ROUTLEDGE STUDIES IN TRANSPORT ANALYSIS

The Airline Profit Cycle

A System Analysis of Airline Industry Dynamics

Eva-Maria Cronrath

ROUTLEDGE

The Airline Profit Cycle

The air transport industry has high economic impact; it supports more than 60 million jobs worldwide. Since the early years of commercial air travel, passenger numbers have grown tremendously. However, for decades airlines' financial results have been swinging between profits and losses. The airline industry's aggregate net average profit between 1970 and 2010 was close to zero, which implies bankruptcies and layoffs in downturns. The profit cycle's amplitude has been rising over time, which means that problems have become increasingly severe and also shows that the industry may not have learned from the past. More stable financial results could not only facilitate airline management decisions and improve investors' confidence but also preserve employment. This book offers a thorough understanding of the airline profit cycle's causes and drivers, and it presents measures to achieve a higher and more stable profitability level.

This is the first in-depth examination of the airline profit cycle. The airline industry is modelled as a complex dynamic system, which is used for quantitative simulations of 'what if' scenarios. These experiments reveal that the general economic environment, such as GDP or fuel price developments, influence the airline industry's profitability pattern as well as certain regulations or aircraft manufactures' policies. Yet despite all circumstances, simulations show that airlines' own management decisions are sufficient to generate higher and more stable profits in the industry.

This book is useful for aviation industry decision makers, investors, policy makers, and researchers because it explains why the airline industry earns or loses money. This knowledge will advance forecasting and market intelligence. Furthermore, the book offers practitioners different suggestions to sustainably improve the airline industry's profitability. The book is also recommended as a case study for system analysis as well as industry cyclicality at graduate or postgraduate level for courses such as engineering, economics, or management.

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A System Analysis of Airline Industry Dynamics
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The Airline Profit Cycle

A System Analysis of Airline Industry Dynamics

Eva-Maria Cronrath

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Foreword

The Airline Profit Cycle: A System Analysis of Airline Industry Dynamics deals with highly important aspects of this particular branch of the economy. Since the early beginnings in the 1950s, commercial air travel showed a strong and persistent general growth trend, with passenger numbers doubling approximately every 18 years, thus growing more than the global economy. The financial situation of the airline industry – the term 'airline industry' comprises all airlines providing scheduled or non-scheduled air transportation – is nowhere near as healthy as the growth numbers might lead one to expect. Over this time span the world airlines profit average is virtually zero but it shows significant fluctuations; fluctuation with both a strong and growing amplitude and a declining cycle's period. This overall behaviour pattern is very similar for all major carriers. Some airlines manage to achieve financial results much above the world's average, but even those superior performers generate only a meagre return on invested capital.

The consequences of this behaviour are obvious. Especially in the down cycle periods, bankruptcies occur rather frequently; on the supplier side, aircraft manufacturers face a highly fluctuating order income. Over the past three or four decades, this performance made the airline industry rather unattractive for investors. On this basis, three questions guide the author's research process:

1 Why are the airline profits cyclical?
2 What are the causes and dynamics that determine the profit cycle's shape?
3 How can the situation be improved?

Because of its importance, Cronrath starts with a thorough analysis of business cycles in general, their drivers and their common characteristics. She then opens the perspective to oscillations as a fundamental mode of behaviour and introduces the concept of (negative) feedback. Time delays between the actual state of the system, the perceived state, the discrepancy between perceived and (explicit or implicit) desired state – the goal – and corrective action, have an impact on the state of the system. An effective 'controller' can curb such an oscillating system. A key example of oscillating systems in the business world is the supply chain, which frequently shows increasing amplitudes of fluctuations for each successive stage upstream.

Industry practitioners' views on airline profit cyclicality revealed that even though the airline profit cycle is highly relevant to business in the industry, only two-thirds of those interviewed reported knowledge about it. The cycle was largely seen as something exogenous, something 'happening to them', to which they can only react. Overcapacity is seen as a cycle's driver, and cost cutting the appropriate remedy.

The chapter with the System Dynamics model of airline industry profit development is the 'core theory' of the publication. Here the findings from the previously investigated different sources come together, are integrated and transformed into a concise model, which in turn is the basis for the experiments and mitigation policies in the subsequent chapter. The author emphasises the complexity of the research questions by statistical examination of three popular cycle driver hypotheses. These hypotheses are that airlines' profit cycles are caused either by the general economic development (H1) or by external shocks like oil crises, the gulf war, financial crises, etc. (H2) or finally by fluctuating fuel prices (H3). Empirical evidence shows that all three factor sets do have influence on airline profits; however, none of them alone can explain the actually observed behaviour. Their interrelationships are interdependent, non-linear, and time delays play an important role. The methodology suitable to address such a conundrum of problems is System Dynamics. And the subsequently developed model is used to answer the author's above-mentioned research questions.

The airlines' behavior as driver of cyclicality focuses on the impact of internal mechanisms, on the airlines' own influence on the profit cycle. Capacity planning, ordering policies, utilisation strategies, aircraft retirement practice and aircraft leasing, and finally price setting and cost adjustment, are all investigated. And they show that, indeed, airlines' own behaviour can cause profit cycles. Flexible cost structures and a rather steady aircraft order policy are successful remedies. The strife for ancillary yields can help but also distracts from genuine tasks. A multitude of highly interesting and important findings for practical airline management are compiled here. They underline the potential of the model and the power of having such a device at hand.

Eva-Maria Cronrath's book – it is the outgrow of a PhD Manuscript submitted to the Fakultät für Betriebswirtschaftslehre der Universität Mannheim, Germany – deals with an important topic of corporate management and business administration. It presents the findings in a competent and convincing way; the research questions are clearly formulated; the investigation proceeds in a logical manner. Eva-Maria Cronrath's results are remarkable, both from the scientific or academic point of view and from the importance of her findings for airline management.

Professor em. Dr Dr h. c. Peter-M. Milling

Foreword

For the past 50 years the airline industry has generally experienced cyclic profitability at approximately ten-year periods. This type of cyclic behaviour is not unique to airlines but this industry represents one of the most consistent examples of this behaviour and it is important to understand the dynamics. This book starts with an empirical analysis of available airline profit data and potential exogenous factors, including a statistical analysis of simple mechanisms which have been hypothesised to drive this cyclic behavior. The conclusion of the empirical analyses is that the general economy, external demand shocks, and the fuel price have influence on airline profits. However, each of them alone cannot explain the airline profit cycle.

A number of researchers have investigated this cyclicality using simple system dynamics models which can be shown to capture general oscillatory behaviour, but this work takes the system dynamics analysis of the airline industry to a significantly higher level of detail and fidelity than any of the prior studies. The analysis includes well reasoned, supported and calibrated sub-models for processes such as Pricing, Cost and Supply which really capture the actual practice in the airline industry.

For example, in the Supply sub-model Cronrath models the flows of available aircraft assets considering retirement of older aircraft and modeling airline purchasing decisions. What is impressive is the next level of modeling where she captures the productivity of the aircraft asset (e.g. how many seats are sold), the utilisation of the aircraft (e.g. how many hours a day is the asset utilised). In these second-level models she is able to capture subtle but important effects. For example, the productivity of aircraft has changed over the past 20 years due to the development of yield-management approaches by airlines.

By capturing these effects Cronrath is more accurately able to calibrate the model with historical data from the United States and other worldwide data sources. The calibrated model is then used to conduct a series of simulation experiments to investigate how changes in market factors and airline behaviour impact the airline industry profit cycles.

One interesting and important finding explores the impact of yield management on the profit cycle. The model indicated that the extensive use of revenue management was found to be a major cycle amplifier. If airlines

refrained entirely from revenue management as a technique for short-term demand stimulation by price, they would eliminate the profit cycle after a demand shock. The model was also able to observe the cycle driving impact of aircraft ordering behaviour due to delay in aircraft delivery which had been hypothesised by a number of previous researchers. However, Cronrath was uniquely able to investigate how aircraft utilisation can be used to manage and dampen the cycle. Experiments show that if aircraft utilisation adjustments after a demand shock were completely prevented, the profit cycle's amplitude would double compared to the reference.

The book concludes with a discussion on what can be done to manage cyclicality in the airline industry and gives practical advice for airline executives and decision makers which is insightful and useful.

This book provides an excellent and comprehensive analysis of the factors that drive the system dynamics of the global airline industry.

Professor R. John Hansman
Director, MIT International Center
for Air Transportation

Preface

Why do airlines altogether suffer deep losses only a few years after they earned record high profits? Why does this pattern repeat itself over and over again? How can that happen in an industry that is as advanced and popular as aviation? The repeated loss periods cost several thousand people their jobs. Yet, in my time as a consultant in the aviation industry I learnt that the airlines' profitability cycle is not understood, and even the awareness for the phenomenon is low. This is why I decided to focus my PhD research on the airline profit cycle in order to explain why the airline industry exhibits this very particular profitability pattern and to conclude how the situation could be improved.

The methodology I chose to approach the problem is System Dynamics. This way to address complex and dynamic problems has fascinated me since I first heard about it in my Master studies at the University of Mannheim. Even though the modelling process proved to be challenging in many ways, the results of my model simulation experiments show how useful and powerful System Dynamics can be.

This book is based on my doctoral dissertation at the University of Mannheim and the Massachusetts Institute of Technology. Writing this PhD thesis would not have been possible without invaluable help.

First of all, I would like to thank Prof e.m. Dr Dr h.c. Peter Milling for supervising my thesis, for his constant support and academic guidance. Likewise, I would like to express my gratitude towards my second supervisor, Prof Dr R. John Hansman, for challenging ideas to help me find the best solutions, and for giving me the opportunity of working with him in the inspiring environment of MIT. Furthermore, I thank Prof Dr Andreas Größler who would always make time to help me with precious advice and motivating comments. Thank you to Alexander Zock, PhD for providing the idea to research the airline profit cycle and for giving me faith in the feasibility of this project. In addition, I am grateful to Prof Dr Jürgen Strohhecker for helping me with my modelling issues, and to Prof Dr Raik Stolletz for reviewing my work.

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Many thanks for giving me expert interviews go to employees/members of Boeing, Deutsche Lufthansa, Deutsche Flugsicherung (German ATC), Fraport, MIT Aeronautics Department, Star Alliance, and the System Dynamics Society.

Thank you to my former fellow PhD students at the University of Mannheim's Industrieseminar who have accompanied me during my years of doctoral studies. Also, I would like to thank my former colleagues at the European Center for Aviation Development and at the MIT International Center for Air Transportation for their support. Discussions with Dr Mark Azzam were especially enjoyable as they were productive.

This book has benefited from intense feedback on the last versions. Thank you to Ulrich Cronrath, Friederike Flory, Jens Hemmerich, and Nike Trost who invested their free time in improving my manuscript.

I am more than grateful to my family and friends for their patience and persistent support. In particular, my husband's good humour and his constant encouragement carried this project to its conclusion. THANK YOU.

Eva Cronrath
Frankfurt, October 2015

1 The airline profit cycle as a persistent phenomenon

1.1 The development of airline traffic and cyclic financial results

Ever since the early years of commercial air travel in the 1950s the air transport industry has followed a general growth trend. Since 1997 worldwide passenger air traffic has more than doubled (see Figure 1.1).[1] In 1987 the threshold of 1 billion air passengers per annum worldwide was crossed.[2] Only 18 years later, in 2005, over 2 billion passengers were counted. Despite past economic crises and demand shocks, the airline industry returned to the growth track and passenger numbers increased.

In terms of output the airline industry grew more than the global economy. The 'airline industry' comprises all airlines around the world providing scheduled or non-scheduled air transportation.[3] The industry's output, measured in passengers, is compared to the world economy's output, expressed as gross domestic product (GDP).[4] While the world economy's real (= inflation adjusted) GDP grew by 3.1% per year on average from 1970 to 2010, airline passenger numbers expanded at 5.0% average annual

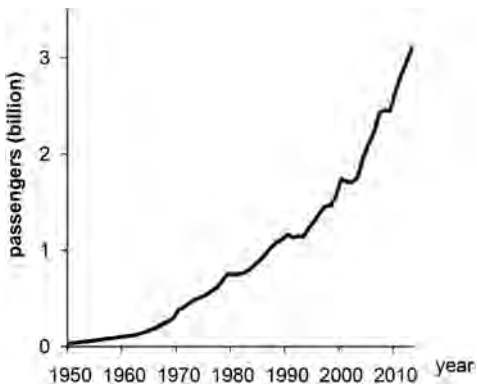

Figure 1.1 Worldwide passenger air travel 1950–2013

Figure 1.2 Aggregate airline revenues worldwide

growth.[5] Especially in recent years the airline industry exhibited almost twice as much growth as the general economy.[6] In 2010, the world had 1,568 commercial airlines which operated 26.7 million commercial aircraft movements.[7] The world's 3,846 airports provided sufficient infrastructure for this traffic load.[8]

Given the overall positive air traffic growth trend it may be expected that the industry is highly prosperous. In line with passenger traffic, airlines' revenues have grown progressively (see Figure 1.2).[9] Between 1970 and 2010 the compound annual growth rate of worldwide airline revenues amounted to 9.0%, and 4.3% in real values, respectively.

However, the airline industry's financial situation is not as healthy as one might expect. Figure 1.3 illustrates aggregate world airline operating and net profits since 1970,[10] and Figure 1.4 depicts profitability relative to revenues.[11] Operating profits are earnings before interest and taxes (EBIT); net profits are earnings after deduction of interest and tax payments, and consideration of non-operating items.[12] It can be observed that the profit development does not mirror the traffic volume and revenue increases. Over time aggregate airline profits do not seem to develop randomly either. On the contrary, the profit history looks surprisingly systematic. It seems to follow a cycle which has the shape of an expanding sine wave (see Figure 1.3).

The world airlines' profit average is zero. To be precise, the average net annual profit from 1978 to 2010 amounts to -0.04 billion USD, and 0.10 billion USD for real net profit. For the period operating profit has a positive annual average of 5.6 billion USD, the real operating profit's mean is 6.5 billion USD.

The amplitude of the worldwide aggregate airline profit cycle is growing. Between 1970 and 2013 every profit peak is higher than the previous one. On the downside, every profit trough was followed by even greater losses in the next downcycle phase. The highest peak so far was reached in 2010 with net profits of 17.3 billion USD and operating profits of 27.6 billion USD. The biggest net loss was reported in 2008, after the breakout of the financial crisis, amounting to -26.1 billion USD. The largest operating losses of -11.8 billion USD occurred in 2001, after the 9/11 terror attacks in the United States.

The world airlines' profit cycle's period was found to be 10 years between 1978 and 2002,[13] and seems to have become shorter after 2007. So far, the

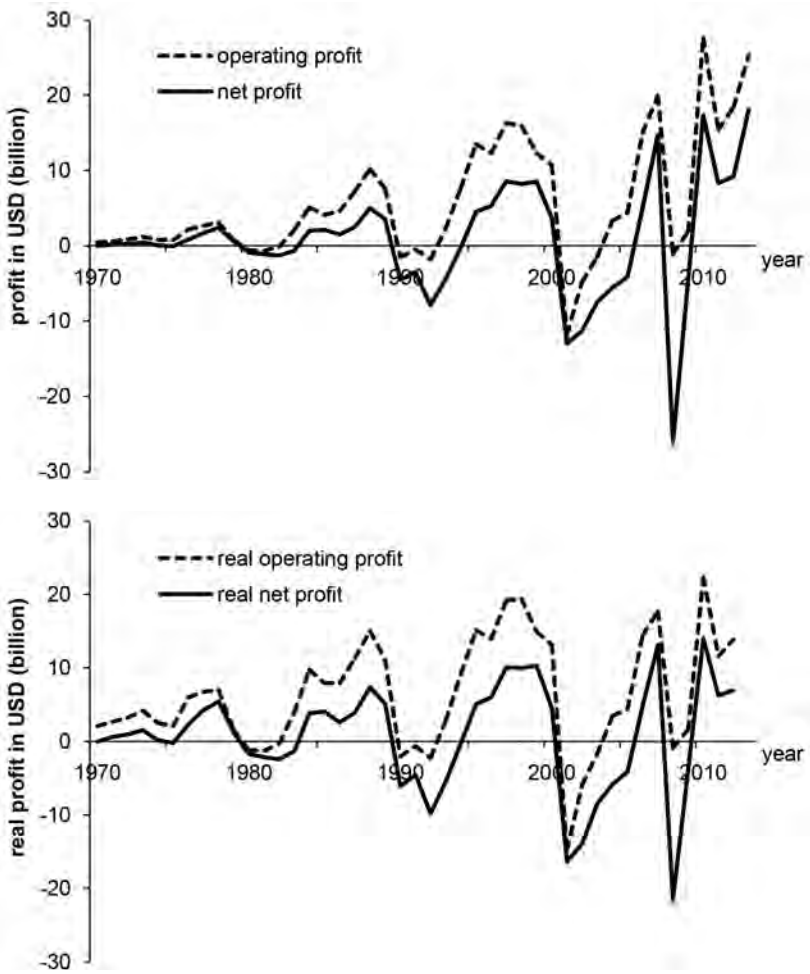

Figure 1.3 Profits of worldwide airlines in nominal and real US dollar values

airline industry has experienced four profit cycles. Cycles from peak to peak were: 1978–1988, 1988–1997, 1997–2007, and 2007–2010.

Cyclicality in airline profitability can be observed throughout world regions. Figure 1.5 shows the operating profitability development in North America, Europe, and Asia, which are the world regions with most air traffic.[14] North America exhibits more cyclicality than other world regions, and than the world airlines' aggregate. Profitability in Europe is in line with the world's development. Airlines in Asia-Pacific are generally more profitable. However, their profits are also cyclic.

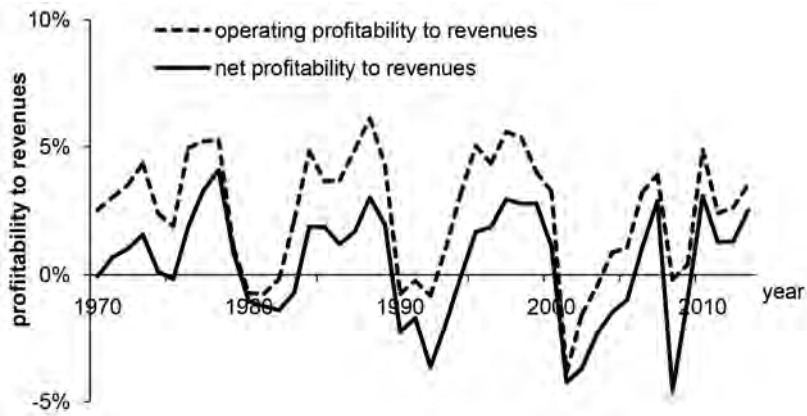

Figure 1.4 Operating and net profitability to revenues of worldwide airlines

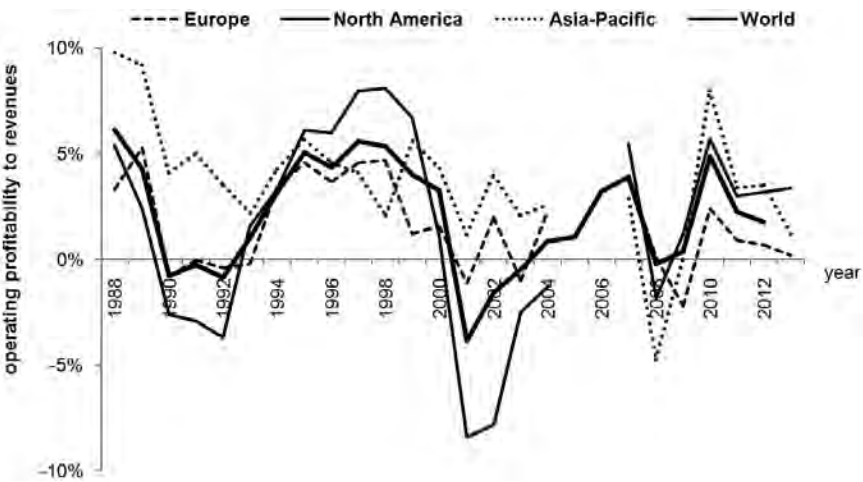

Figure 1.5 Airline profitability throughout world regions

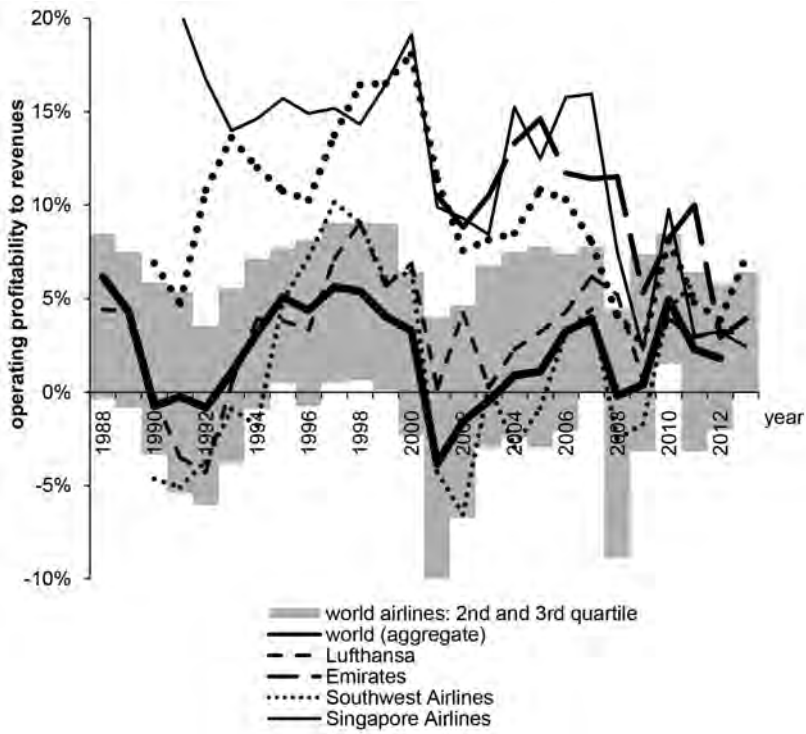

Figure 1.6 Profitability of individual airlines

Profitability does not only differ by geographic region but also among individual airlines. Some airlines manage to achieve financial results significantly above the world's average, for example Singapore Airlines, Emirates, or Southwest Airlines (see Figure 1.6).[15] These financially successful airlines cannot easily be categorised.[16] They have different business models, different sizes, and operate in different world regions. Regardless of their financial success over time, all airlines appear to experience a cyclic profitability pattern (see Figure 1.6). Examples of airlines with a rather average profitability performance are Lufthansa or Continental Airlines. Their average operating profitability over three cycles from 1988–2010 of 3.1% for Lufthansa and 1.0% for Continental Airlines is in line with the world's operating profitability average of 2.1%. The net profitability average of global airlines between 1988 and 2010 is -0.1%.

The International Air Transport Association (IATA) investigated the financial performance of airlines around the world and concludes:

> The evidence of the last cycle suggests that poor airline profitability is certainly not fully explained by business model nor geography. It is true that LCCs [= low cost carriers] as a group tend to have a higher return on

> capital than network airlines in their region. It is also the case that network airline profitability has been lowest on the more mature N. American and European regions. However, none have managed to generate a ROIC [= return on invested capital] sufficient to meet the minimum expected by investors. [. . .] The ubiquity of this under-performance points to **system wide issues** affecting all airlines.[17]

The research presented here aims to identify the 'system wide issues'[18] which negatively impact the airline industry's profitability. Hence, this study takes a system approach to reveal the airline profit cycle's causes, to explain its particular shape, and to derive measures which mitigate or even eliminate the profit cycle. Simulation experiments will be conducted based on a System Dynamics model[19] calibrated for the US airline industry, which is the world's most cyclic one and has already been deregulated in 1978, and offers exceptional data availability.[20] To underline the importance of this research, the airline profit cycle's consequences will be described in the subsequent section.

1.2 Consequences of the airline profit cycle

The airline profit cycle, and especially the fact that net profits are zero on average, has several negative implications. Downcycle periods involve bankruptcies. Some recent examples of airlines in the United States going out of business or filing for bankruptcy protection are: Continental Airlines in 1990; Pan American Airways in 1991; United Airlines in 2002; US Airways in 2002 and 2004; Northwest Airlines and Delta Air Lines in 2005; and American Airlines in 2011.[21] Gritta and Lippman find in 2010 that since 1978 'over 155 air carriers [in the US market] have declared bankruptcy and reorganized or ceased operations, and this rate has increased in recent years. Just since the year 2000, more than 50 airlines have declared bankruptcy'.[22] Outside the United States the profit cycle's downswings have also involved several financial breakdowns, for example: Swissair,[23] Sabena,[24] and Aerolineas Argentinas[25] in 2001, Air Canada[26] in 2003, Olympic in 2003[27] and 2009,[28] Sterling,[29] and Alitalia[30] in 2008.

Though bankrupt airlines do not necessarily cease operations, their financial struggle nonetheless entails major restructuring and workforce reductions. American Airlines, for example, announced in 2012 that 'it has notified more than 11,000 workers they could lose their jobs as part of its bankruptcy reorganization'.[31] Furthermore, as part of the restructuring process, airlines are likely to cut unprofitable connections and hence reduce their traffic supply.

Consequently, other industries, which rely on air transportation, also suffer from airline bankruptcies and restructuring processes. Globally the air transport industry supports 58.1 million jobs, 52% of international tourists travel by air, and in 2013 aviation carried 35% of interregional exports of goods by value.[32] Airline bankruptcies and traffic reductions thus have negative employment, social, and economic consequences outside the airline industry. More stable positive

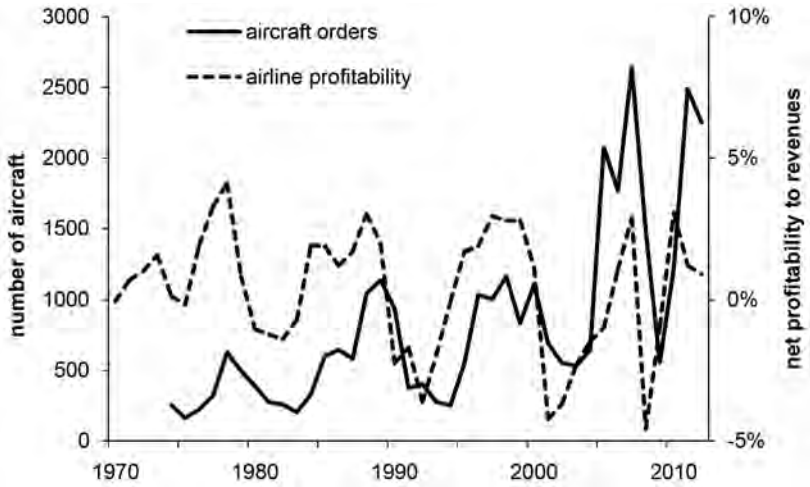

Figure 1.7 Worldwide airline profitability and aircraft orders of Boeing and Airbus

airline profits could create a more reliable business environment for air transport dependent industries, ensure tourism and trade, and preserve employment.

Being a direct supplier for the airline industry, aircraft manufacturers strongly experience the airline profit cycle's negative effects. Airlines tend to buy aircraft when they have money and refrain from ordering new capacity when they struggle financially. Figure 1.7 illustrates the almost parallel evolution of the world aggregate airline profitability and aircraft orders placed with Boeing and Airbus.[33]

In the past, the aircraft manufacturer Boeing reacted strongly to the cyclic behaviour by trying to match production capacity to incoming orders.[34] As a consequence, in upcycle periods many employees are hired to increase production. For example, Boeing's number of employees increased by approximately 85% from 1983 to 1989, by 40% from 1995 to 1997, and by 35% from 2004 to 2007. However, airlines' downcycle periods entailed sharp workforce reductions at the aircraft manufacturer. From 1981–1983 approximately 30% of Boeing's employees were made redundant, 35% between 1989 and 1995, and 45% between 1997 and 2004. Presumably, more stable airline profits would positively impact aircraft manufacturers' business through smoother aircraft order patterns, which ensure steady production capacity utilisation and enable manufacturers to retain their workforce.

Another consequence of the airline industry's financial performance is its comparable unattractiveness for investors. To judge the attractiveness of an investment the return on invested capital (ROIC) is compared to the weighted average cost of capital (WACC).[35] The main difference between ROIC and operating profitability to revenues is that the costs of operating leases are deduced to compute the return on invested capital, because only owned aircraft form

part of airlines' invested capital. Hence, the ROIC is significantly higher than airlines' profitability. The WACC indicates what investors could earn if they invested their capital elsewhere (in an asset of similar risk in the same country). For the airline industry Figure 1.8 shows that the ROIC is constantly below the WACC.[36] Broadly speaking this means investors lose money on every dollar invested in the airline industry. They could have earned more if they had invested their capital in alternatives.

If the airline industry was more profitable, the ROIC would be higher, and investments would be more attractive. The industry's persistent financial under-performance may be expected to encourage investors to withdraw their money and invest elsewhere. Nonetheless, the airline industry has attracted large investments in the past. These must have thus been made for reasons other than mere returns on investment. To ensure future growth the IATA estimates the immense investment of 4–5 trillion USD in new aircraft will be needed, especially in emerging economies.[37] Given this great financial need the IATA concludes that '[w]ithout an improvement in the return on capital invested in the airline industry it may well be difficult to attract such investment capital'.[38]

The airlines' financial struggle is not mirrored in other aviation industries. Along the aviation value chain, airlines achieve the lowest returns on invested capital. Figure 1.9 shows how returns on capital vary throughout the value chain between 2004 and 2011.[39] In contrast to airlines, many other aviation businesses earned more or close to their WACC. Among airlines' suppliers, service providers earned returns higher than their cost of capital. Manufacturers, lessors, and airports did not reach their WACC. Airline distributers generated the highest return in the aviation value chain. Computer reservation system (CRS) services, travel agents, and freight forwards produce returns more than twice their cost of capital.

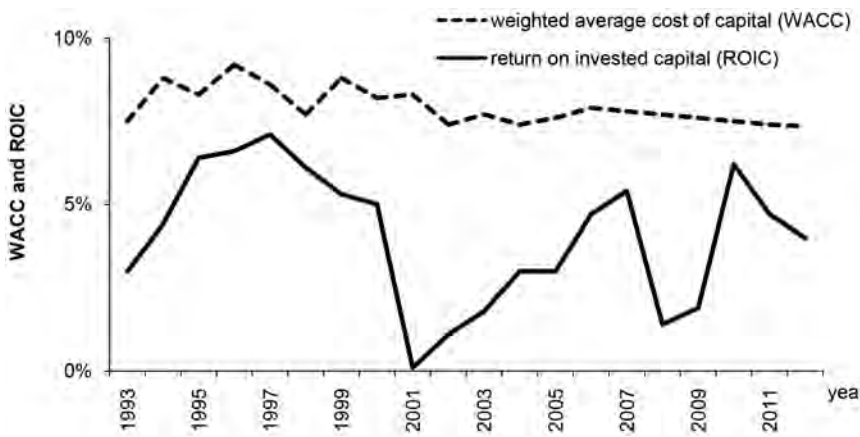

Figure 1.8 Evaluation of investments in the global airline industry
Source: IATA

Comparing the airline industry to 28 other industries, such as chemicals, IT services, or department stores, the IATA finds even more evidence for the airline industry's striking profit problem: 'Over the past 30–40 years the airline industry has generated one of the lowest returns on invested capital among all industries.'[40]

During the last decades the airline industry made considerable efforts to improve its financial situation. Between 1990 and 2010 real costs per unit of output have been reduced by almost a third (see Figure 1.10).[41] This implies

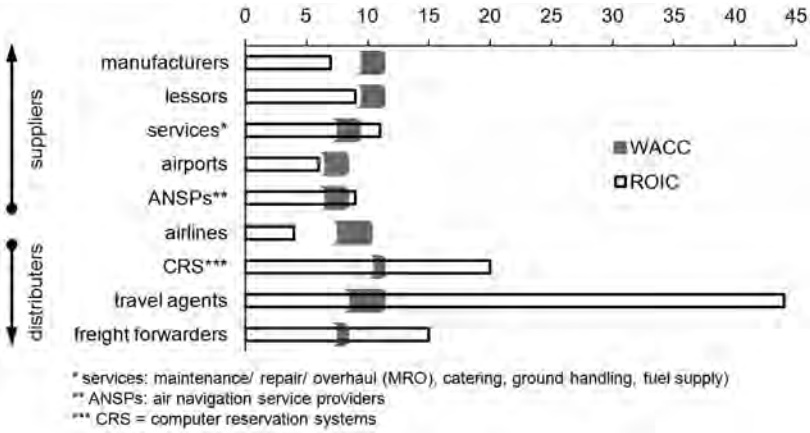

Figure 1.9 Profitability along the aviation value chain – return of invested capital (ROIC) versus costs of capital (WACC)

Source: IATA

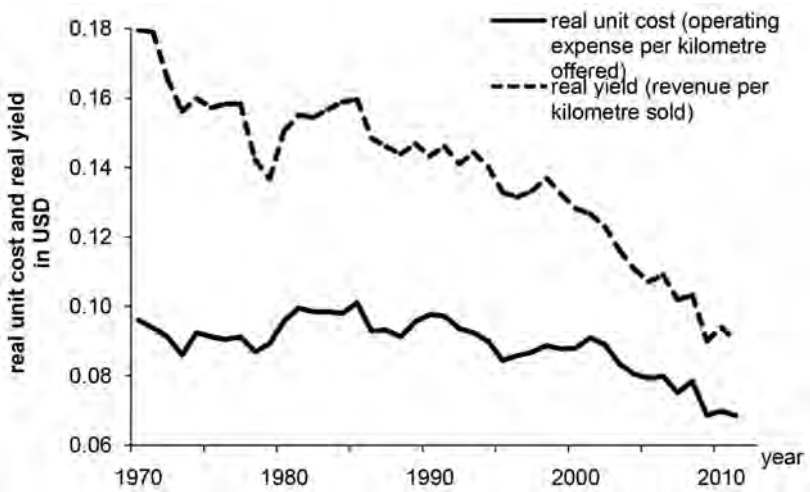

Figure 1.10 Unit cost and yield development of global airlines

airlines achieved substantial efficiency gains. However, airlines' revenue per unit sold, which is called 'yield' in the airline industry, has also declined. Figure 1.10 illustrates how yields have fallen over the past four decades.

In summary, it is evident that the airlines' cyclic profitability with repeated loss periods has negative consequences for many stakeholders. Not only the airline industry itself but also its supply chain partners, dependent businesses, and investors suffer as a consequence of the airlines' poor financial performance. More stable positive financial results could not only facilitate airline management decisions and improve investors' confidence but also preserve employment.

1.3 Research objective and approach

The question is how the airline industry can achieve more stable positive profits to prevent the airline profit cycle's negative consequences. To be able to answer this question it is necessary to understand the airline profit cycle's causes, and the drivers behind its particular shape (zero average profit, rising amplitude, regular and recently shorter cycle period). A literature analysis will reveal that research on the airline profit cycle's causes and drivers is scarce, and previous studies contradict each other in several aspects. The purpose of this study is to address these aspects in order to achieve a detailed understanding of the airline profit cycle, and to suggest cycle mitigating measures. Accordingly, three questions are formulated to guide the research process:

1 Why are airline profits cyclical?
2 What are the causes and dynamics that determine the profit cycle's shape?
3 How can the situation be improved?

The research process to answer these questions is presented in five chapters, as outlined in Table 1.1. Chapter 1 has introduced the phenomenon 'airline profit cycle' and motivated the research questions. In Chapter 2 previous airline profit cycle research is examined, as well as related literature on cyclicality. Potential causes and drivers of the airline profit cycle are derived from literature and expert interviews. In addition, potential cycle mitigation measures are compiled. In Chapter 3 an empirical investigation of the most popular cycle drivers reveals the need for further analysis with a systemic approach. Hence, a System Dynamics model of the airline industry's profit development is constructed and calibrated for the US airline industry. Once confidence in the model's behaviour has been gained, the potential airline profit cycle causes, drivers, and mitigation measures gathered in Chapter 2 are examined in model simulation experiments in Chapter 4. Their impact on the airline profit cycle will be assessed to reveal the cycle's causes and drivers as well as dampers. Chapter 5 concludes how the airline industry's profit situation could be improved.

Table 1.1 Outline of this airline profit cycle study

Outline of content			
Ch.	*Stage*	*Summary*	*Main results*
1	Problem definition	The airline profit cycle: What is the problem? Why is it a problem? Research questions: 1 Why are airline profits cyclical? 2 What determines the cycle's shape? 3 How can the situation be improved?	Relevant research questions
2	Inventory	What is known about the airline profit cycle's causes and drivers? What can be learned from cyclicality in other contexts? (Sources: literature and experts)	Potential cycle causes, drivers, and mitigation policies
3	Model formulation, calibration, and validation	• Empirical analysis of selected potential cycle causes (→ need for a system approach) • Formulation of a System Dynamics model of the airline industry • Calibration for the US airline industry • Tests to build confidence in model structure and behaviour	First insights about cycle causes and System Dynamics model of the airline industry
4	Model experiments	Potential cycle causes, drivers, and mitigation measures (from Chapter 2) are tested for their impact on airline profitability	Actual airline profit cycle causes, drivers, and mitigation policies
5	Conclusion	• Discussion and summary of results • Counter-factual illustration of promising cycle mitigation measures • Suggestions for further research	Compilation and illustration of key results

Notes

1 Data source: A4A Airlines for America, 'World airlines: Annual results. Traffic and operations 1929 – present', web page, accessed: 21 Nov 2014.
2 Note for clarification: A 'billion' equals 10^9.
3 Definition corresponds to Standard Industrial Classification (SIC) codes 451* and 452*. This includes airlines' passenger and cargo transportation as well as ancillary businesses.
4 Data source: Passenger numbers: A4A Airlines for America, 'World airlines: Annual results. Traffic and operations 1929–present', accessed: 21 Nov 2014. – Real GDP data: 'UN Statistics, World. GDP, at constant 2005 prices' – US Dollars, web page, accessed: 14 Nov 2013.
5 Own calculation of Compound Annual Growth Rates = (end value / start value) ^ (1/years) -1.

6 In 2000–2010 annual growth rate of real GDP 2.6%, of airline passengers 4.3%.
7 See International Air Transport Association (IATA), *Fact sheet: Economic and social benefits of air transport* (2012).
8 Globally, 94% of all flights in 2008 operated in unconstrained airport capacity conditions. See Gelhausen, Marc, Peter Berster and Dieter Wilken, 'Do airport capacity constraints have a serious impact on the future development of air traffic?', *Journal of Air Transport Management* 28 (2013): p. 9. – Data source of airport number: International Air Transport Association (IATA), *Fact sheet: Economic and social benefits of air transport*.
9 Revenue data source: A4A Airlines for America, 'World airlines annual results: Financial results 1947–present', web page, accessed: 21 Nov 2014. – Inflation adjusted by Implicit Price Deflator in 2005 US dollar values, data source: UN Statistics, 'World. GDP, Implicit Price Deflators – US Dollars. Implicit Price Deflator (2005 = 100)', web page, accessed: 21 Nov 2014.
10 Profit data source: A4A Airlines for America, 'World airlines annual results: Financial results 1947–present', accessed: 21 Nov 2014. Inflation adjusted by Implicit Price Deflator in 2005 US dollar values, data source: UN Statistics, 'World. GDP, Implicit Price Deflators – US Dollars. Implicit Price Deflator (2005 = 100)', accessed: 21 Nov 2014.
11 Own calculation. Data source: A4A Airlines for America, 'World airlines annual results: Financial results 1947–present', accessed: 21 Nov 2014.
12 See International Civil Aviation Organisation (ICAO), *Air transport reporting form: Financial data – Commercial air carriers (FORM EF)* (2013).
13 See Jiang, Helen and R. John Hansman, 'An analysis of profit cycles in the airline industry', *6th AIAA Aviation Technology, Integration and Operations Conference (ATIO)*, (Wichita, Kansas: 2006), p. 9.
14 Data sources: North America, Europe, and Asia-Pacific: For 1988–2004: ICAO via Morrell, Peter S., *Airline finance*, 3rd ed. (Aldershot, UK; Burlington, VT: Ashgate, 2007) p. 5, Figure 1.4. – For 2007–2009: International Air Transport Association (IATA), *Fact sheet: Industry statistics, December 2010* (2010). For 2010–2012: International Air Transport Association (IATA), *Fact sheet: Industry statistics, September 2013* (2013). For 2013: International Air Transport Association (IATA), *Fact sheet: Industry statistics, December 2014* (2014). – World profitability: Own calculation, data source: A4A Airlines for America, 'World airlines: Annual results. Financial results 1947–present', web page, accessed: 15 Nov 2013.
15 Own calculation. Data sources: financial results from BTS (US airlines only), Compustat, A4A, and financial statements on company websites. See US Bureau of Transportation Statistics (BTS), 'Schedule P-1.2 Air carrier financial', web page, accessed: 28 Jan 2014. And Compustat, 'Fundamentals Annual Data', web page, accessed: 28 Jan 2015. And A4A Airlines for America, 'World airlines: Annual results. Financial results 1947–present', accessed: 15 Nov 2013. And Lufthansa, 'Financial statements 1988–2013', web page, accessed: 28 Jan 2015. And Emirates, 'Financial statements 2004–2014', web page, accessed: 28 Jan 2015.
16 See International Air Transport Association (IATA), *Vision 2050* (Singapore 2011), p. 14. – The recipe for an individual airline's success remains to be discovered. To date (2014) the only one large-scale empirical study on airlines' critical success factors; also published in International Air Transport Association (IATA), *Profitability and the air transport value chain* (2013).
17 International Air Transport Association (IATA), *Profitability and the air transport value chain* (2013), p. 16. – Emphasis not in original.
18 Ibid.

19 A brief introduction to System Dynamics will be given in section 3.1.2 before the airline industry model is presented in sections 3.2–3.3.
20 The model calibration choice is explained in section 3.5.1.
21 See The Associated Press, 'American joins long list of airline bankruptcies', 2011, web page, accessed: 15 Nov 2013.
22 Gritta, Richard and Ellen Lippman, 'Aircraft leasing and its effect on air carriers debt burdens: A comparison over the past several decades', *Journal of the Transportation Research Forum* 49, no. 3 (2010): p. 101.
23 See SWISS, 'Swissair: Switzerland's former national airline ceased operations in 2002, 2013', web page, accessed: 15 Nov 2013.
24 See Sabena, 'A historic airline is gone', 2013, web page, accessed: 15 Nov 2013.
25 See Jayanti, Rama K. and S.V. Jayanti, 'Effects of airline bankruptcies: An event study', *Journal of Service Marketing* 25, no. 6 (2011): p. 401.
26 See Simon, Bernhard, 'Air Canada is granted bankruptcy court protection', *New York Times*, 2 April 2003, web page, accessed: 15 Nov 2013.
27 See The Agence-France Presse, 'Olympic Airways changes name, strategy but keeps rings', *USA Today*, 2003, web page, accessed: 15 Nov 2013.
28 See Freshfields, Bruckhaus and Deringer, 'Olympic Airlines: Judgement clarifies definition of "establishment" in secondary insolvency proceedings', 2013, web page, accessed: 15 Nov 2013.
29 See CAPA Centre for Aviation, 'Bankruptcy of Denmark's Cimber Sterling will leave no long-lasting network gaps', 2012, web page, accessed: 15 Nov 2013.
30 See BBC News, 'Alitalia seeks bankruptcy measure', 2008, 29 August, web page, accessed: 15 Nov 2013.
31 Reuters, 'American Airlines issues layoff notices, cuts flight schedule', 2012, web page, accessed: 15 Nov 2013.
32 See International Air Transport Association (IATA), *Fact sheet: Economic and social benefits of air transport* (2014).
33 Own calculation. Aircraft orders are the sum of received commercial aircraft order published by Boeing and Airbus. – Data source for Boeing orders: 'Boeing, Orders and deliveries', 2013, web page, accessed: 20 Nov 2013. – Data sources for Airbus orders: For 1975–2009: 'Airbus, Historical orders and deliveries 1974–2009', 2010, web page, accessed: 8 Sept 2010. For 2010–2012: Airbus, 'Airbus summary results 1989–2012', updated Jan 2013, 2013, web page, accessed: 21 Nov 2013. – Data source for world aggregate airline profits: A4A Airlines for America, 'World airlines: Annual results. Financial results 1947–present', accessed: 15 Nov 2013.
34 Data source employee numbers on Boeing's prime production site in Washington state: For 1997–2012: Boeing, 'About us: Boeing employment numbers', 2013, web page, accessed: 21 Nov 2013. Values for 1971, 1980, 1983, 1989, and 1995 in: Sgouridis, Sgouris P., 'Symbiotic strategies in enterprise ecology: Modeling commercial aviation as an Enterprise of Enterprises', PhD thesis, Massachusetts Institute of Technology, 2007, p. 123. – Data source aircraft orders: Boeing, 'Orders and deliveries', accessed: 20 Nov 2013.
35 Definitions of ROIC and WACC (used in Figure 1.8): The ROIC is the payment investors receive for providing capital and bearing risk. It is the after-tax operating profit (adjusted for operating leases) expressed as a percentage of invested capital. The ROIC differs from operating profitability to revenues mainly because it is a return on the capital invested, not on revenues. – The WACC indicates the opportunity costs for investors, i.e. what the investor would earn if their capital was invested elsewhere in an asset of similar risk in the same country. Source: International Air Transport Association (IATA), *Profitability and the air transport value chain*, p. 15.

36 Ibid., chart 5, p. 11.
37 See ibid., p. 13.
38 Ibid.
39 Ibid., chart 12, p. 19. Illustrated is ROIC excluding goodwill of sample, period 2004–2011, in per cent. Only limited sample for travel agents.
40 Ibid., p. 12.
41 Own calculations. Data sources: A4A Airlines for America, 'World airlines: Annual results. Financial results 1947–present', accessed: 15 Nov 2013. A4A Airlines for America, 'World airlines: Annual results. Traffic and operations 1929–present', accessed: 21 Nov 2014. Inflation adjustment by Implicit Price Deflator, in 2005 values, data source: UN Statistics, 'World. GDP, Implicit Price Deflators – US Dollars. Implicit Price Deflator (2005 = 100)', accessed: 14 Nov 2013.