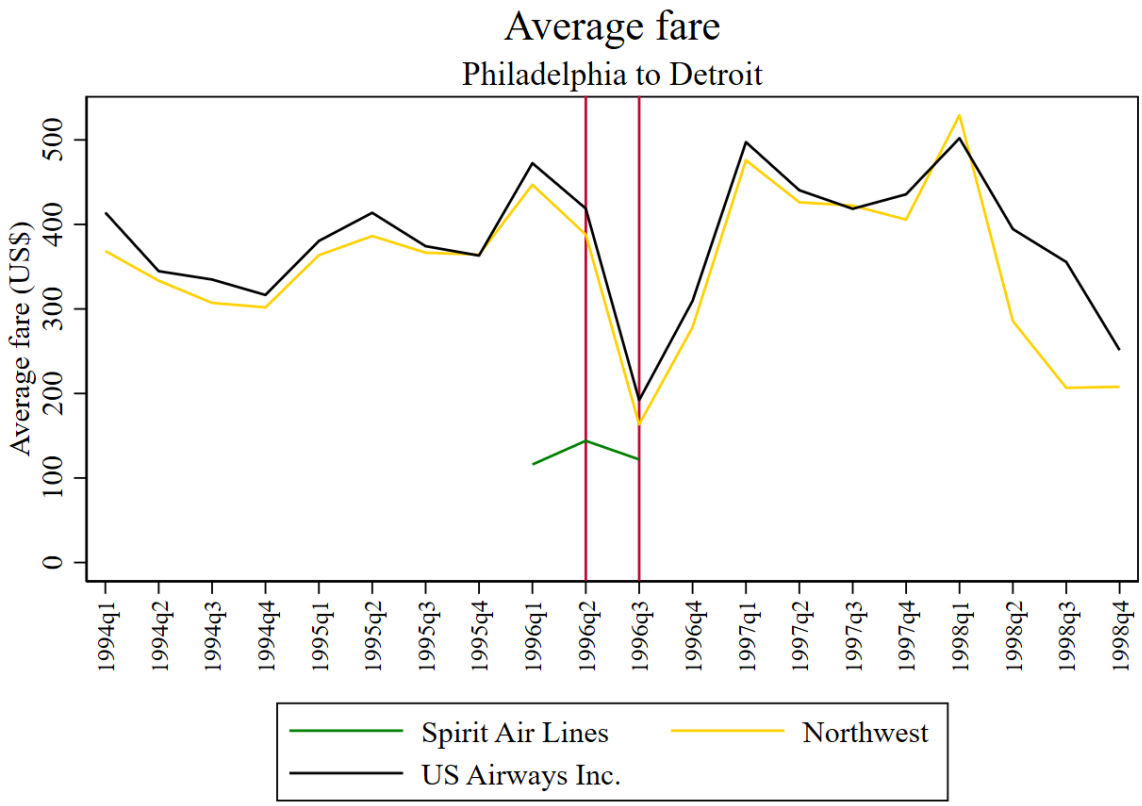


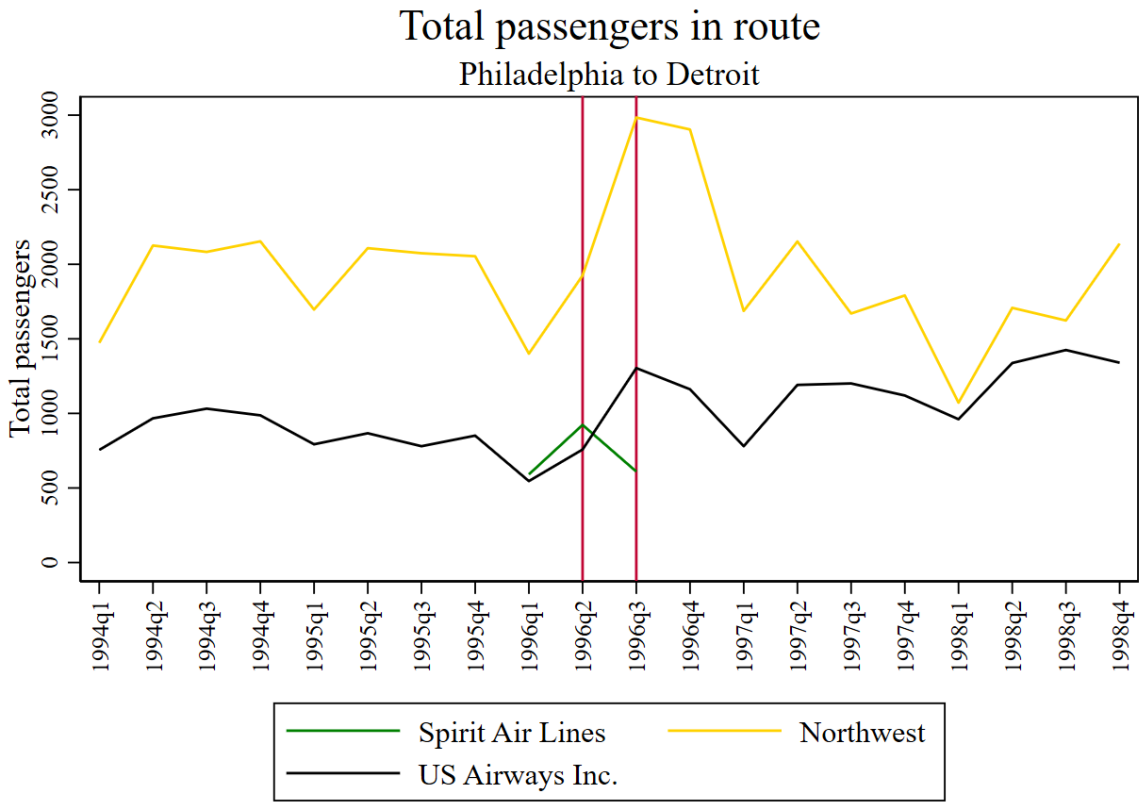
A11. Without the $450 fare filter

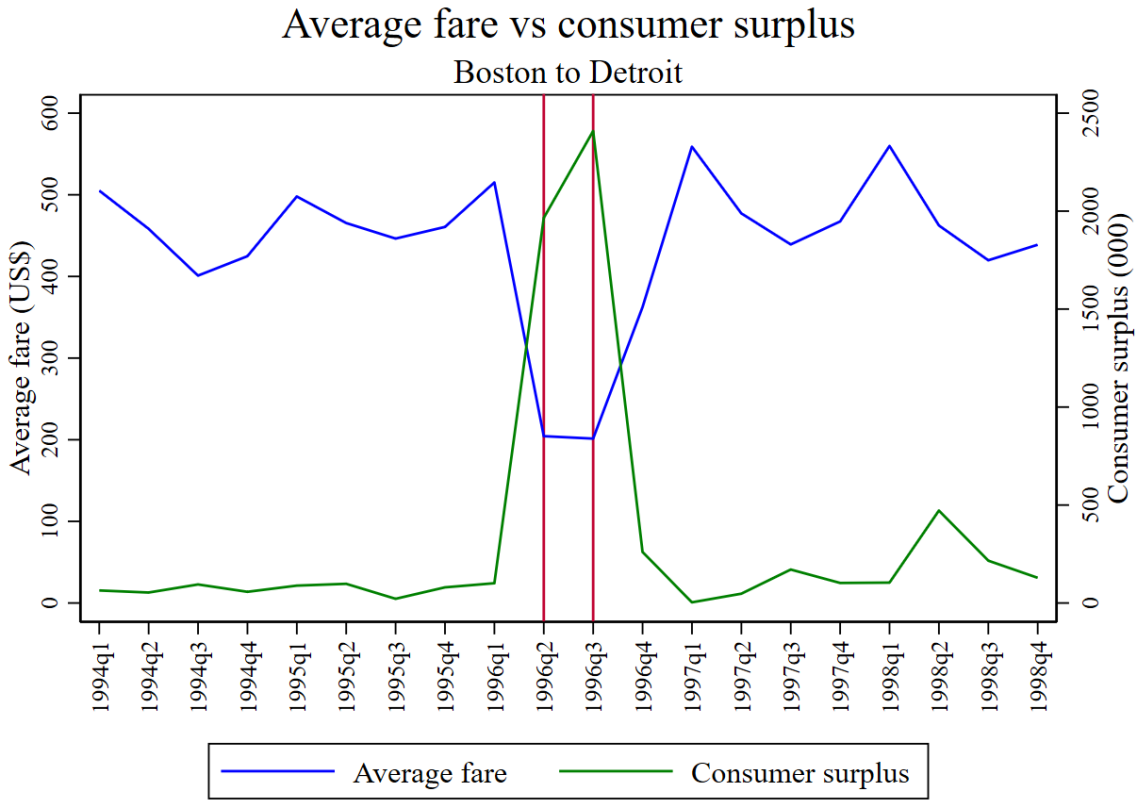
An earlier version of the dissertation did not have the fare filter. It was assumed, erroneously, that the whole economy roundtrip fare market consisted of price sensitive passengers. However, the graphs below show that it was not the case. There were some irregularities in the data and graphs, which necessitated a closer reading of the facts in *Spirit vs. Northwest*. Issues included the counterfactual Bertrand CS being unusually high compared to the actual CS and average fare for Northwest not being particularly close to the total cost.

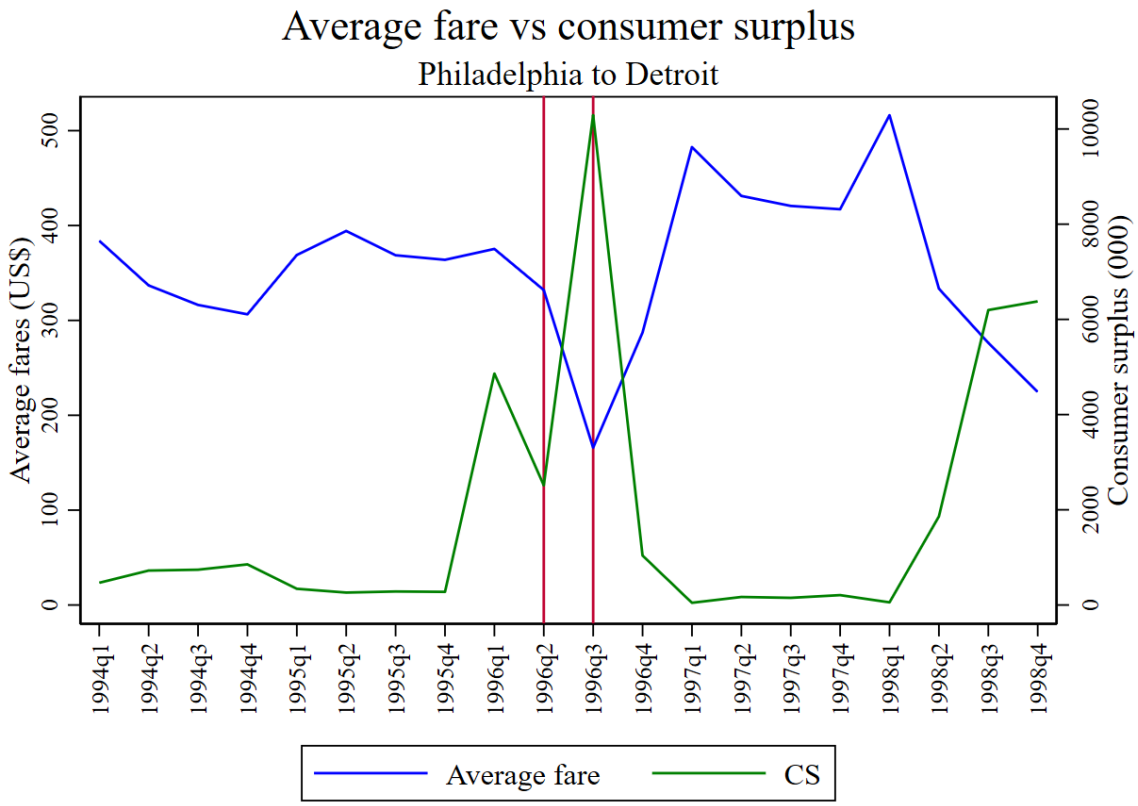

Average fare
Boston to Detroit
Average fare (US$)
0
100
200
300
400
500
600
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Continental Air Lines Inc.
Northwest Airlines Inc.
US Airways Inc.
Spirit Air Lines
United Air Lines Inc.

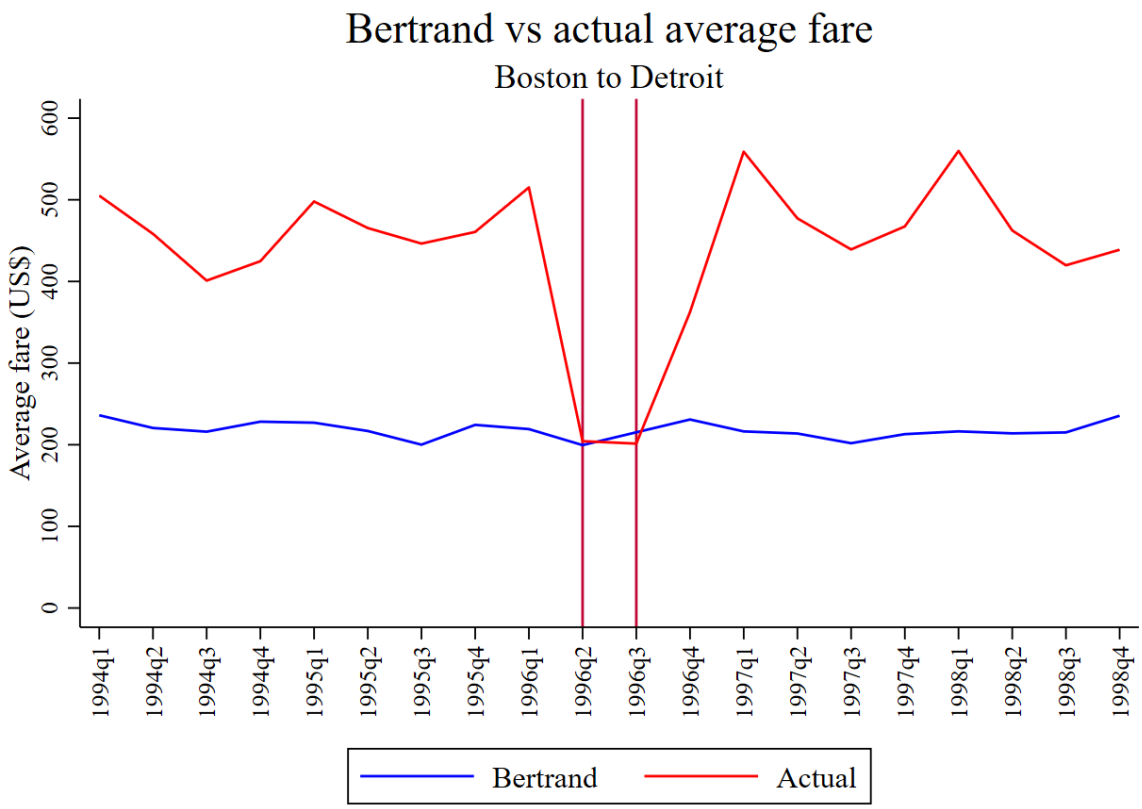

Total passengers in route
Boston to Detroit
Total passengers
0
1000
2000
3000
4000
5000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Continental Air Lines Inc.
Northwest
US Airways Inc.
Spirit Air Lines
United Air Lines Inc.

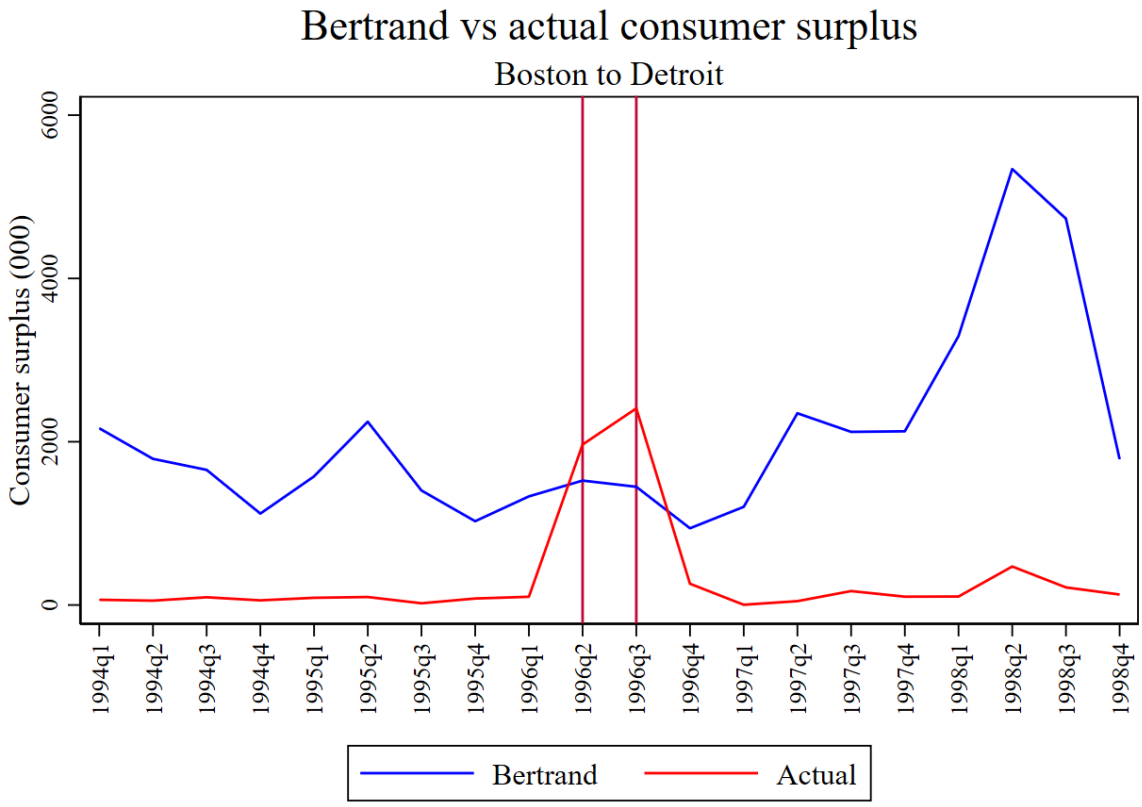

Average fare
Philadelphia to Detroit
Average fare (US$)
0
100
200
300
400
500
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Spirit Air Lines
Northwest
US Airways Inc.

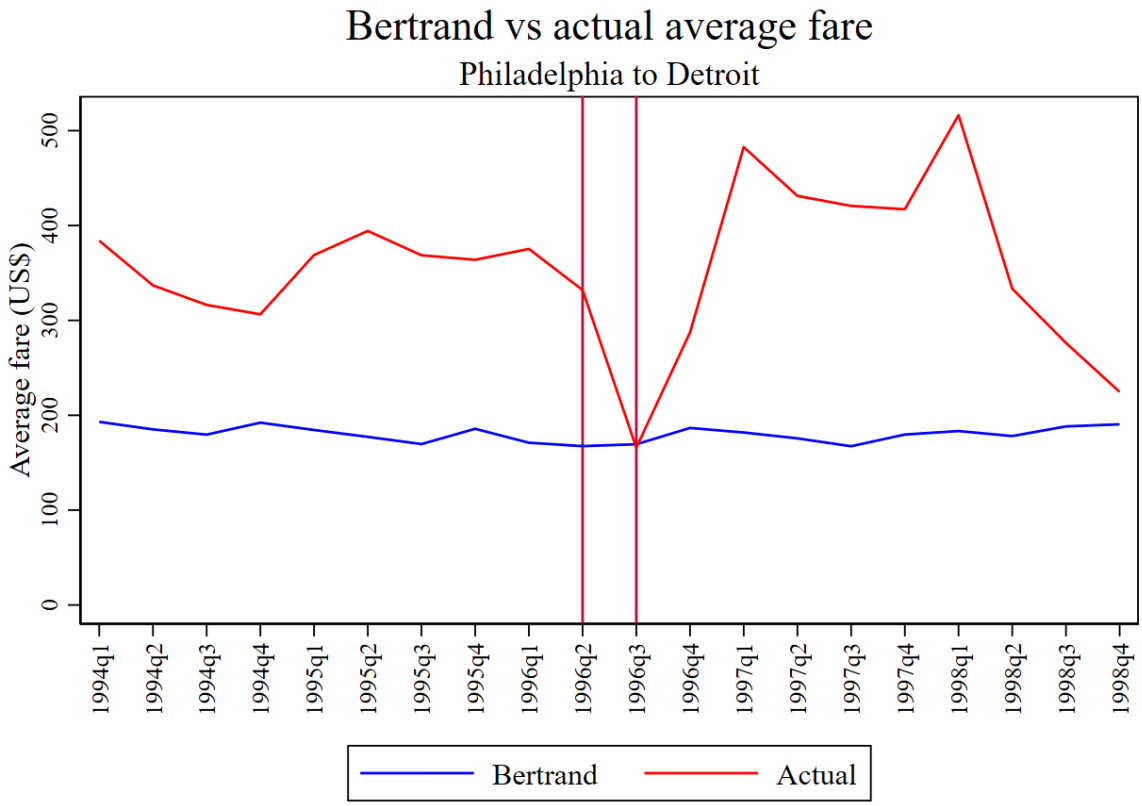

Total passengers in route
Philadelphia to Detroit
Total passengers
0
500
1000
1500
2000
2500
3000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Spirit Air Lines
Northwest
US Airways Inc.

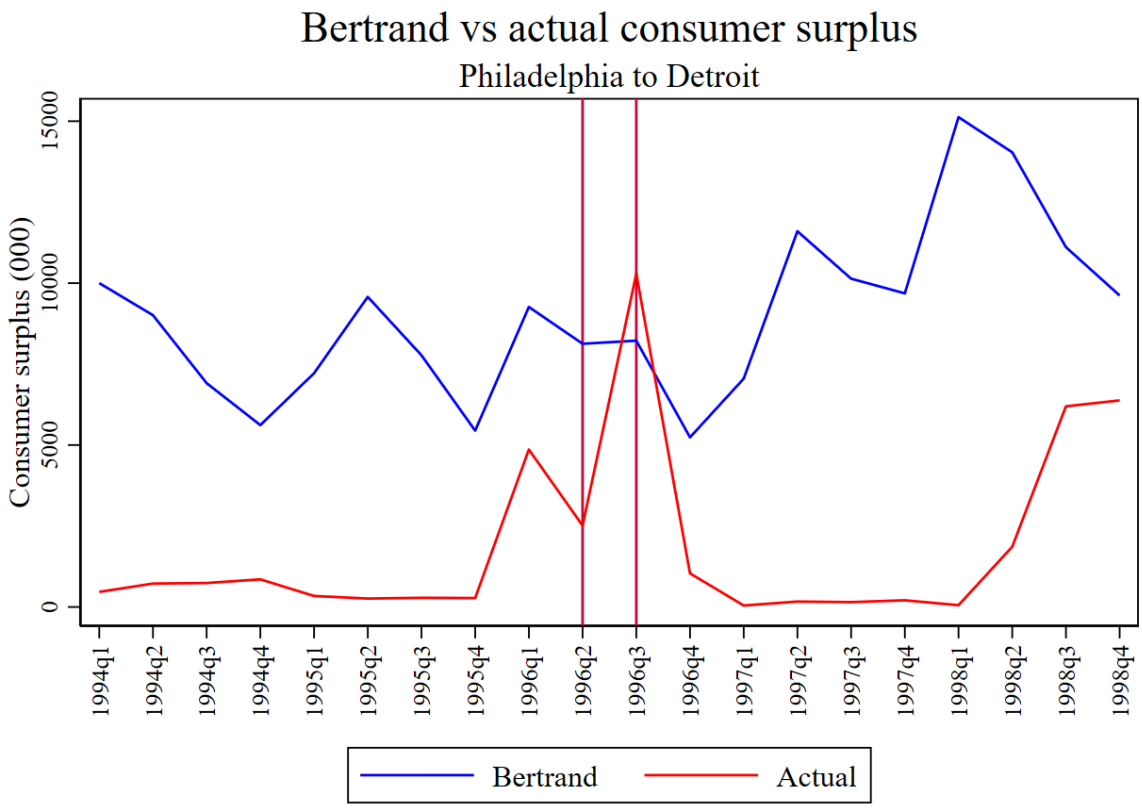

Average fare vs consumer surplus
Boston to Detroit
Average fare (US$)
0
100
200
300
400
500
600
Consumer surplus (000)
0
500
1000
1500
2000
2500
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Average fare
Consumer surplus

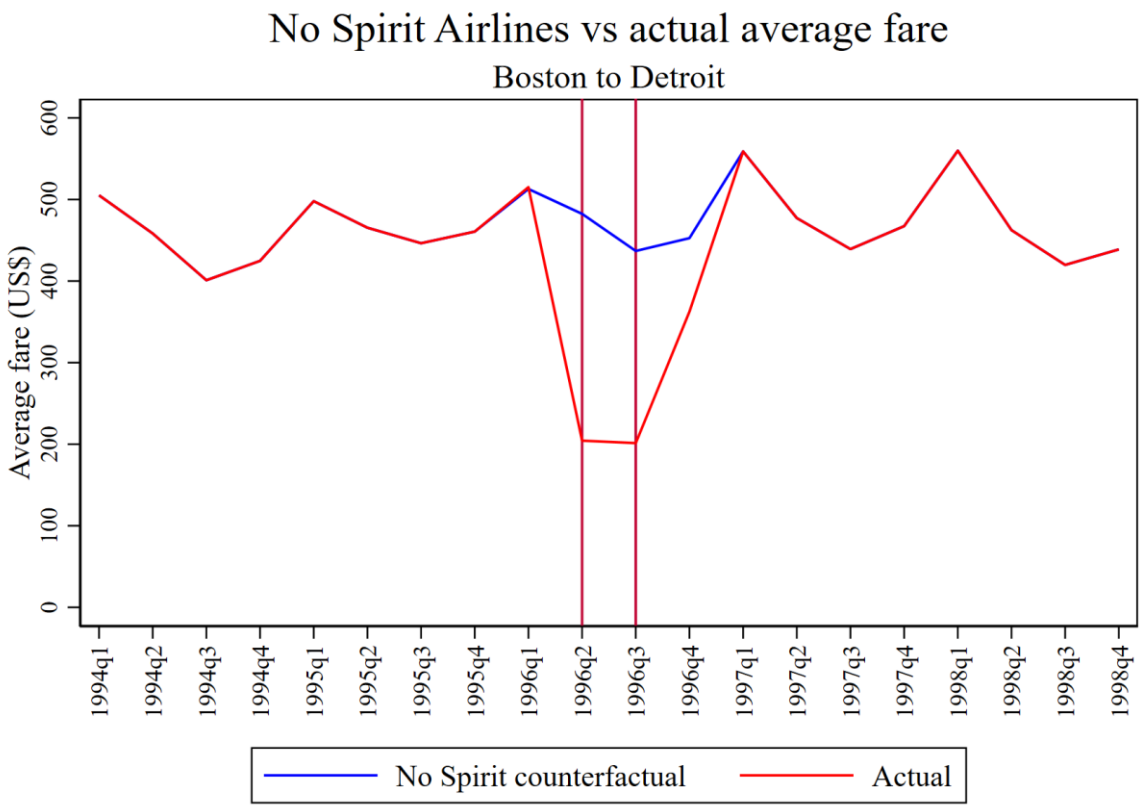

Average fare vs consumer surplus
Philadelphia to Detroit
Average fares (US$)
0
100
200
300
400
500
Consumer surplus (000)
0
2000
4000
6000
8000
10000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Average fare
CS

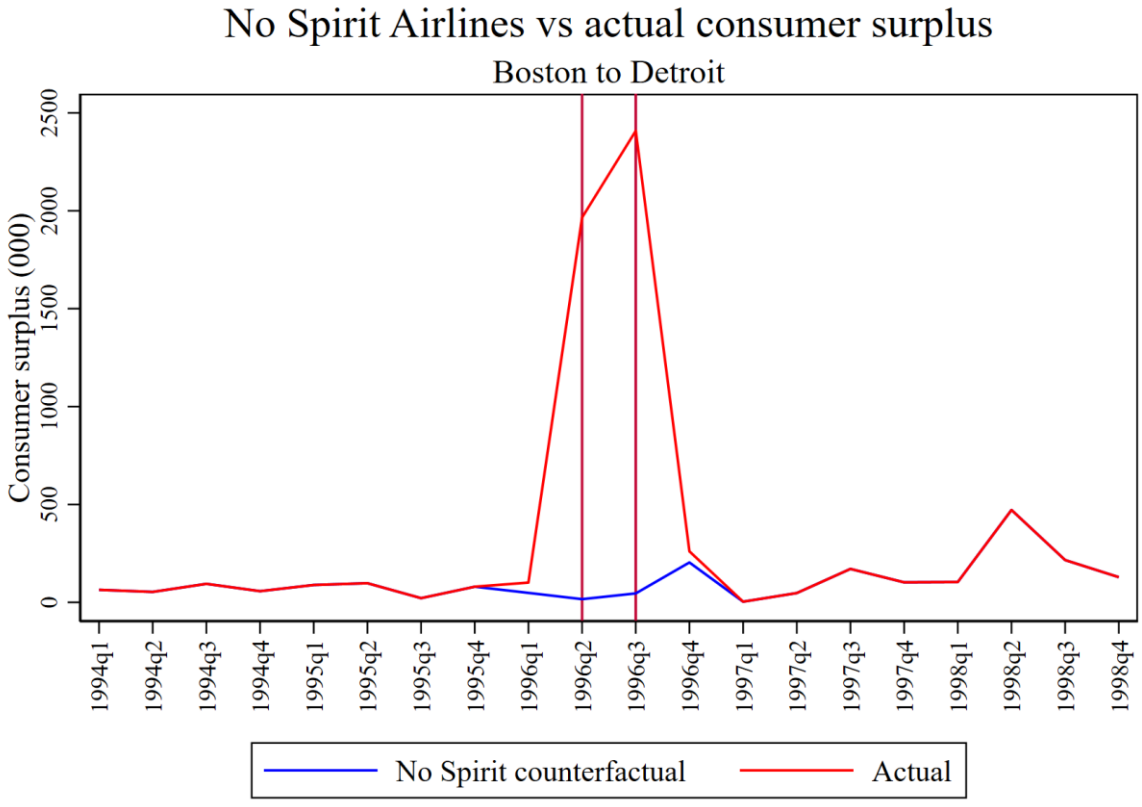

Bertrand vs actual average fare
Boston to Detroit
Average fare (US$)
0
100
200
300
400
500
600
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Bertrand
Actual

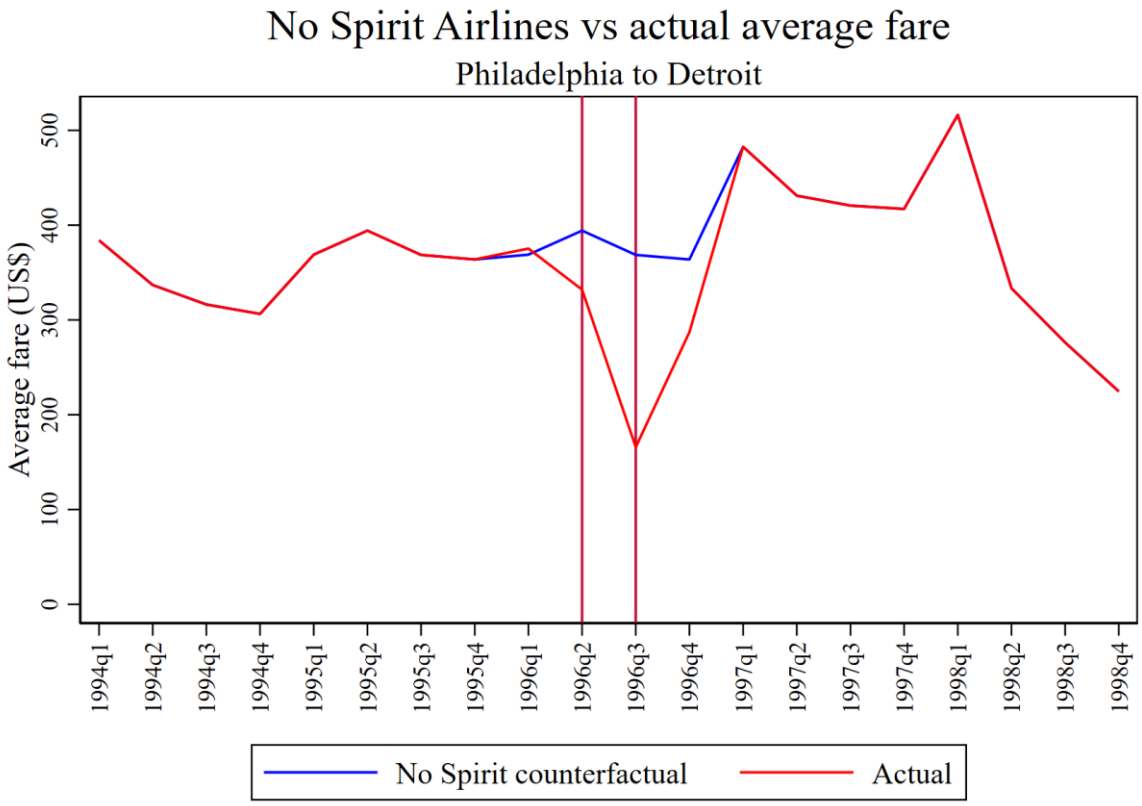

Bertrand vs actual consumer surplus
Boston to Detroit
Consumer surplus (000)
0
2000
4000
6000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Bertrand
Actual

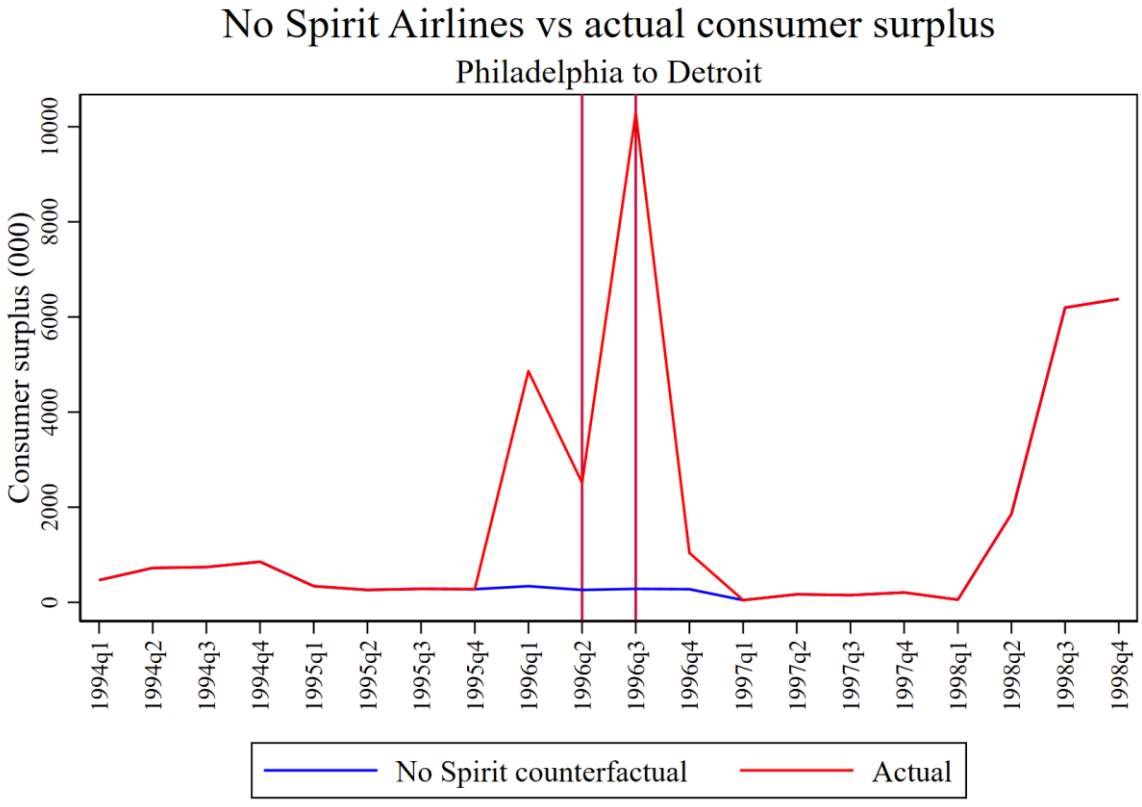

Bertrand vs actual average fare
Philadelphia to Detroit
Average fare (US$)
0
100
200
300
400
500
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Bertrand
Actual


Bertrand vs actual consumer surplus
Philadelphia to Detroit
Consumer surplus (000)
0
5000
10000
15000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
Bertrand
Actual


No Spirit Airlines vs actual average fare
Boston to Detroit
Average fare (US$)
0
100
200
300
400
500
600
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit counterfactual
Actual


No Spirit Airlines vs actual consumer surplus
Boston to Detroit
Consumer surplus (000)
0
500
1000
1500
2000
2500
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit counterfactual
Actual


No Spirit Airlines vs actual average fare
Philadelphia to Detroit
Average fare (US$)
0
100
200
300
400
500
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit counterfactual
Actual


No Spirit Airlines vs actual consumer surplus
Philadelphia to Detroit
Consumer surplus (000)
0
2000
4000
6000
8000
10000
1994q1
1994q2
1994q3
1994q4
1995q1
1995q2
1995q3
1995q4
1996q1
1996q2
1996q3
1996q4
1997q1
1997q2
1997q3
1997q4
1998q1
1998q2
1998q3
1998q4
No Spirit counterfactual
Actual