1 Introduction

The development of freight prices in logistics markets is subject to notable fluctuations. In addition to seasonally and regionally observable trends, particularly in recent years, changes in freight rates have been challenging to investigate and mitigate. Moreover, in the wake of the COVID-19 crisis, the already volatile logistics industry has undergone unprecedented developments in freight prices, stemming from an overall imbalance between the supply and demand of goods. In this context, sky-rocketing freight rates for individual transport modes have increasingly attracted the attention of practitioners and the media. Consequently, due to increasing external uncertainty and turbulent fluctuations on both the supply and demand sides, actors in logistics markets such as shippers and logistics service providers (LSPs) are increasingly exposed to volatility and urged to develop strategies to mitigate related risks. As such, the COVID-19 crisis revealed that transport prices could become prohibitively expensive, thus necessitating that shippers rethink their supply chain design. At the same time, building inventory levels to minimize supply chain disruption, ensuring overall supply security, and adjusting to a changing market environment have become central themes of logistics markets. Accordingly, shippers, carriers, and LSPs are challenged to evaluate appropriate measures to reduce volatility in logistics markets in addition to their day-to-day operations.

This study seeks to address this problem by providing practitioners with a set of practices with which to manage volatility in a standardized and concise spreadsheet format. The study findings are based on a broad series of interviews in which 44 experts, consisting of shippers, carriers, and intermediaries, were asked about their challenges, views, and approaches in dealing with volatility in logistics markets, thus ensuring triangulation of the different perspectives. The present study also adopts a change of perspective by considering the possibility of consolidating information and coherently portraying different management approaches. In this way, this study offers a unique selling point by providing the three primary actors in logistics markets with a comprehensive overview of possible measures by which to reduce their respective volatility exposure. Thereby, the practical relevance of the study facilitates the transfer and application of the research results for practitioners.

1.1 Study objectives

The primary objective of this study is to present good practices in dealing with freight price volatility in logistics markets in a standardized spreadsheet format summarizing relevant measures from the perspective of shippers, intermediaries, and carriers to derive individual recommendations for action. To derive good practices in responding to volatility in logistics markets, a better understanding of volatility sources and related effects is necessary. Therefore, this study also seeks to shed light on the myriad of factors driving freight price volatility. Finally, by incorporating the perspectives of shippers, intermediaries, and carriers, the present study aims to contribute to a stimulating and constructive discourse by ensuring that the different perspectives of three key actors in logistics markets are considered.

To summarize, this study aims to identify management strategies concerning freight price volatility by considering the heterogeneity of volatility sources, leading to the central research question:

"How can shippers, intermediaries, and carriers better manage the volatility of freight prices in logistics markets?"

The following underlying research questions are developed and answered incrementally throughout this thesis to answer the above question:

RQ1 – Challenges:
What are the general sources of freight price volatility in logistics markets?

RQ2 – Practices:
What are good practices in dealing with freight price volatility in logistics markets?

RQ3 – Tools:
Which indices and digital business models can legacy players use to deal with volatility in logistics markets?

1.2 Study structure

To answer the above research questions and achieve the overall objective, this study features a funnel-shaped structure, with the breadth of analysis decreasing and the depth of analysis increasing as the investigation progresses. As a result, more accurate and detailed conclusions are presented as the research unfolds. Therefore, the present study is structured as follows:

Chapter 2 provides a brief overview of practical challenges facing logistics markets and related theoretical gaps, thereby explaining the general motivation for conducting this study.

Chapter 3 presents the methodological background of the present study. In doing so, the main building blocks of desk research (DR), nominal group technique (NGT), and expert interviews (EI) are briefly introduced.

Chapter 4 presents a guideline on how practitioners can apply the research results based on the methodological approach.

Chapter 5 highlights sources of volatility in logistics markets and clusters these sources into four dimensions to better understand the problem space.

Chapter 6 introduces a general systematization of measures and practices for dealing with volatility in logistics markets to derive practices with which to address the identified volatility sources.

Chapter 7 applies this systematization to derive a set of practices for four exemplary logistics scenarios, namely air, rail, road, and sea freight.

Chapter 8 demonstrates the application of approaches employed by logistics actors when managing freight price volatility, highlighting six practical case studies. In addition, Chapter 8 highlights key challenges and future trends introduced by the Russia-Ukraine crisis.

Chapter 9 presents a meta-list of indices and digital business models, thus providing practitioners with an overview of relevant information sources and (solution) providers. For each index and company, we provide key information in the appendix.

Chapter 10 presents an integrated discussion and evaluation of the study results, critically examining, in particular, the contribution and limitations of the present study.

Finally, **Chapter 11** draws conclusions for practitioners, summarizes the study results, and identifies the potential for further development regarding related challenges, practices, and tools when managing volatility in logistics markets.

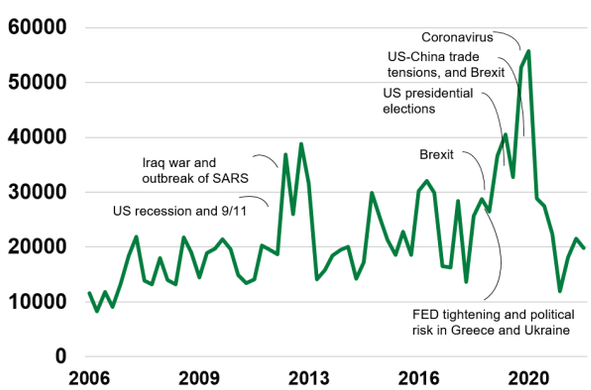
2 Motivation

This section presents a status quo analysis of practical challenges and theoretical gaps, that serves to highlight the need for the present study.

As indicated in Chapter 1, the entire logistics market is in a state of upheaval caused by the COVID-19 crisis. Consequently, actors in logistics markets must operate in a constantly changing environment. Given this structural dynamic, the acronym VUCA (volatility, uncertainty, complexity, ambiguity) describes the insecure environment in which businesses operate (Bennett & Lemoine, 2014). Figure 1 illustrates the increasing extent of global uncertainty based on the Stanford University World Uncertainty Index. In the first quarter of 2020 the index hit a new high, rating 152% higher than the average value between 2006 and 2020.

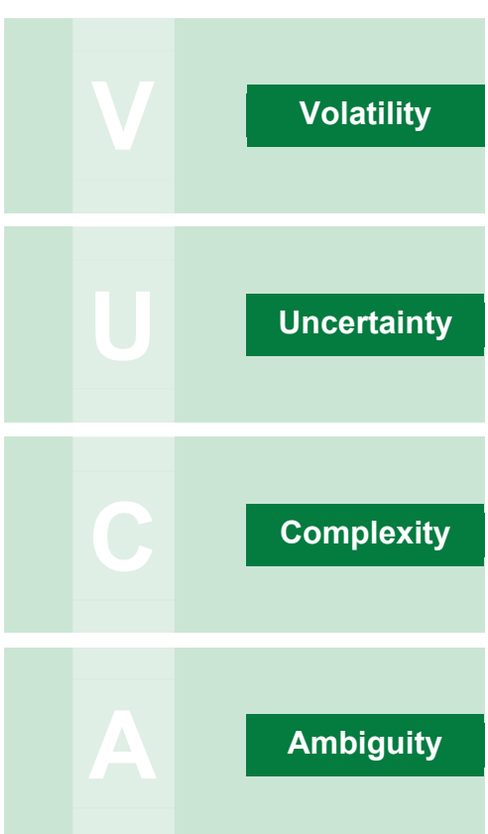
Figure 1

World Uncertainty Index (Ahir et al., 2018)



In this context, the logistics industry is increasingly exposed to rising costs and inflation rates fueled by external disruptions such as the COVID-19 and the Russia-Ukraine crisis.

In addition to escalating energy prices, the logistics industry suffers from a shortage of personnel, particularly in road freight transport, which said crises have only exacerbated. As a result, freight rates are highly volatile and soaring, putting extreme strain on LSPs and shippers. Against this background, a fundamental understanding of the root causes and effects of different volatility drivers and the implementation of reasonable practices would be crucial in the years to come. To this end, we first describe how the challenges posed by VUCA affect logistics markets and the resulting practical problems for shippers and LSPs within the individual transport modes. Second, we describe the theoretical gaps that this study seeks to address.



PESTEL analysis

Different drivers in a volatile, uncertain, complex, and ambiguous (VUCA) environment can be explained by political, economic, social, technological, environmental, and legal (PESTEL) factors, which can cause a significant change in today's logistics markets (Diaz Ruiz et al., 2020). We discuss and illustrate challenges within the PESTEL framework below with brief examples from logistics markets:

Political:

As a legislative force, politics (e.g., government policies) significantly impact logistics actors located in a particular jurisdiction and their supply chains due to dependencies on other transport modes and countries. For instance, geopolitical tensions with corresponding import tariffs, airline reroutings in restricted airspace (e.g., those prompted by the Russia-Ukraine conflict), or a complete economic boycott can contribute significantly to the volatility of freight prices.

Economic:

Since players in logistics markets, such as shippers or LSPs, are dependent on the general economic situation and trading activity, financial risks are considered a significant volatility component (Lim et al., 2019). For example, freight rates are affected by exchange rates, general stability of oil prices, or raw material availability, which are also subject to external influencing factors, so precise forecasts are often impossible, and the costs are often incalculable. For this reason, clauses such as the diesel floater have emerged, especially in the contract market, to hedge existential risks.

Social:

Demographic changes and a changing job profile pose challenges to the job market for the logistics industry. For example, the current shortage of truck drivers in road freight in Germany, estimated at 80,000, could reach 185,000 truck drivers by 2027 (IRU, 2019). Therefore, logistics personnel is already a determinant variable regarding the load space and a significant price trigger in logistics markets.

Technological:

The transport and logistics industry is undergoing a massive structural transformation, including different fields such as data analytics, automation, and new propulsion technologies (Tipping & Kauschke, 2016). On the one hand, competitive pressure is rising as shippers increasingly use technology to influence logistics processes while new entrants are seizing a value creation share through digital business models. On the other hand, incumbent LSPs are challenged by the need to determine how and to what extent they should commit themselves to adopt technological improvements and radical innovations.

Environmental:

The ongoing climate crisis and increased emphasis on environmental factors increasingly creature pressure for shippers and LSPs to reduce (carbon) emissions during transport. In this regard, The EU considers emissions trading schemes using CO2 certificates in transport logistics, especially in road and sea freight (Hütten, 2021). For example, the EU's Fit for 55 package for marine shipping intends to reduce greenhouse gas intensity of energy by up to 75% by 2050.

Legal:

In Germany, the Supply Chain Act, which sets requirements for the due diligence of companies to monitor social and environmental standards, will come into force at the beginning of 2023 (BMWI, 2021). Within supply chains, this

will likely result in significant changes in supplier structures and may lead to a re-regionalization of production, thereby directly impacting logistics markets and the freight price volatility of individual transport modes.

Practical challenges

Based on the PESTEL analysis, several variables affect the overall volatility of freight prices. Applied to the individual transport modes, different practical challenges for transportation via air, sea, road, and rail emerge, pushing shippers, intermediaries, and carriers to adapt to a constantly changing environment. We discuss and illustrate critical challenges within each transport mode below:

Sea freight is characterized by its boom-and-bust cycles, with many years of low rates where shipping lines did not earn their cost of capital (Saxon & Remes, 2021). However, amplified by the COVID-19 crisis, sea freight was confronted with a myriad of challenges: Congestion at ports, blank sailings, container misallocations, the Suez Canal blockage, and an overall increasing supply chain slowdown, leading to widespread supply bottlenecks and an explosion in sea freight (spot) rates. As a result, shipping lines "passed the buck" to shippers who were challenged to remain profitable due to increased rates. On the one hand, LSPs generate higher revenues but at the same time face uncertainty in operations (e.g., port congestions), complicating transportation planning. On the other hand, shippers must spend more for shipping services, face long lead times for their shipments, and accept increased costs of tied-up capital, indirectly increasing the attractiveness of other modes of transportation, such as air freight.

Air freight rates have historically been stable at a low level, given the global underutilization of capacity (at 50%) as passenger airlines expanded into new markets (Häberle & Stölzle, 2020). However, during the COVID-19 crisis, rates exploded due to the sudden loss of belly capacity, with airlines withdrawing contracted volumes. In addition to a shrinking availability of cargo space, the need for personal protective equipment (PPE) led to severe freight rate increases. While carriers faced the challenge of maintaining their operations in compliance with sanitary regulations, shippers were confronted with margin pressures as spot market prices increased tenfold (Whelan, 2021).

Road freight is characterized by low profitability margins, poor asset utilization, and multiple competing providers, leading to a commoditization of transportation services. In addition, new (digital) entrants are upsetting the industry by depressing prices, shifting volumes, and further intensifying competition among carriers and freight forwarders. Meanwhile, mandated rest periods further aggravate the ongoing truck driver shortage. In light of these developments, intermediaries and carriers must improve asset utilization and eliminate empty runs to remain competitive, while shippers are encouraged to secure capacity for their transportation needs.

Rail freight is affected by comparatively low price fluctuations, resulting in high price stability. However, this stability results from an oligopoly of rail operators on the supply side (Vanelslander, 2019). This market situation implies less market efficiency in terms of profit maximization. Instead, prices are adjusted based on developments in competing transport modes. Accordingly, shippers face the challenge of paying higher prices for historically stable logistics services. In addition, there are problems related to customs and border crossing on international routes, such as the Małaszewicze-Brest border crossing between Poland and Belarus on the New Silk Route (van Leijen, 2022). Lastly, severe storms or infrastructural disruptions (e.g., the Rastatt Tunnel in Germany 2017) have repeatedly led to operational delays or even the closure of essential rail routes in the past, posing significant challenges for shippers and rail operators.

Theoretical gaps

Given the practical challenges shippers and LSPs face in the market, research has – until now – mainly focused on price changes in maritime trade, for example, by identifying economic-related shipping cycles such as trough, recovery, peak, and collapse within which freight rates develop (Ferrari et al., 2018). Although authors such as Christopher and Holweg (2011, 2017), Barlas and Gunduz (2011), and Nitsche (2019) have already addressed the causes of volatility in supply chains, their research primarily focuses on volumes and the study of specific drivers of these fluctuations. In contrast, authors such as Childerhouse et al. (2008) or Handfield et al. (2013) only adress supply chain volatility mitigation capabilities. A holistic overview of the problem space of relevant freight price volatility sources and the solution space covering actor-specific practices is not yet available. However, a basic understanding of the phenomenon is necessary to derive appropriate mitigation measures. In addition to these prevailing theoretical gaps, rapid advancements have brought about a host of new influencing factors that have fundamentally altered the fluctuations of volatile market prices. Key factors to consider include globalization, increasingly complex material flows, and the emergence of supply chain networks (Nitsche, 2019). Simultaneously, digitization is giving rise to new digital business models and new trade relationships that are not, or insufficiently, highlighted in the literature (Mikl et al., 2021). As already shown, companies operating in the logistics markets, such as shippers and LSPs, are not unaffected by these changes. Therefore, research on managing volatility in logistics needs to be revisited.

Conclusion

Given the practical challenges and theoretical gaps, it is essential to provide recommendations for shippers, intermediaries, and carriers to navigate through an increasingly complex environment. Contrary to the intuition arising from the above, the management of price fluctuations in practice is rare, and the question arises as to why systematic volatility management is only practiced to a limited extent. A possible explanation is that freight procurement was not (as) necessary in the past as shippers focused extensively on the procurement of goods by cutting costs and taking advantage of lower labor costs in emerging markets (den Butter & Linse, 2008). Accordingly, freight purchasing was assigned a minor role compared to the procurement of materials and commodity groups. Furthermore, fluctuations in transportation costs were often attributed to volatile wage costs and uncontrollable external variables such as oil prices (Nitsche, 2019). The COVID-19 crisis has made it clear how immature the management of volatility has been so far and what impact (e.g., bullwhip effect) different volatility drivers can have on the existence of companies if not managed appropriately (e.g., visibility). If nothing else, the COVID-19 crisis has made the need for a deeper examination of volatility and related drivers evident.

This study starts at the interface between theory and practice and attempts to fill the gap between practice and academic research in understanding and dealing with freight price volatility in logistics markets. To this end, the present study makes a significant contribution by identifying the various sources of volatility and deriving reasonable practices to address the inherent volatility of freight prices. In this context, the scientific examination and reappraisal of freight price volatility management shed light on management approaches for handling different logistics scenarios.

3 Methodological approach

The following chapter outlines the underlying methodology of the present study. Due to the high practical relevance of the underlying study topic, engaged scholarship, following Matthiassen (2017) and Van de Ven (1971), was chosen as a methodological framework. Engaged scholarship is fundamentally characterized by a participatory approach to research, using multiple viewpoints and ideas from relevant stakeholders to examine complicated real-world situations (Mathiassen, 2017).

Following Kuckartz (2014), we propose a mixed-method approach to answer the underlying research questions. Therefore, Chapter 3 is divided into three parts, which are discussed in more detail below to explain the methodology step-by-step.

First, Chapter 3.1 describes the desk research conducted for the literature review and the definition of logistics scenarios.

Second, Chapter 3.2 deals with the nominal group technique (NGT), which was applied within the consortia to develop an understanding of freight price volatility sources.

Third, Chapter 3.3 elaborates on the interview process used to extract practitioners' knowledge concerning practices by which to reduce freight price volatility.

3.1 Desk research

Period

- August 2021

Objectives

- Definition of homogeneous logistics scenarios for the analysis of adequate measures by which to deal with freight price volatility

Approach

To address the high complexity of transport price developments in logistics markets, we do not consider a homogeneous analysis of transport prices appropriate for the entire logistics market. Instead, due to the high diversity of services offered, there is a need to divide the logistics market into homogeneous submarkets to reduce complexity and identify segment-specific dynamics (Gleissner & Femerling, 2016; E Hofmann & Wessely, 2012; König, 2001). To this end, we identify segments susceptible to different market fluctuations. Following pertinent literature (Hofmann & Wessely, 2012), we use established criteria for segmenting logistics scenarios to investigate the volatility of freight prices in logistics markets. Hofmann and Wessely (ibid.) distinguish the following eight segmentation criteria: type of logistics object, means (and technologies) of transport, size of logistics object, logistical function, industry reference of the logistics object, performance character, dimension of goods transformation, and type of goods. Since not all segmentation criteria are equally relevant for the analysis of freight price volatility, we exclude individual criteria for the study of logistics scenarios in the following.

First, we exclude the criteria **type of goods** and **size of logistics object**, as we assume that the size or weight of goods do not fundamentally drive freight price volatility but that other, often macroeconomic factors are underpinning them. In addition, although transport prices for certain goods certainly vary by season (e.g., fruit season), this criterion exceeds the scope of the present study due to the large variety of products. Accordingly, it seems less suitable as a criterion for segmenting logistics scenarios to analyze freight price volatility.

Second, we ruled out the criterion of **logistical function** in the context of this study, as we have already limited our object of investigation to the transportation process of shipments. Therefore, we do not consider further distinctions between logistical functions such as warehousing or order fulfillment.

Third, we omit the criterion **industry reference of the logistics object** from our investigation since addressing the specific details of individual industries and product diversity would place too much focus on individual industry segments. Accordingly, this study does not present results for specific industries (e.g., temperature-controlled transportation for the pharmaceutical industry).

Fourth, we exclude the criterion **performance character**. Although transport prices in the spot market and the contract market on different transport modes sometimes develop entirely independently, this view is implicitly taken into account in the study and is not used as a strict criterion to distinguish between different scenarios.

Based on our exclusion measures, we consider the following criteria to be essential for the study of price volatility in logistics markets:

First, there are significant differences in freight prices depending on the **transport mode**. In this context, air, road, rail, and sea freight are subject to different dynamics. For example, while road freight primarily suffers from a shortage of drivers, air freight struggled with the loss of belly capacity during the COVID-19 crisis, and sea freight experienced a bottleneck of containers in certain regions.

Second, we consider the **dimension of goods transformation** by distinguishing between national, international, and global transportation. While national transports are subject to regional effects that affect transport prices, a

further distinction between international and global transport seems useful. One reason for this is that country-specific features characterize international transport (e.g., cabotage restrictions in road freight transport), while global transport is often subject to increased complexity.

Third, we include the segmentation criterion **type of logistics object** to distinguish between freight shipping of FTL, LTL, general cargo, containers, and unit load devices (ULD). This is because other transport objects are subject to different dynamics and are, to some extent, based on different types of production. For example, cargo networks (e.g., Elvis) usually govern general cargo transport in road freight, requiring a significantly higher coordination effort and resource input in the "production" of the service compared to FTL and LTL transport.

In summary, we propose a segmentation of logistics markets according to the **mode of transport**, **dimension of goods transformation**, and **type of logistics object**. Based on this three-level segmentation, we differentiate our study of freight price volatility into four different logistics scenarios. Figure 2 illustrates the four scenarios based on the underlying segmentation:

Figure 2

Overview of the four selected logistics scenarios