PLANE TO SEE?
EMPIRICAL ANALYSIS OF THE 1999-2006 AIR CARGO CARTEL

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ABSTRACT:

"Cargo tariffs are agreed through the IATA machinery, and in theory approved by governments....the IATA Tarff Coordination Conferences still agree cargo tariffs on over 200,000 separate routes. But these tariffs bear little relevance to what is actually charged in the marketplace " (Doganis, 2002).

"The stipulations ICAO standards contain never supersede the primacy of national regulatory requirements. It is always the local, national regulations which are enforced in, and by, sovereign states, and which must be legally adhered to by air operators making use of applicable airspace and airports. ICAO is therefore not an international aviation regulator, just as INTERPOL is not an international police force. We cannot arbitrarily.....condemn airlines for poor safety performance or customer service..... should a country transgress a given international standard adopted through our organization, ICAO's function in such circumstances.....is to help countries conduct any discussions, condemnations, sanctions, etc., they may wish to pursue, consistent with the Chicago Convention and the Articles and Annexes it contains under international law."(ICAO, 2021)

In spite of being a growing liberalized global industry served by many firms, we know that much of the international air cargo sector operated as an admitted cartel from 1999 through 2006. Given its visibility and importance to world trade, how did this cartel go undetected for so long? It seems that partly due to the way the cartel was uncovered, almost no empirical analysis has been done about the case. To fill this gap, we use publicly available air carrier data and examine whether a diligent anti-trust authority could have identified cartel/collusive behavior in the air cargo industry using established empirical methods. Our stark findings point to a regulatory failure in an industry whose long-standing business practices through the era of airline liberalization effectively "slipped through the cracks", leaving the many shippers of air cargo unprotected against collusive behavior.

KEYWORDS:

1. cartel
2. anti-trust
3. de-regulation
4. structural breakpoints

1 Introduction and overview

While usually overshadowed by the more publicly known passenger mode, through increasing trade liberalization the air cargo sector has become a vitally important freight transportation mode across the globe. In a world of growing online transactions and the need to move even more consumer goods faster and more reliably, economically efficient air cargo operations seem more important than ever. If more proof of the importance of air cargo was needed, the Covid-19 epidemic and efforts to distribute emerging vaccines was a prime example of the specialised demand for air cargo services. Formerly the purview of national governments/airlines in many countries, the air passenger and air freight transportation sectors have been gradually deregulated and liberalized across most of the globe since the latter part of the 20th century. This process has driven much of the ongoing growth in commercial aircraft output, including cargo. To see this remarkable trend, Figure 1 is a plot of International Civil Aviation Organization (ICAO) generated data highlighting the growth of the world wide air cargo sector from 1985 to 2019 (World Bank, 2021).

There are now a number of dedicated air cargo carriers in operation (including integrated freight carriers like Fed Ex and Amazon), but most international commercial airlines carry both passengers and some non-passenger related cargo within their aircraft. The market is now such that in any large inter- national city market pairing, a shipper located near either city typically has a few choices among both the integrated cargo carriers or scheduled passenger airlines to move cargo to their destination. Given the level of consumer choice that has been present for some time within the cargo sector, it would seem that concerns about the possibility of anti-competitive or collusive behavior should be very limited. So in spite of extensive liberalization, just a few years ago the air cargo sector found itself in turmoil because of public revelations (as well as convictions, leading to a range of fines) over market cartelization, achieved mostly through collusion-determined fuel surcharges on air cargo shipments applied on multiple routes around the world. Even though the case went public and was newsworthy at the time, due to other concurrent economic concerns it did not seem to remain newsworthy for long. In spite of the severity of the cartel, it seems subsequently that the air transportation research community has only done limited research about the cartel. This is a major oversight. We offer that empirical analysis is necessary to help understand the effects and consequences of what some now refer to as the ”accidental” cartel, albeit one that lasted ”accidentally” from the latter 1990’s through to its revelation by Lufthansa in 2006 (Levenstein and Suslow, 2006).

To date, there is some nascent literature describing certain case details as well as its resolution, but what little has been written about the air cargo cartel focuses mostly on legal aspects and the financial penalties that were levied on participating air carriers. Furthermore, we can find almost no publicly available discourse about other consequences that might stem from open knowledge about a convicted international cartel and its participating members, including whether or not the industry is more strictly monitored by various national competition authorities, how air cargo shippers reacted and what the case did to their level of confidence in the industry, or even whether or not current business and operational practices in the air cargo sector can be reliably trusted to prevent future collusive behavior.

While air cargo shippers were clearly disadvantaged by the cartel, in a sense they were fortunate that the cartel was exposed by one key participant (Luftansa), who was in turn motivated by (potential) immunity from heavy legal punishment in return for revelation of cartel details (Leandro, 2020). This self-admission form of cartel exposure is not unusual, but hints that whatever industry monitoring was done by regulators at that time (if any?) was ineffective. While anti-trust oversight in Western nations often relies on insider information to expose anti-competitive practices (Waldman and Jensen, 2016), various national competition authorities/regulators are in fact tasked with collecting detailed market data in order to conduct analyses that track firm and industry behavior across the economy. What this means is that before the air cargo cartel was exposed internally, the sector ought to have been under some regulatory scrutiny. Since the air cargo cartel was never exposed by any national regulatory body, we want to examine whether available industry data was consistent with the anti-competitive behavior that we now know was occurring across the air cargo sector through the time of the cartel.

The cartel was extremely international in scope. As listed in the data section below, we can see that along with some privatized carriers, several nationally operated airlines were also implicated and fined. Many of the affected cargo routes originated or ended in either the U.S. or the EU. Concerning the important U.S. market and domestic air cargo industry performance since the cartel case, Alexander and Merkert (2021) list and discuss several recent key statistics about U.S. air freight markets. Interestingly, inbound air cargo to the U.S. remains strong - as an example, between 2009 and 2018 the value of imports moved by aircraft into the U.S. approximately doubled. However, among U.S. carriers, the same data show consistent market growth in air cargo until 2007, with a gradual drop since attributed by these authors to the sub-prime financial crisis of 2007-2008. As one of the few recent papers about the U.S. air cargo sector, it is worth noting that the paper makes no mention of the cartel case. Given macroeconomic factors like the recession of 2008, it remains difficult to discern how or if the evolution of U.S. air cargo traffic is linked to the cartel case. Other evidence points to varied reactions among U.S. carriers to the cartel as it evolved. As an example, a recent textbook covering the topic of cartels describes that at least some U.S. airlines avoided being linked to the cartel case because these carriers (i.e. Northwest and United) sensed by 2004 that industry discussions on pricing and surcharges were de facto illegal, at least from a U.S. anti-trust perspective (Waldman and Jensen, 2016).

Given the limited background literature coupled with a lack of empirical analysis about the cartel case, we offer some additional exposition and try to determine whether the cartel could have been uncovered earlier with available data analyzed by a diligent regulator. What is surprising is that while some regu latory oversight on international air transportation remains, the operation of the international air cargo cartel seems to have slipped through the proverbial regulatory cracks. To accomplish this, we use air cargo price/revenue data along with modern econometric techniques designed to identify statistically significant structural breaks in time series data.

From the perspective of positive regulation and the process of identifying anti-competitive behavior, this admitted but understudied international anti-trust case provides an interesting example of ex post behavioral testing. To our knowledge from the literature, analysis of the air cargo data using these empirical methods has not been attempted before. Therefore we offer that our analysis can best be

categorized as validating some of the empirical toolkit used in anti-trust analysis and cartel detection (Von Blanckenburg and Geist (2009)), as well as highlighting that regulatory oversight using empirical analysis, in light of what already seems to have been known by key observers about the industry, very likely could have identified the air cargo cartel some time before it was exposed internally.

2 Review of the air cargo sector

Through the 1980's and 1990's, air transport has been gradually deregulated and liberalized. Beginning with the Airline Dereglation Act of 1978 in the United States, and subsequently overseen by both national and international regulatory agencies (such as ICAO), air cargo transport today is characterized by dynamic entry and exit of firms as both specialized and former national air carriers expand their air cargo operations in response to growing demand for "just in time" or "overnight" delivery services of both mail and all types of non-bulk cargo.

Air cargo remains a nuanced and interconnected market. To start, by classification there are three basic types of airlines that move cargo. These are i) combination carriers, meaning all those airlines also moving revenue passengers; ii) all-cargo airlines, those firms that only move airborne freight; and iii) integrated carriers like FedEx or UPS, companies who contract for point-to-point freight, using aircraft as but one mode of their delivery chain (Doganis, 2002).There are other smaller players in this market (like postal companies who own or own shares in freight air carriers), but the three main classes of air cargo carrier represent the bulk of the market at the time the cartel workings were exposed.

Other types of firms also operate and potentially affect air cargo operations (Doganis, 2002). All of these players fall within the definition of freight brokerage and operate in varying locales and capacities, but essentially the latter are secondary capacity markets for the air cargo carriers and do not appear to have played a part of the cartel or the legal case settlement.

To re-iterate, there are surprisingly few references on the subject of the air cargo cartel. The exhaustive discussion of air cargo regulations contained in Abeyratne (2018) mentions the cartel only briefly and much of the discussion is relegated to footnotes. Bergman and Sokol (2014) offer a legal perspective of the case, and in particular describe Lufthansa's part in admitting to participating in price fixing (fuel surcharges) on air cargo. Most recently, Leandro (2020) explores additional details about the case, including a discussion of actual monetary settlements as well as exploring the actions of the various regulatory jurisdictions involved in moving the case forward. But overall, in this chapter we are covering considerable new ground and hope to shed some additional insight on this intriguing anti-trust case.

3 Theoretical considerations: Cartel formation and behavior

Since the time of Adam Smith, economists have tried to bring attention to market cartelization and the negative consumer welfare effects associated with a functioning market cartel. Considering our modern economic system, some have argued that government involvement in markets through law and regulation was initially driven by the formulation of market cartels that emerged as a consequence of the industrial revolution (Viscusi et al., 2005). From ancient guilds to maritime (liner) shipping

conferences to OPEC to modern sports leagues, identifying cartels and empirically discerning collusive behavior remains controversial. Indeed others have argued that cartel formulation can in certain circumstances represent a welfare optimizing response to relatively thin and variable market demand (Sjostrom, 1989). In any cartel by design, if every firm maintains their agreed upon price and output share, inter-firm co-operation improves the welfare of the entire cartel by maximizing cartel profit (with the potential for re-distribution) as extracted by the firms based on their individual (demand driven) market decisions.

While there is no absolute consensus on the exact conditions that give rise to market cartelization (Levenstein and Suslow, 2006), when present the following economic conditions are believed to be associated with a higher chance of cartel formation (Waldman and Jensen (2016); Sjostrom (1989)):

(1) when the market is served by a small number of large firms, operating with excess capacity;

(2) firms are in geographic proximity and can readily contact one another;

(3) market product is relatively homogeneous, and not very differentiated;

(4) there are relatively high barriers to entry in the industry;

(5) demand growth and elasticity;

(6) characterized by mostly uniform cost conditions among firms, with the latter usually a function of the degree of product homogeneity;

Examining these criteria with respect to air cargo, we can see that conditions (2) and (4) are met as we know that various carriers would actually meet to discuss cargo issues (Leandro, 2020), whereas obtaining air cargo permits/insurance, along with airport/gate access as well as obtaining capital can be very costly. In turn, it seems the industry did not consistently satisfy points (1) and (6). Regarding point (1), we know some cargo markets are quite dense and competitive, while others less so, but meeting capacity is always an issue with air cargo. However, basic costs/technology (i.e. fuel efficient turboprop and jet aircraft) are relatively consistent across all-cargo and combined air cargo carriers (which categorizes all the carriers found guilty in the cartel case). For point (5), we know the air cargo industry remains characterized by highly variable demand (Doganis, 2002), and that this demand was increasing during the time of the cartel. But the issue about degree of product homogeneity (3) present in air cargo remains somewhat ambiguous. While air cargo itself is quite heterogeneous and diverse, the fact remains that the technology (i.e. mode) involved in the transaction (i.e. cargo carrying aircraft) is relatively homogeneous across both combined and all-cargo carriers. The latter implies that the overall transaction of moving cargo (loading and transporting) is considerably more homogeneous than the products being transported. Through to the present, the common use of so-called unit load devices (ULD's) (similar in concept to TEU containers used in surface transportation) means that the packaging and loading for all manner of cargo on all commercial aircraft became much simpler and more standardized than previously (Doganis, 2002).

Turning to the issue of identifying anti-competitive behavior and collusion, we note there is an established regulatory empirical literature that has been designed to identify this kind of market behavior. An excellent review of this literature can be found in Davis and Garces (2010). The analysis conducted here fits best with their defined ”before and after” analysis whereby available data series are examined around a specific time period or periods to try to identify anti-competitive practices (Brémond et al., 2012). Within the bounds of the chapter, we limit our analysis to a set of time series procedures designed to find significant but not otherwise obvious structural breaks in data. While not mentioned explicitly in the Davis and Garces (2010) description of these techniques, other researchers have more recently argued for a focus on measurable structural breaks in economic data to identify cartel induced distortions (Boswijk et al., 2019). Given the novelty of the methods and the dearth of empirical work about the cartel, we determine whether or not there are statistically significant structural breaks in the time series of revenue/pricing data as reported by a set of the indicted cargo carriers over the known cartel time frame.

As additional insight into the absence of anti-trust oversight in air cargo, consider the quote at the beginning of the chapter, coming from the Doganis (2002) overview of the airline industry and written dur ing the period of the cartel. While the author is well versed in the industry and indeed somewhat of a pundit, in his chapter on air cargo he alludes several times to the on-going consequences of airline deregulation on the air cargo sector. He also highlights the swiftness and breadth of regulatory change in the sector, describing reactions by extant industry associations that seemed to facilitate tolerance for various long-standing air cargo business practices that were very cartel-like indeed. In addition, Doganis used terms like ”agreed upon’, ”what the market will bear” or ”facilitates interlining” in describing long standing air cargo practices, all suggesting that air cargo markets for many carriers, often characterized (for example) by excess capacity and highly variable demand, led to ”marketing and pricing problems which are unique to the cargo side of the industry” (Doganis, 2002). Without stating the equivalence directly but given the industry’s similarity to cargo movements in the ocean shipping industry (Sjostrom, 1989), it certainly seems likely he was not the only industry observer to find themselves at least unconsciously aware of the possibility for cartel behavior within the air cargo sector.

4 Data and methods

4.1 Data

Empirical work identifying potential cartel activity in this industry relies on data from the Air Carrier Statistics database, also known as the T-100 data bank, reported by U.S. and foreign air carriers to the Office of Airline Information, Bureau of Transportation Statistics (BTS), U.S. Department of Transportation. The T-100 database can be found on the BTS website [1] organized into six tables containing domestic as well as international market and segment traffic monthly information for all reporting carriers from 1990 to 2021. Although the data is reported monthly, each observation includes monthly, quarterly, and annual identifiers. Of relevance to this study is the T-100 Segment (All Carriers) table

[1] transtats.bts.gov

which combines non-stop segment data such that each observation is identifiable by unique carrier name and contains pounds of freight/mail transported, number of passengers transported, and miles between origin and destination. Using this information, *Revenue Freight Ton Miles* (*RFTM*) is computed as the product of freight tons transported [2] and miles between origin and destination. Then we sum *RFTM* by unique carrier and quarter from 1997Q1 to 20017Q4 to encompass the time period from 1999 to 2006 during which cartel activity occurred in the aviation freight sector. *RFTM* measures output for cargo carriers. Given that collusive firm activity is associated with relatively lower output levels during antitrust infringement periods, examining *RFTM* levels before, during, and after the time frame antitrust regulators claimed air cargo carriers colluded.

Only unique carriers fined or investigated by the U.S. Department of Justice and/or the European Commission are kept for analysis [3].These carriers include American Airlines (AA), Air Canada (AC), Air France (AF), British Airways (BA), China Airlines Ltd. (CI), Cargolux Airlines International S.A. (CV), Cathay Pacific Airways Limited (CX), Japan Airlines (JL), Korean Airlines (KE), KLM (KL), Nippon Cargo Airlines Co., Ltd. (KZ), LAN Cargo S.A. / Aerolinhas Brasileiras S.A. (LA), Deutsche Lufthansa AG (LH), EL AL Israel Airlines Ltd. (LY), Martinair Holland N.V. (MP), All Nippon Airways Co., Ltd. (NH), Qantas Airways Ltd. (QF), SAS Cargo Group A/S (SK), and Singapore Airlines Cargo Pte Ltd. (SQ). While both the U.S. DOJ and EC as well as other national regulatory entities located in Australia, South Korea, and New Zealand looked into many more cargo airlines, the T-100 database contains complete, relevant information on the firms selected. Cartel activity among these firms occurred during various periods between 1999 and 2006. This analysis begins in 1997Q1 and concludes in 2017Q4 in order to provide context for output levels both before and after the cartel time period identified by both the U.S. DOJ and EC.

Annual descriptive statistics for average quarterly *RFTM* per air cargo carrier presented in Table 1 show freight and passenger output levels increasing between 1997 and 2000. Average quarterly *RFTM* per air cargo carrier is computed as the ratio of total *RFTM* per quarter and the number of firms active in said quarter. Output levels fall substantially in 2001 and see a somewhat constant trend until 2005 after which a somewhat positive trend occurs until 2008. Freight revenue ton miles fall in 2009 after which it sees a steady increase fluctuating now and again until 2017. The significant drops in output align with significant, global economic shocks, including 9/11 (2001) and the subprime recession (end of 2008).

4.2 Methods [4]

The univariate time series used to analyze cartel activity in the international air cargo sector includes quarterly average *RFTM* per carrier from 1997Q1 to 2017Q4. Figure 3 features the univariate time series plot[5] of *RFTM*. A cursory assessment of the plot suggests potential seasonality as well as level non-stationarity (James et al., 2013). For a closer look, Figure 4 presents both the autocorrelation and partial

[2] Pounds of freight is converted into freight tons by dividing by 2000 pounds since 1 ton = 2000 pounds.

[3] U.S. DOJ: https://www.justice.gov/atr/antitrust-case-filings
EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017XC0614(07)

[4] All analyses were performed in RStudio (R Core Team, 2021).

[5] Time-series created using ts command from main 'stats' package in R Core Team (2021). Same series plotted using R package 'ggplot2' (Wickham, 2016).

autocorrelation function plots (ACF and PACF, respectively)[6]. The ACF shows a maximum correlated lag of 12 before which the other significant lags decrease slowly indicating likely non-stationarity. The PACF has a maximum lag of 5 as well as a quicker decline than the ACF, but not quick enough to suggest stationarity (James et al., 2013).

Table 3 contains a variety of unit root tests[7] including the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, Dickey-Fuller Generalized Least Squares (DF-GLS) test, and the Elliot, Rothenberg & Stock (ERS) test. Quarterly average *RFTM* per carrier fails to reject the non-stationarity null hypotheses of the ADF, PP, DF-GLS, and ERS tests and also rejects the stationarity null hypothesis of the KPSS test at the 1%-level. In plotting the decomposition of the series[8], seasonality is confirmed, shown in Figure 5. Given this, it follows that we should fit the data series first parametrically using a seasonal ARIMA[9]:

$$\hat{Y}_t = \alpha_0 + \phi(1)Y_{t-1} + \phi(2)Y_{t-2} + \Phi(1)(Y_{t-1} - Y_{t-5}) + \Phi(2)(Y_{t-2} - Y_{t-6}) + \epsilon_t$$

where $Y_t \equiv RFTM$, $\alpha \equiv$ drift, $\phi \equiv AR$-coefficient, $\Phi \equiv SAR$-coefficient, and $\epsilon \equiv$ residuals (Nau, 2021).

To start finding break points within the air cargo data, we note that our basic ARIMA output is shown in Table 3. We compute the results of a Ljung-Box Test in Table 3. We reject the null, meaning that there is some autocorrelation in the error term, as shown in Figure 6. Knowing this, we can next fit a non-parametric specification as suggested in Bai and Perron (2003), as follows:

$$\hat{Y}_t = 1$$

which in turn implies that the series dynamics are contained in the disturbances, allowing any change in mean on the level of the series to be unaffected. Subsequently, we conduct an OLS-CUMSUM test[10] in order to identify exact structural breaks in the series. Once these were run, we plotted the OLS-CUMSUM tests[11], shown first for the non-parametric specification in Figure 7. Examining this figure in detail, we find approximately four periods of parameter instability (level changes in the mean) associated with these estimates, while Figure 8 shows that approximately one period of parameter instability is associated with our corresponding parametric estimates.

Buttressing these initial findings, next we implemented a method for identifying multiple breakpoints simultaneously, as developed by Bai and Perron (1998) [12] for both non-parametric and parametric estimates using the appropriate R package (Zeileis et al., 2002). Next, we plot breakpoint F-statistics for the non-parametric specification, shown in Figure 9, which again confirms the existence of four sta-

[6] Both the ACF and PACF are plotted using R package 'ggplot2' (Wickham, 2016)

[7] Each test estimated using R package 'urca' (Pfaff, 2008).

[8] Decomposition created using decompose command from main 'stats' package in R Core Team (2021), done within the R package using 'ggplot2' (Wickham, 2016).

[9] ARIMA model, using the 'auto.arima' command from R package Hyndman et al. (2021)

[10] OLS-CUMSUM tests to both parametric and non-parametric specifications using 'efp' command (Zeileis, 2006) using the R package Zeileis et al. (2002)

[11] using 'plot' command from main graphics package in R Core Team (2021)

[12] using 'breakpoints' command (Zeileis et al., 2003)

tistically significant breakpoints, occurring at 1999Q4, 2004Q1, 2008Q3, and 2014Q1. Alternatively, the parametric specification in Figure 10 indicates just a single statistically significant breakpoint at 2003Q1.

As a final summary of our breakpoint analysis for the $RFTM$[13]series, we draw out the breakpoints identified by the Bai and Perron (1998) approach, as well as associated confidence intervals for these breakpoints[14]. This is done again for both the non-parametric specification in Figure 11 and the parametric specification in Figure 12.

5 Interpretation of results

While used to formally test for signs of air cargo cartel activity, our investigative time series analysis has also provided other insights into the air cargo data. We start by summarizing information on break points in the entire data series. Since initially we found evidence of some remaining autocorrelation in the error terms using the parametric approach, our focus here is on those results generated by our non-parametric estimations. Once again, the latter approach yielded a total of four series breakpoints, with two of these occurring through the cartel era. We will discuss each of these in turn.

The first breakpoint in the air cargo series occurred in the fourth quarter of 1999, with a confidence interval stretching from 1998Q4 all the way to 2001Q1. This particular identified breakpoint corresponds to the time period during when both the U.S. Dept. of Justice and the European Competition Commission reported that significant air cargo collusive activity began. Our second breakpoint occurred in the first quarter of 2004 with a confidence interval beginning just after 2003Q2 and ending after 2004Q2. This breakpoint corresponds to a brief period of cartel stability, occurring some time before Lufthansa exposed the cartel. We also note that between these first and second temporal breakpoints, sector output was noticeably lower relative to the subsequent time frame. The latter observation also seems to confirm another market outcome associated with a well-functioning cartel.

Our third identified breakpoint occurred in the third quarter of 2008, associated with a confidence interval beginning after 2007Q3 and ending after 2009Q1. This breakpoint interval surely is capturing the consequences on the industry stemming from the global (subprime) financial crisis, during which fuel prices surged and much of the industry was affected by falling demand. All air transportation was affected by that economic crisis, and air cargo was clearly no exception. Finally, our fourth breakpoint occurred in the first quarter of 2014, with an associated confidence interval beginning after 20011Q2 and ending after 20015Q2. While its cause is less obvious than the other breakpoints, this one seems to correspond to the timing of a major production slowdown in China (News, 2016), coupled with various protectionist measures enacted by several countries around the world, including the U.S. and parts of the EU (Fritz, 2015).

As a validation exercise, we found that non-parametric time series tests performed better at identifying critical but less obvious structural breakpoints in the data. Two of the breakpoints occurred during the cartel era, both well before the cartel was exposed. Econometric and data analysis techniques are always being changed and updated. While we acknowledge that some of the techniques

[13]using 'plot' command from main graphics package in R Core Team (2021)
[14]using 'confint' command in main stats package (R Core Team, 2021)

used here were available only partway through the era of the cartel, we re-iterate that it is the job of regulatory bureaucrats to keep current on anti-trust detection methodologies and statistics. In spite of this, we also found that older parametric versions of these tests identified a series break point more or less right in the middle of the cartel era, with the latter method being known at that time as part of the established empirical anti-trust toolkit (Davis and Garces, 2010).

Ultimately, we offer that our econometric analysis and testing indicates a failure of anti-trust oversight in a major international industry. Whether or not our findings are indicative of a complete lack of oversight on the part of competition authorities around the world (consider the on-going ambiguity over the role of ICAO in such circumstances, please see the quote in the abstract) remains to be seen. The reaction of the relevant academy subsequent to this event (this paper notwithstanding) also seems to indicate that something was seriously amiss with anti-trust oversight of the air cargo industry. To this end, we are pleased to see some of the recent legal research describing aspects of the case. It is our hope that this event remains a wake up call for all industry participants, each of whom should remain diligent about the potential for collusion and cartels to emerge once again in this important and growing transportation sector.

6 Conclusions

It seems that airline liberalization, among other factors, failed some users of international air cargo services by facilitating the creation of a sector-level cartel dating from approximately 1999 to 2006. As discussed, there were claims, especially by non U.S. carriers, that the air cargo cartel was in some sense ”accidental”. This claim refers to the argument that cargo carriers were never informed by any oversight or regulatory agency that grandfathered air cargo business practices through an era of broader air carrier liberalization in fact violated basic anti-trust tenets. However, as we have discussed in this chapter there were numerous and high profile ”red flags” about the international air cargo business particularly with respect to the legality of its long standing cooperative and planned pricing/surcharge practices. There is even documentation about certain major carriers bowing out of formal cargo meetings and negotiations due to recognition about the legality of air cargo practices, yet these carriers chose not to relay the problem to the proper anti-trust authorities. While it may never be completely clear why, it took a major EU combined airline (Lufthansa), a formerly government operated airline that was relatively new to market liberalization and anti-trust restrictions, to reveal the existence of the cartel while ultimately absolving itself of major penalties as an informant (Leandro, 2020).

Given the admitted existence of the cartel, we performed a unique ex post structural data analysis of this understudied yet major economic event in the air transportation sector. Our finding of significant structural breaks in the air cargo price/revenue series during the middle of the cartel era is not simply a case of adding more supporting evidence that empirical techniques employed by anti-trust authorities perform as they were designed to do. As part of an industry so important globally that the United Nations devotes a sizable budget to operating an oversight agency (ICAO) tasked with ensuring efficient and reliable international aircraft/airport operations, somewhere in the regulatory ”chain of command” in cargo aviation there appears to have been a substantial lack of oversight and in some

cases, outright denial of harmful collusive behavior by industry observers. No matter who is to blame for overlooking this international anti-trust event, we believe the duration and strength of the air cargo cartel represents a vast public policy failure. Even today, shippers/customers using air carrier services would seem to be protected only by their own national competition authorities from any potential collusive behavior in this structurally international industry (Leandro, 2020). The latter is another case of the inherent dichotomy with international regulatory enforcement in an era of economic globalization. We offer that the on-going absence of a truly independent international economic regulator for world aviation is not likely to discourage other air transportation cartels from forming in the near future.

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Table 1 Summary Statistics

Year	Revenue Freight Ton Miles	Carriers
1997	194,462,672	19
1998	196,165,052	19
1999	215,426,572	19
2000	232,844,308	19
2001	212,967,024	19
2002	225,154,756	19
2003	226,445,688	19
2004	254,507,508	18
2005	255,843,444	19
2006	262,818,524	19
2007	275,250,820	19
2008	254,399,884	19
2009	219,027,824	19
2010	257,974,496	19
2011	247,146,544	19
2012	236,459,172	19
2013	240,574,360	19
2014	259,082,068	19
2015	252,087,980	19
2016	251,528,848	19
2017	286,433,500	19

Table 2 Unit Root Tests

Unit Root Test	Statistic	Critical Value 1%	H_0
KPSS	1.139	$>$ 0.739	stationary
ADF	0.8645	$<$ -2.6	non-stationary
PP	-2.547	$<$ -3.51	non-stationary
DF-GLS	-0.6332	$<$ -2.59	non-stationary
ERS	3.8463	$<$ 1.95	non-stationary

Table 3 Auto.ARIMA

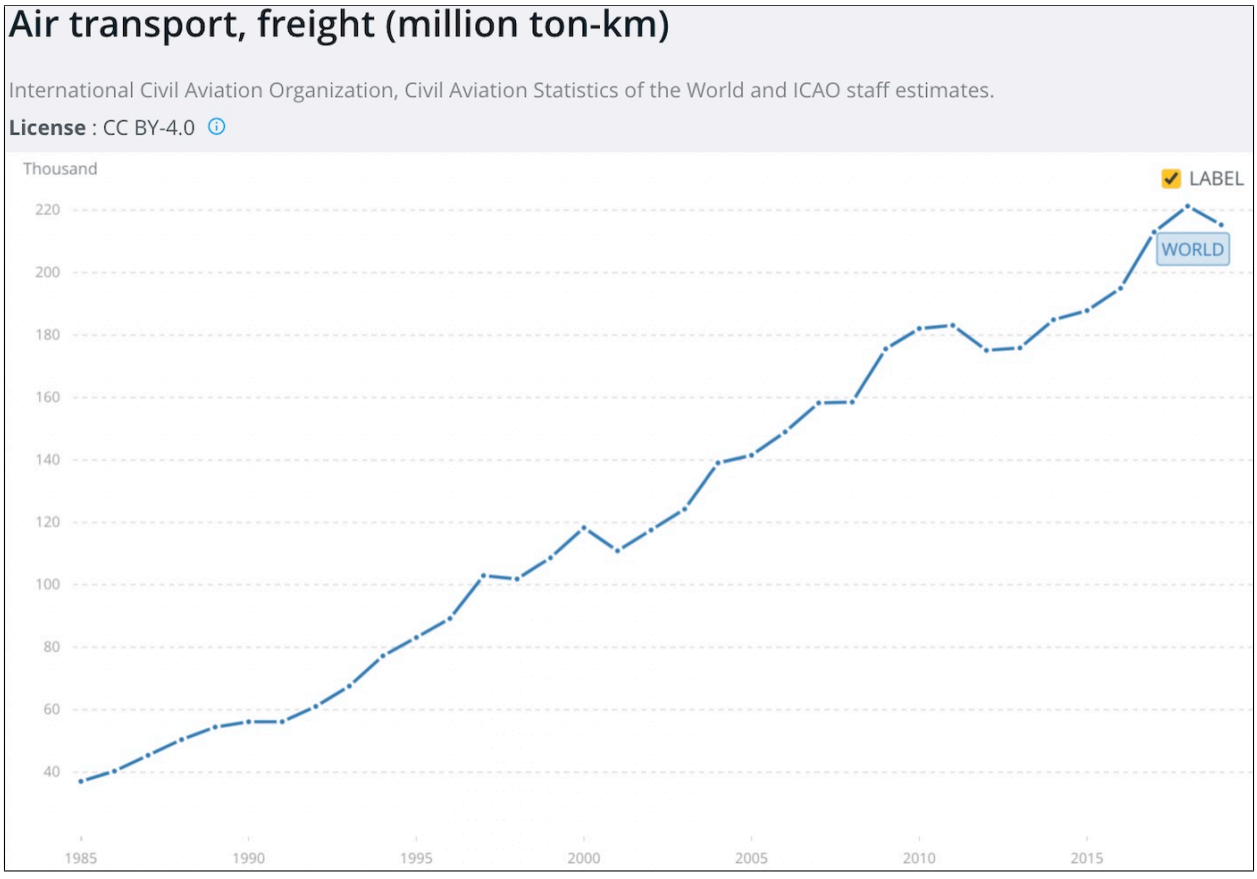
Component	Coefficient	Standard Error
AR(1)	1.1889	0.1039
AR(2)	-0.3906	0.1086
SAR(1)	-0.6300	0.1108
SAR(2)	-0.4431	0.1013
Drift	1,178,131.4	672,499.5
Ljung-Box Test	p-value	H_0
Residuals	0.04688	no autocorrelation

Figure 1: IATA: World Air Transport Traffic by Route Area

	Revenue Passenger Kms		Available Seat Kms		PLF		Cargo Tonnes Kms		Available Cargo Tonne Kms		CLF		Available Tonne Kms	
Route Areas	2020	% Change	2020	% Change	2020	pp Change	2020	% Change	2020	% Change	2020	pp Change	2020	% Change
Africa - Europe	59,675	-68.4	96,348	-58.8	61.9%	-18.8	4,198	-20.6	8,221	-31.4	51.1%	7.0	18,623	-46.1
Africa - Far East	5,685	-79.7	9,508	-73.6	59.8%	-17.7	2,086	9.0	4,025	2.1	51.8%	3.3	5,620	-28.0
Africa - Middle East	22,360	-72.3	37,811	-66.6	59.1%	-12.2	1,700	-31.5	3,967	-42.5	42.9%	6.9	7,902	-55.6
Central America / Caribbean - South America	10,255	-72.1	13,515	-69.7	75.9%	-6.7	190	-51.9	458	-61.7	41.4%	8.5	1,803	-67.5
Europe - Central America / Caribbean	52,165	-68.0	75,351	-59.5	69.2%	-18.4	1,708	-38.1	3,794	-44.3	45.0%	4.5	11,375	-54.5
Europe - Far East	115,313	-79.0	197,269	-70.5	58.5%	-23.6	41,001	-10.6	58,235	-17.1	70.4%	5.2	80,500	-40.1
Europe - Middle East	75,708	-73.2	136,946	-64.0	55.3%	-18.8	9,404	-18.1	16,595	-30.2	56.7%	8.4	30,952	-48.7
Europe - North America	122,936	-80.4	229,358	-69.1	53.6%	-31.2	23,635	-17.7	41,279	-36.7	57.3%	13.3	65,510	-52.3
Europe - South America	31,784	-71.4	48,115	-62.6	66.1%	-20.3	3,521	-23.6	5,302	-39.6	66.4%	14.0	10,051	-52.5
Far East - North America	78,635	-80.1	144,582	-69.8	54.4%	-28.1	53,149	7.6	81,089	3.5	65.5%	2.5	96,321	-22.4
Far East - Southwest Pacific	40,608	-79.4	63,433	-73.4	64.0%	-18.7	4,333	-30.4	7,016	-45.9	61.8%	13.8	13,816	-61.3
Middle East - Far East	104,020	-73.6	172,412	-65.2	60.3%	-19.3	13,476	-7.0	26,268	-15.8	51.3%	4.8	45,026	-42.3
Middle East - North America	28,023	-71.3	48,243	-60.3	58.1%	-22.3	4,571	-8.5	7,616	-27.2	60.0%	12.2	12,395	-44.0
North America - Central America / Caribbean	63,324	-60.4	91,976	-52.2	68.8%	-14.3	1,297	-7.4	3,141	-42.5	41.3%	15.7	11,755	-50.8
North America - South America	36,453	-68.8	52,663	-61.5	69.2%	-16.4	5,762	-10.6	10,451	-21.9	55.1%	6.9	15,508	-40.3
North / South America - Southwest Pacific	17,468	-74.0	25,744	-68.1	67.9%	-15.3	1,259	-28.8	2,178	-43.0	57.8%	11.6	4,902	-58.0
Within Central America	3,570	-73.4	4,900	-71.6	72.9%	-4.9	23	-56.2	98	-72.1	23.2%	8.4	573	-71.8
Within Europe	290,342	-70.7	400,968	-65.0	72.4%	-14.2	4,592	-23.1	9,024	-43.1	50.9%	13.2	48,148	-61.8
Within Far East	117,277	-84.1	192,763	-79.0	60.8%	-19.5	14,595	-19.6	21,401	-40.6	68.2%	17.8	40,909	-66.5
Within South America	9,583	-76.2	12,716	-74.6	75.4%	-5.1	447	-32.8	926	-53.9	48.3%	15.2	2,171	-67.5
Other / Residual	88,696		113,134				6,459		24,404				21,184	
Total International	1,373,881	-75.5	2,167,755	-68.3	63.4%	-18.6	197,407	-11.1	335,488	-22.4	58.8%	7.5	545,045	-50.0
Total Domestic	1,613,112	-48.8	2,421,623	-35.8	66.6%	-16.9	33,935	-0.8	94,528	-17.7	35.9%	6.1	319,516	-31.6
Total Systemwide	2,986,993	-65.9	4,589,378	-56.7	65.1%	-17.4	231,342	-9.7	430,016	-21.4	53.8%	7.0	864,561	-44.5

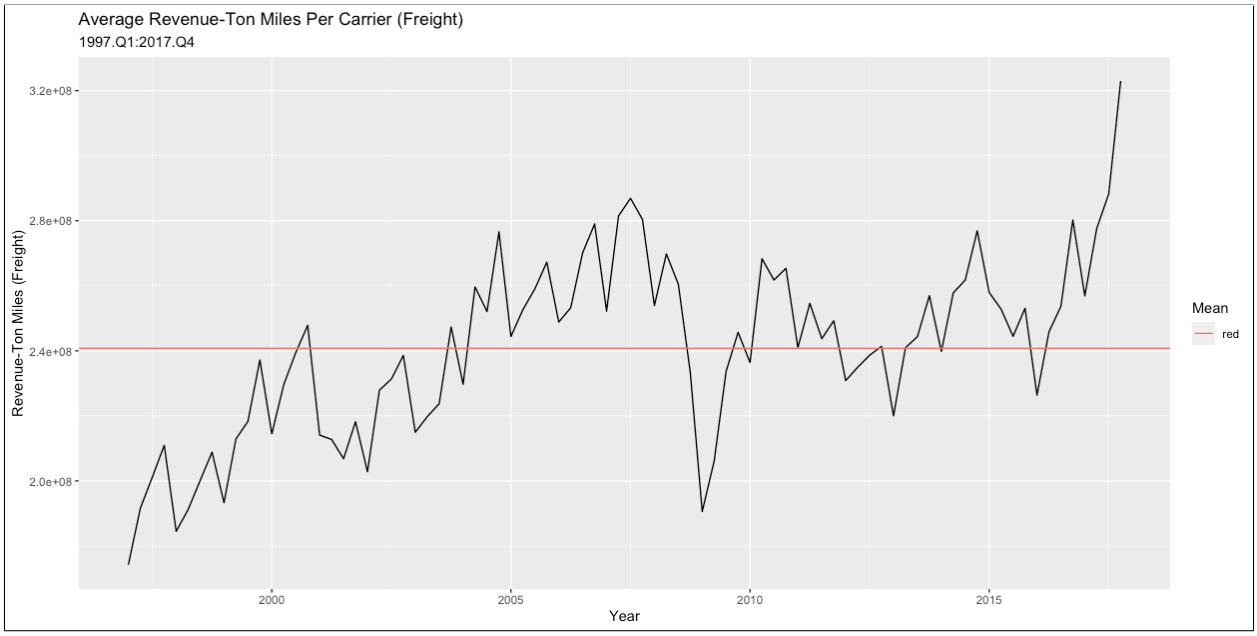
Source: International Air Transport Association

Figure 2: ICAO data on Air Cargo, 1985-2019



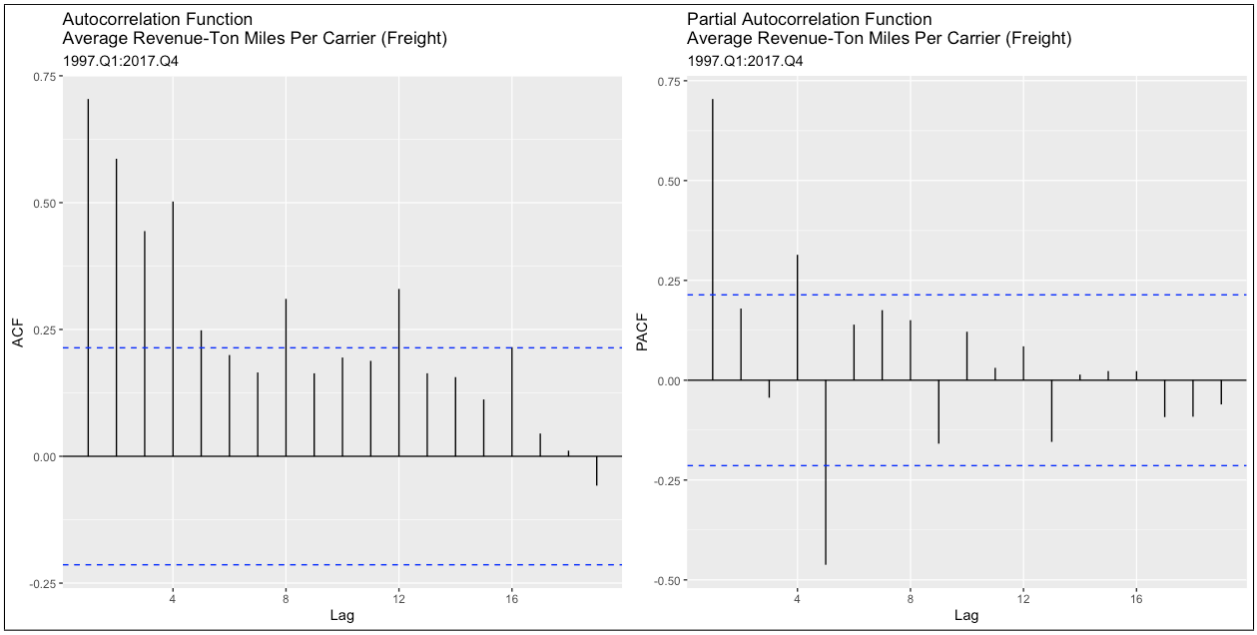
Source: International Civil Aviation Organization, Civil Aviation Statistics of the World and ICAO staff estimates.

Figure 3: ARTM per carrier (freight), 1997-2017



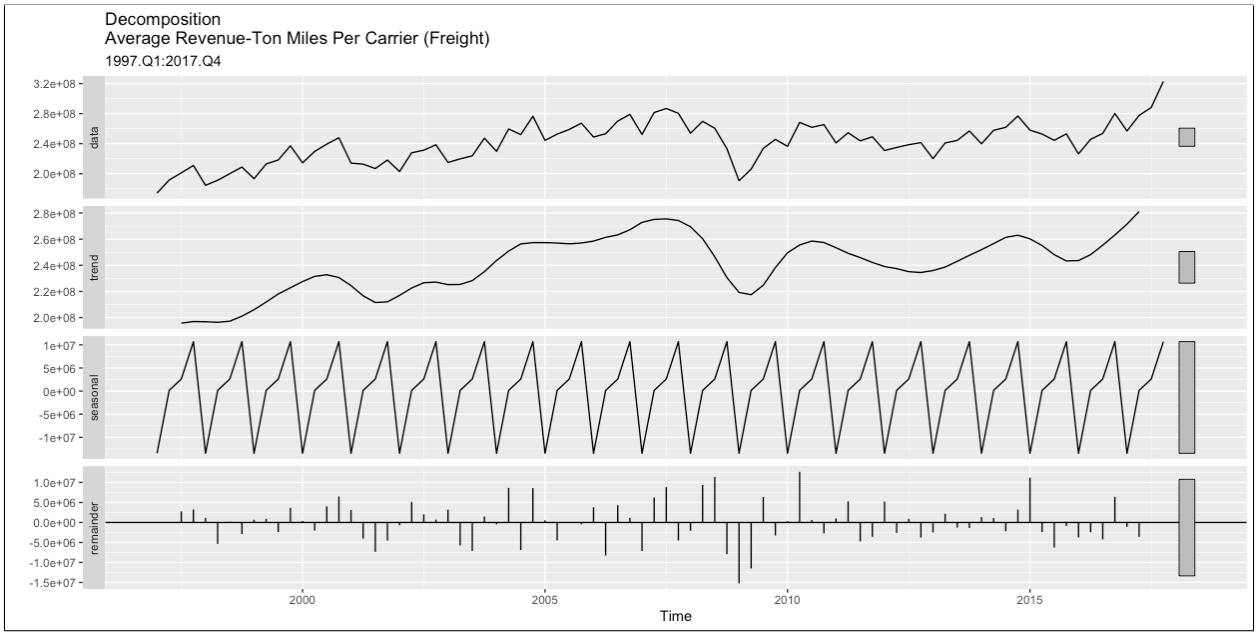
Source: Created by the authors in R Studio (R Core Team, 2021) using the ggplot2 package (Wickham, 2016).

Figure 4: ARTM autocorrelation graphs



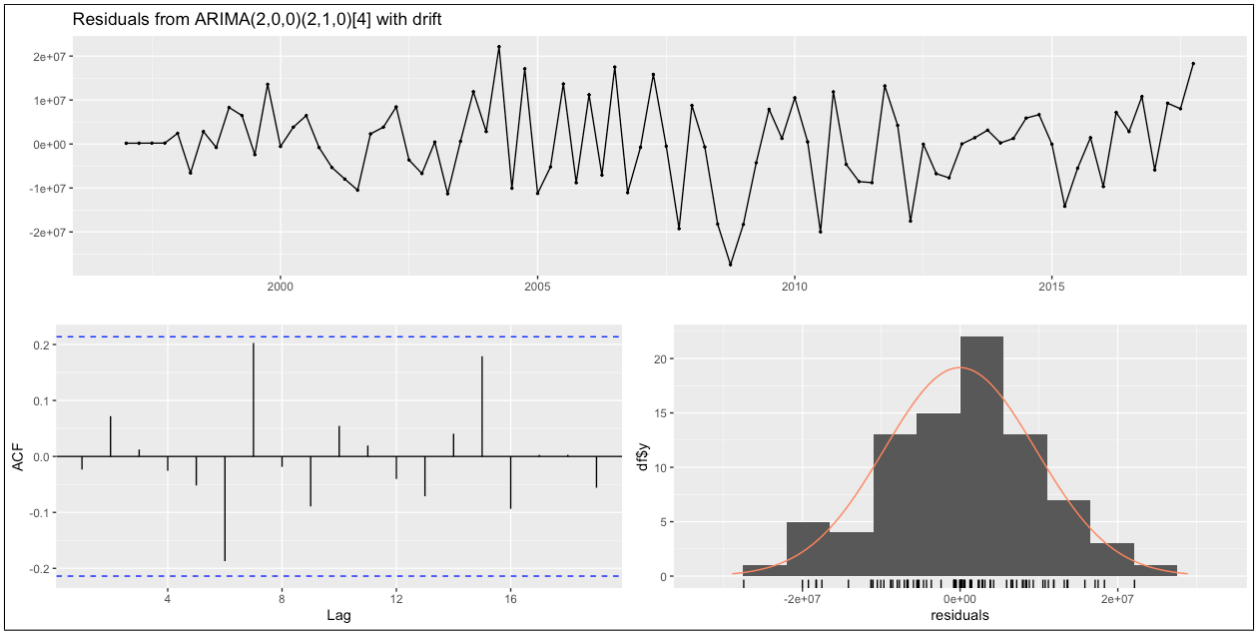
Source: Created by the authors in R Studio (R Core Team, 2021) using the ggplot2 package (Wickham, 2016).

Figure 5: ARTM series decomposition



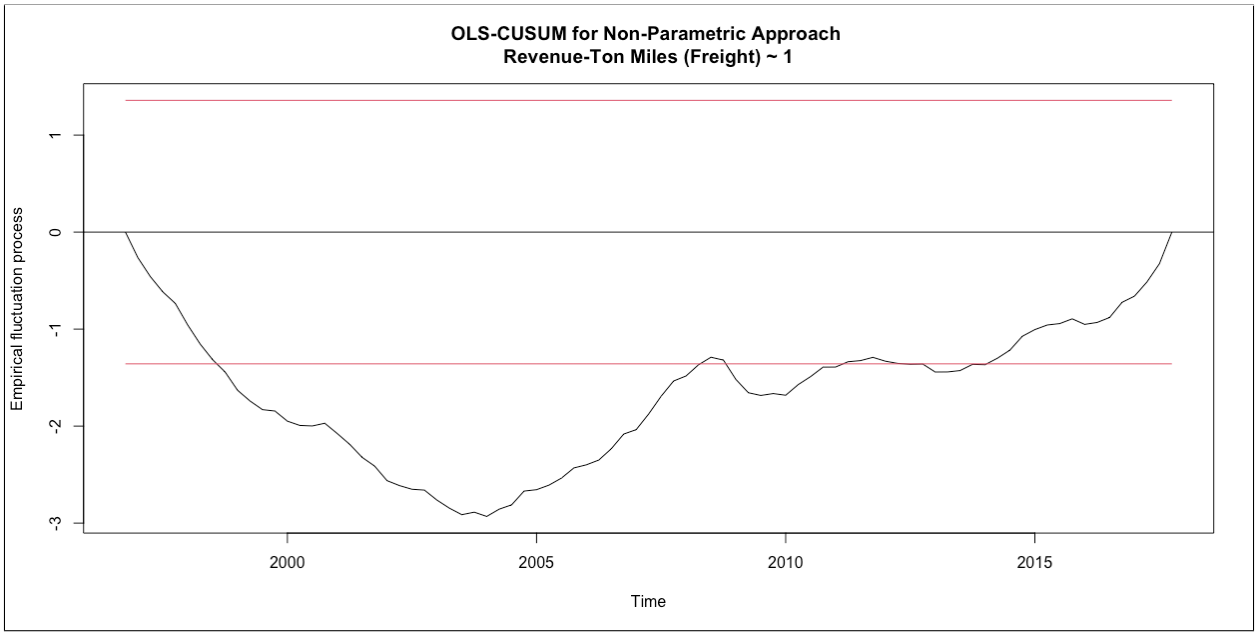
Source: Created by the authors in R Studio (R Core Team, 2021) using the ggplot2 package (Wickham, 2016).

Figure 6: ARTM residuals



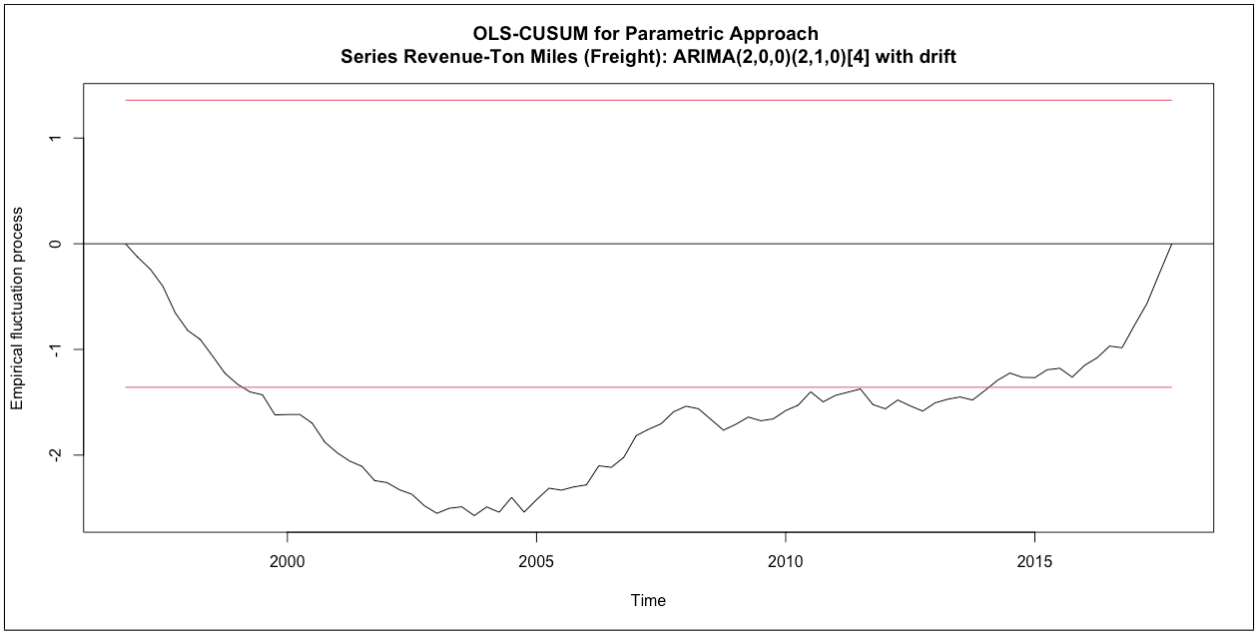
Source: Created by the authors in R Studio (R Core Team, 2021) using the ggplot2 package (Wickham, 2016).

Figure 7: Non-parametric empirical fluctuation process, RTM (freight)



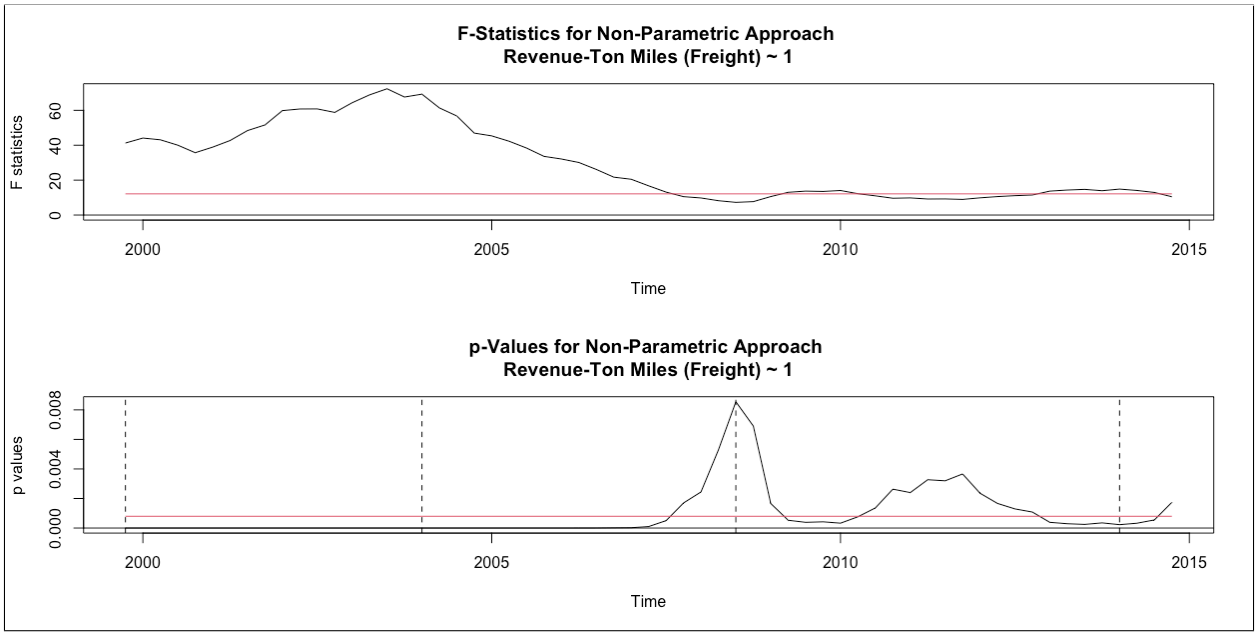
Source: Created by the authors in R Studio (R Core Team, 2021) using 'plot' command from the standard graphics package.

Figure 8: Parametric empirical fluctuation process, RTM (freight)



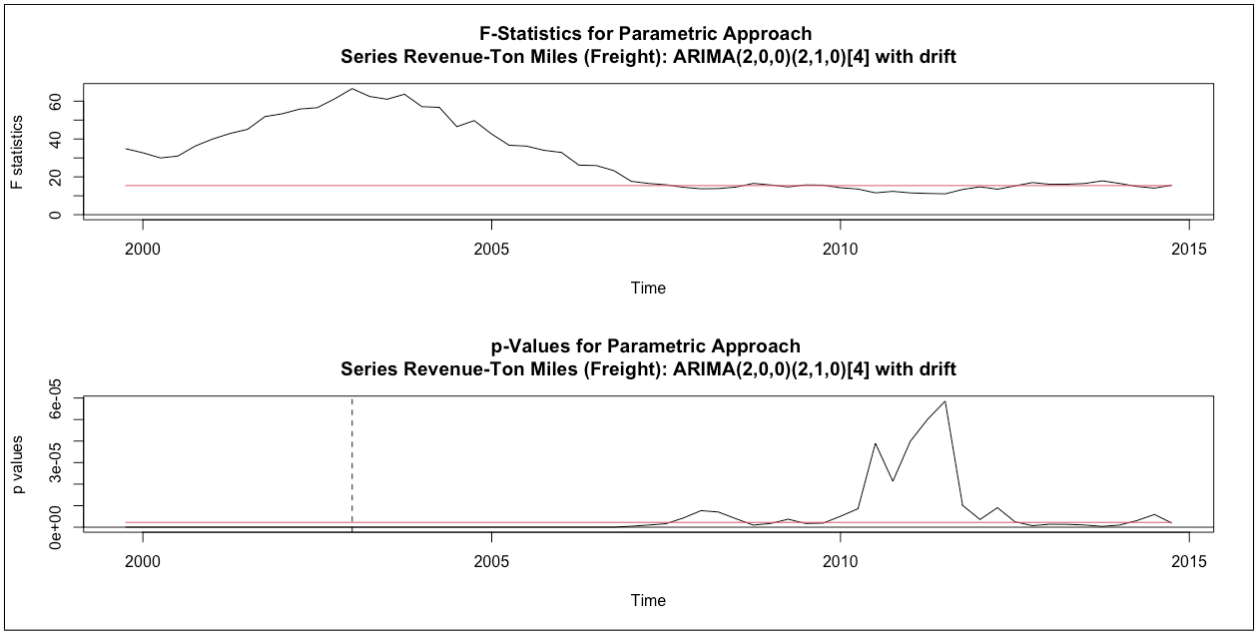
Source: Created by the authors in R Studio (R Core Team, 2021) using 'plot' command from the standard graphics package.

Figure 9: Non-parametric approach, F-tests for break points



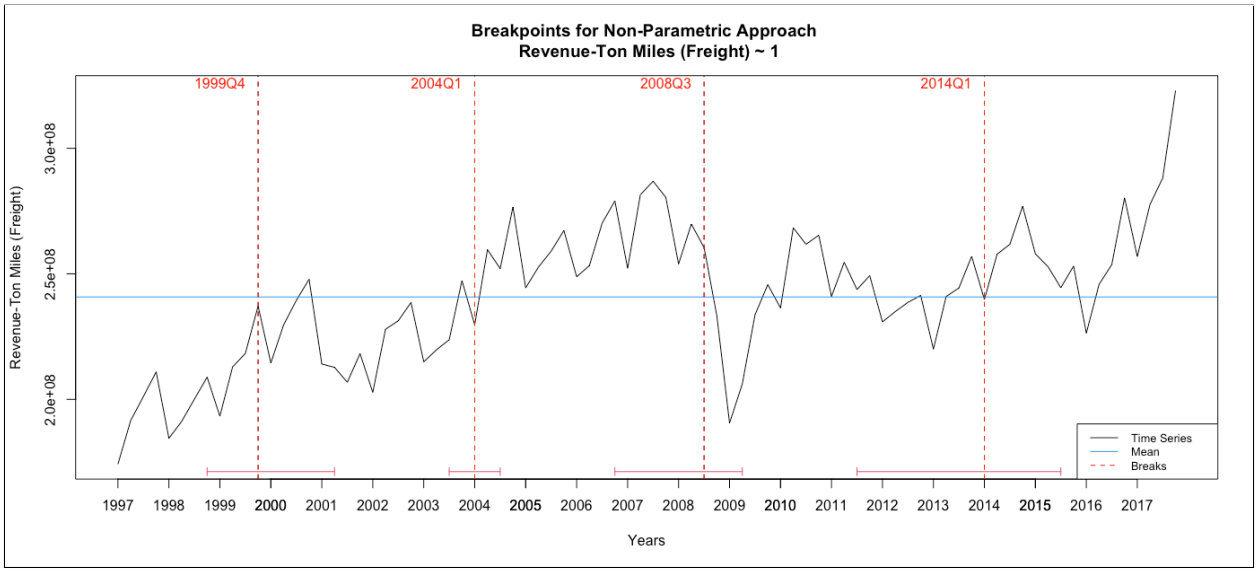
Source: Created by the authors in R Studio (R Core Team, 2021) using 'plot' command from the standard graphics package.

Figure 10: Parametric approach, F-Tests for break points



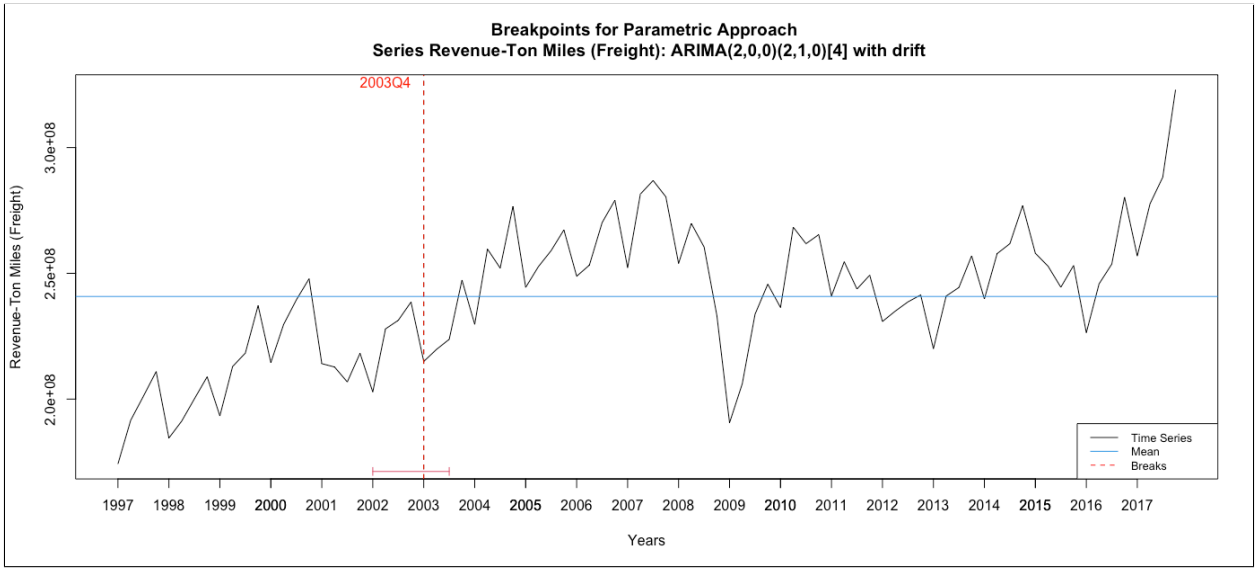
Source: Created by the authors in R Studio (R Core Team, 2021) using 'plot' command from the standard graphics package.

Figure 11: Non-parametric, series breakpoints



Source: Created by the authors in R Studio (R Core Team, 2021) using 'plot' command from the standard graphics package.

Figure 12: Parametric, series breakpoints



Source: Created by the authors in R Studio (R Core Team, 2021) using 'plot' command from the standard graphics package.