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Disruptions and propagation: the effects of Covid-19 on the supply chain dynamics in Portugal

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DISRUPTIONS AND PROPAGATION: THE EFFECTS OF COVID-19
ON THE SUPPLY CHAIN DYNAMICS IN PORTUGAL

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This dissertation represents the conclusion of another significant chapter in my academic and personal journey. Two years ago, I arrived in a new city, at a new university, embarking on a new programme of study with one main goal: to learn and to grow, both as an individual and as an economist.

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Abstract

This dissertation examines the effects of the COVID-19 pandemic on Portuguese firms, analysing how supply chain structures and reliance on external markets shaped both vulnerability (depth of the downturn) and resilience (recovery trajectory). In a context marked by climate-related disasters, geopolitical tensions and strategic trade restrictions, which have exposed critical sectoral dependencies, the topic is of particular contemporary relevance.

Using an event study approach on monthly firm-level data for the period 2017–2022, the analysis combines a sectoral perspective with a microeconomic firm-level perspective, focusing on Sector I (Accommodation and Food Services). The empirical investigation addresses three main questions: (i) which sector was most severely affected; (ii) how demand channels and supply chain linkages adjusted within Sector I; and (iii) which structural features and degrees of international dependence are associated with greater vulnerability or resilience.

The results indicate that the sharpest declines occurred in the tertiary sector, particularly in Sector I, whereas the primary and secondary sectors displayed greater resilience, except where digitization or essential status mitigated losses. In Sector I, international demand proved highly volatile, while domestic demand acted as a buffer and rebounded once restrictions were lifted. Downstream sales adjusted immediately, whereas upstream purchases adapted more gradually. Furthermore, an intermediate degree of export dependence was associated with the most favorable balance, and broader, more complex supplier networks initially deepened contraction but subsequently accelerated recovery, suggesting advantages in scalable configurations.

Two key implications emerge: strengthening domestic demand as a countercyclical buffer, coordinated with selective and well-managed international reopening; and fostering scalable supply networks, stable under normal conditions but rapidly expandable in response to shocks. These findings advise against uniform policy support, instead favoring measures tailored to firms' structural characteristics and the specific nature of shocks.

JEL-Codes: E32; D22; L14; H12

Keywords: COVID-19 pandemic, External Shock, Supply chain, International dependence, Firm-to-firm relationships

Resumo

Esta dissertação estuda os efeitos da pandemia COVID-19 sobre as empresas portuguesas, examinando de que modo as cadeias de abastecimento e a dependência de mercados externos condicionaram a vulnerabilidade (profundidade da quebra) e a resiliência (trajetória de recuperação). Num contexto marcado por desastres climáticos, tensões geopolíticas e restrições comerciais, a análise torna-se particularmente relevante.

Através de um 'event study' com base em dados mensais ao nível da empresas para o período 2017–2022, procede-se primeiramente a uma análise setorial, seguida de uma análise microeconómica centrada no Setor I (Alojamento, restauração e similares). O estudo organiza-se em torno de três questões: (i) qual o sector mais severamente afetado; (ii) como se ajustaram, na Secção I, os canais de procura e os canais associados às cadeias de abastecimento; e (iii) que características estruturais e graus de dependência internacional se associam a maior vulnerabilidade ou resiliência.

Os resultados indicam que as quebras foram mais acentuadas no setor terciário, em especial na Secção I, enquanto os sectores primário e secundário revelaram maior resiliência, exceto onde a digitalização ou o estatuto de essencial mitigaram perdas. Na Secção I, a procura internacional registou elevada volatilidade, ao passo que a procura interna funcionou como amortecedor e recuperou com o levantamento das restrições. As vendas a jusante ajustaram-se de imediato, enquanto as compras a montante evoluíram de forma gradual. Verificou-se ainda que um grau intermédio de dependência das exportações proporcionou o equilíbrio mais favorável, e que redes de fornecimento amplas e complexas agravaram a contração inicial, mas aceleraram a recuperação.

Destas evidências decorrem duas implicações principais: reforçar a procura interna como al-mofada contracíclica, articulada com uma reabertura internacional seletiva; e promover redes de fornecimento escaláveis, estáveis em períodos normais mas rapidamente adaptáveis em contexto de choque.

Códigos JEL: E32; D22; L14; H12

Palavras-chave: Pandemia COVID-19, Choque externo, Cadeia de abastecimento, Dependência Internacional, Relações entre empresas

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I. Introduction

At the core of any modern economy lies a dense and interconnected network of specialized production units that channel goods and services from suppliers through intermediate producers to final consumers. Although global supply chains have undoubtedly enhanced efficiency and productivity, they have simultaneously magnified the economic costs of disruption. In recent decades, natural disasters associated with climate change, geopolitical tensions, and the strategic use of trade restrictions by major economies have exposed structural vulnerabilities and excessive dependencies across critical sectors (Attinasi et al., 2024; Meier & Pinto, 2024).

Although these risks are widely recognized, policy responses remain fragmented, often materializing in overlapping initiatives at regional and international levels (European Commission, 2013). Meanwhile, the empirical literature has been constrained by the methodological difficulty of isolating credible exogenous shocks in firm-level data, limiting systematic analysis of these dynamics (Carvalho et al., 2021).

This dissertation seeks to address this gap. Motivated by one of the most significant global disruptions in recent history—the COVID-19 pandemic—it exploits the unique opportunity presented by this exogenous and systemic shock to examine how Portuguese firms were affected.

Given the methodological and computational challenges of performing a full firm-level network analysis of the Portuguese economy, the study begins by identifying a single sector for detailed investigation. The Accommodation and Food & Beverage Services sector (Sector I) emerges as the strongest candidate: not only was it among the hardest hit by the pandemic, but it also represents a substantial share of national output and remains underexplored in the literature, despite its distinctive supply and demand characteristics. The analysis therefore focuses on how shocks were transmitted through different channels—international versus domestic demand, and downstream versus upstream supply chains- and on how supply-chain characteristics shaped their experiences in terms of both vulnerability, understood as the depth of the initial downturn, and resilience, defined as the trajectory of recovery.

As a small, open economy heavily reliant on international trade, Portugal was particularly exposed to global supply chain disruptions, with its dependence on the tourism sector intensifying the transmission of external shocks. This structural feature makes the distinction between international and domestic channels especially relevant for understanding the dynamics of the pandemic’s impact. Moreover, because COVID-19 represented a disruption simultaneously driven by supply and demand, it provides a valuable setting in which to investigate upstream and downstream transmission mechanisms and the role of firm-level supply-chain characteristics in conditioning the effects of systemic shocks.

To address these questions, the study employs an event-study framework using firm-level monthly transaction payments data from Banco de Portugal’s Microdata Research Laboratory

(BPLIM). The dataset covers all Portuguese firms between 2017 and 2022, encompassing the pre-, during-, and post-pandemic periods, and enables the tracing of both the depth and persistence of the pandemic's effects. The analysis proceeds in three stages: it first examines sector-aggregated sales, then explores firm-level outcomes within Sector I, and finally compares groups of firms defined by characteristics such as diversification, complexity, and export dependence. Supplementary materials not reproduced in the main text—beyond descriptive tables and graphical outputs of cyclical components— and the code are available in a public repository ([GitHub](#)).

The dissertation addresses three research questions:

- (i) Which Portuguese sector was most severely affected by the COVID-19 pandemic?
- (ii) How did domestic and international channels as well as upstream and downstream channels were affected by the pandemic in the Accommodation and Food & Beverage Services sector?
- (iii) Which structural characteristics of supply chains and degrees of international dependence are associated with greater vulnerability or resilience?

By exploiting fine-grained firm-level data, this dissertation seeks to advance the academic literature. It demonstrates the value of granular evidence in capturing the diversity of shock transmission, moving beyond the limitations of aggregate approaches and survey-based methodologies (Banco de Portugal, [2020b](#); Capella-Ramos & Guri, [2022](#); Carvalho et al., [2022](#); Manteu et al., [2020](#)). Moreover, although input–output linkages are increasingly recognized as central to the propagation of shocks, Portuguese research has so far paid limited attention to how these linkages, together with firms' openness to foreign markets, shape both vulnerability and recovery (Carvalho et al., [2021](#); Lafrogne-Joussier et al., [2023](#)).

While causal inference lies beyond the scope of this study, the relevance of the robust empirical correlations identified between firm characteristics, supply-chain structures, and patterns of vulnerability and recovery extends beyond academic debate and carries practical significance in three main ways. First, policymakers can draw on the evidence to design more targeted and effective support measures. Second, firms can benchmark their own resilience against that of peers, thereby gaining a clearer perspective on their relative exposure. Third, the results inform wider discussions on economic resilience in small open economies, where dependence on external demand and fragmented supply chains constitute persistent sources of vulnerability.

This dissertation is structured as follows. Section 2 provides a brief contextual background of the systemic shock under study, while Sector 3 reviews the relevant literature, analyzing the current state of research on the topic. Section 4 presents the dataset, including the firm-level transaction data and constructed variables. The three central chapters contain the empirical results: Section 5 presents the industry-specific analysis of the external shock, Section 6 examines the behavior of each transmission channel at the firm level, and Section 7 identifies the structural characteristics most conducive to resilience. Section 8 concludes.

2. COVID-19 Pandemic - a brief context

The emergence of the COVID-19 pandemic, caused by the novel coronavirus identified as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), was initially reported in Wuhan, China, towards the end of 2019 (Silva et al., 2022). The virus rapidly disseminated worldwide, prompting the World Health Organization to formally declare it a pandemic on March 11th, 2020 (WHO, 2020).

As the virus spread across countries and continents, national governments implemented unprecedented public health interventions, including lockdowns, border closures, and social distancing mandates. These measures, while necessary to curb transmission, also induced a dramatic contraction of global economic activity (Lebastard et al., 2023).

The economic ramifications of the pandemic were immediate and profound. Unlike previous economic downturns rooted in financial or fiscal imbalances, the COVID-19 crisis originated from a public health shock, rapidly translating into simultaneous demand and supply disruptions. The International Monetary Fund estimated that the global economy contracted by 3.4% in 2020, marking 'the worst peacetime recession since the Great Depression' (IMF, 2021).

However, this crisis was not simply a cyclical recession. It exposed deep-seated structural vulnerabilities in global production and supply chains, particularly in systems reliant on lean inventory models and long-distance input sourcing. For the first time in recent economic history, broad segments of the global economy came to a halt. The exogenous nature of the initial shock, the scale of government interventions, and the transformation of incentives for economic agents created an entirely new set of conditions, providing valuable opportunities for economic research and policy evaluation (Capella-Ramos & Guri, 2022).

2.1 The Pandemic in Portugal: A National Perspective

Portugal confirmed its first cases of COVID-19 on March 2nd, 2020, in the northern region of the country. The virus rapidly spread nationwide, prompting the government to declare a state of emergency on March 18th, 2020. This was accompanied by the implementation of rigorous containment and mitigation measures, including restrictions on public gatherings, the closure of schools and workplaces, and severe limitations on both national and international mobility (Peixoto et al., 2020a).

The trajectory of the pandemic in Portugal can be divided into distinct phases, as illustrated in Figure 1, which shows the evolution of the Portuguese government response stringency and in Figure 2, which depicts the daily number of confirmed COVID-19 cases based on data from the Portuguese Directorate-General of Health (DGS) (2025). The COVID-19 Stringency Index is compiled by the Oxford COVID-19 Government Response Tracker developed by Hale et al. (2021) and provides a proxy for the variation in governmental policy responses, captur-

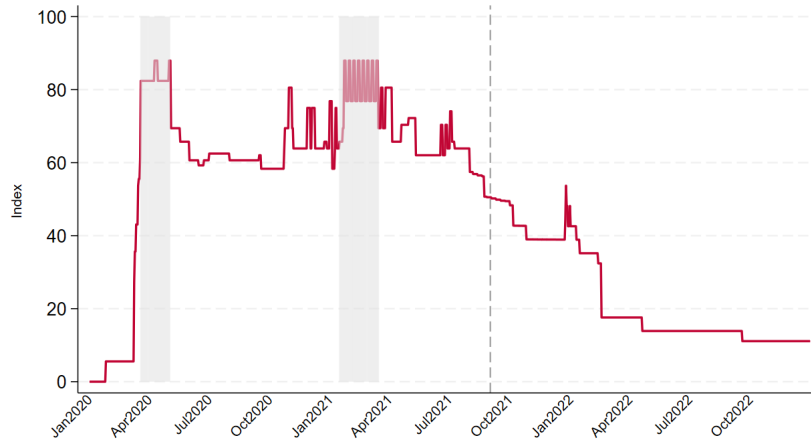


Figure 1: *Portuguese Stringency Index*

Notes: Vertical grey bars indicate the first lockdown (March 19th - May 2nd, 2020) and the second lockdown (January 15th - March 15th, 2021). The grey vertical line marks September 5th, 2021 (date when over 85% of the Portuguese population had been fully vaccinated); Source: Hale et al., (2021) data; elaborated by the author using Stata 18.

ing both the severity of individual measures and their geographical scope within a country.¹ A higher value of the index should correspond to a more closed economy and a more severe shock, reflecting not only the tightening or loosening of restrictions over time but also the extent to which government interventions disrupted economic activity, social interaction, and the functioning of supply chains.

The Stringency Index rose sharply in mid-March 2020, surpassing a score of 80. This increase corresponds to the implementation of the first national lockdown (March 19th - May 2nd, 2020) and the declaration of the first emergency alert level (Silva et al., (2022)). These stringent measures were enacted at a stage when the number of confirmed cases remained relatively low, primarily reflecting the initial spread of the original strain of the virus.

The second wave, beginning around September 2020, emerged with the advent of the Alpha variant, which was significantly more transmissible than the original strain. Despite the rise in cases, the stringency of government responses remained moderate until a sharp resurgence in early 2021. This prompted the re-imposition of strict measures and a second nationwide lockdown from January 15th to March 15th, 2021. This phase was marked by the highest rates of hospitalization and mortality observed in the country and was predominantly driven by the Delta variant (Silva et al., (2022)).

Following the second lockdown, renewed peaks in confirmed cases occurred in January and June 2022. Nevertheless, containment measures continued to be eased, and the Stringency Index declined steadily through the second half of 2021 and into 2022, stabilizing at minimal levels and reflecting the near-complete lifting of restrictions. This divergence between rising

¹The index is constructed by aggregating nine distinct indicators, each assessed on an ordinal scale and subsequently normalized to range from 0 (no restrictions) to 100 (maximum stringency). However, it does not account for the effectiveness or degree of enforcement of these measures (Amador et al., (2023); Hale et al., (2021)).

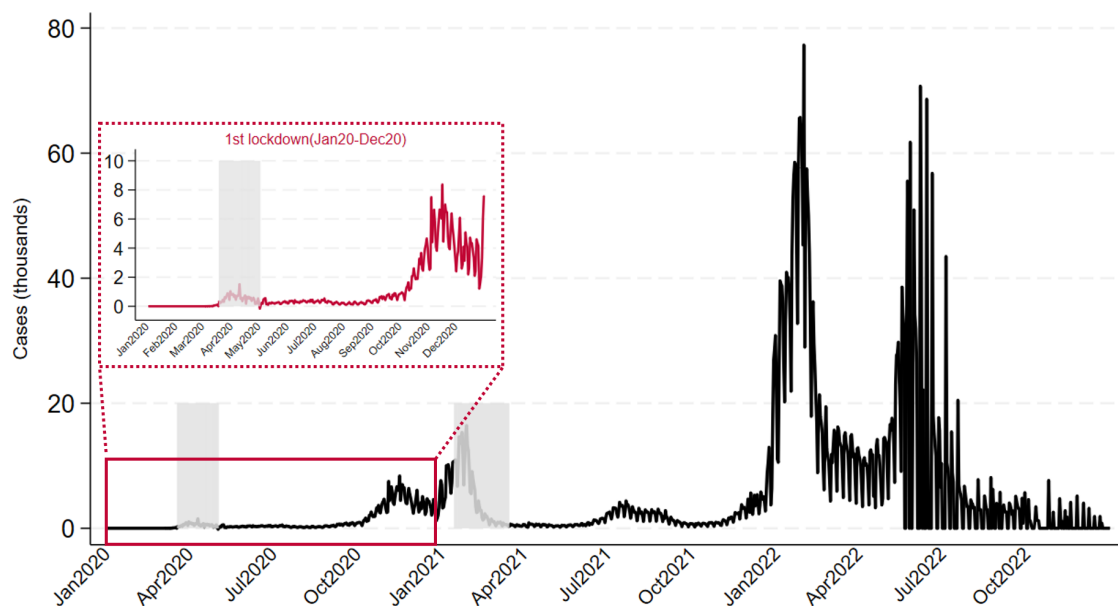


Figure 2: *Number of new COVID-19 cases per day*

Notes: Vertical grey bars indicate the first lockdown (March 19th - May 2nd, 2020) and the second lockdown (January 15th - March 15th, 2021); Source: Portuguese Directorate-General of Health (DGS) (2025) data; elaborated by the author using Stata 18.

case numbers and declining policy stringency in 2022 reflects a strategic shift from generalized lockdowns to targeted public health interventions. The rapid acceleration of the vaccination campaign in summer 2021, culminating in over 85% of the population being fully vaccinated by September 5th, 2021 (Silva et al., 2022), underpinned the sustained easing of restrictions and a strengthened public health framework. Accordingly, it is reasonable to characterize 2022 as the recovery phase, notwithstanding that the official state of alert remained in place until September 30th, 2022.

The graphical evidence thus highlights two critical dimensions of Portugal's pandemic management that shaped the nature of the shock. First, the initial response was characterized by the swift and decisive implementation of containment policies. Second, the later stages of the pandemic were defined by an adaptive policy approach that increasingly relied on public health infrastructure, vaccination coverage, and individual behavioral adjustments rather than on prolonged restrictive measures. Taken together, these dimensions suggest that the pandemic in Portugal can be characterized as a prolonged and dynamic shock.

2.2 Why Portugal Is a Relevant Case Study

Portugal offers a distinctive case for the study of pandemic-related economic disruption due to the timing of its outbreak, the government's proactive response, and the intrinsic characteristics of the national economy.

The virus arrived in Portugal later than in other severely affected European countries, such as Italy and Spain. This relative delay enabled Portuguese authorities to observe the developments in neighboring nations and to act preemptively (Peixoto et al., 2020a). As a result, Portugal implemented national lockdown measures at a stage when case numbers and mortality were still relatively low. For instance, confinement measures were implemented in Portugal when the country had reported only 62.4 cases per million inhabitants and two deaths, whereas Spain had recorded 123.3 cases per million and 136 deaths, and Italy had 121.9 cases per million and 366 deaths at the time of their respective first lockdowns (Peixoto et al., 2020b). This may have helped Portugal flatten the initial curve and delay pressure on its healthcare system.

The success of these early measures was also underpinned by strong public compliance. Portuguese citizens responded quickly to government directives, leading to a substantial reduction in mobility and facilitating the enforcement of lockdown restrictions (Silva & Almeida, 2024). Comparative evidence suggests that while Spain experienced similar levels of compliance, countries like Italy and the United Kingdom saw slower reductions in mobility, likely reflecting differences in public trust, communication strategies, and social norms (Peixoto et al., 2020a).

Despite its initial success in controlling the virus, Portugal experienced one of the sharpest economic contractions in the European Union: GDP fell by 2.3% in the first quarter of 2020, followed by a historic 16.5% drop in the second quarter of 2020 and a further 5.8% decline in the third (Carvalho et al., 2022). As discussed below, this contraction can be attributed to three structural economic characteristics: a high degree of international dependency, the vulnerability of the business landscape, and fiscal constraints.

As a small open economy heavily reliant on international trade, Portugal was particularly exposed to global supply chain disruptions, notably through its significant reliance on the tourism sector. According to INE (2020), in the pre-pandemic year 2019, tourism constituted a central pillar of economic growth and external balance, contributing over 14.8% to national GDP and 9.4% to total employment. However, the imposition of international travel restrictions, nationwide lockdowns, and the mandatory closure of restaurants, hotels, and other leisure establishments brought the sector to an abrupt standstill. While these containment measures were deemed imperative from a public health perspective, they effectively curtailed demand for travel and hospitality services, both from international visitors and domestic consumers. Consequently, a substantial segment of the services sector was paralyzed, resulting in severe contractions in employment and income, and thereby intensifying the broader economic downturn (Banco de Portugal, 2020a). In parallel, the international dimension of the crisis also had adverse effects on the manufacturing sector, with output and exports hampered by supply chain delays, rising input costs, and logistical constraints (Capella-Ramos & Guri, 2022).

The government introduced short-term support measures, including financial assistance and credit lines, to alleviate pressure on firms. However, the overall fiscal response amounted to

only 2.5% of GDP by September 2020, a figure notably lower than those recorded in many other European economies (Carvalho et al., 2022). This comparatively modest intervention reflected Portugal's constrained budgetary capacity, rooted in high pre-pandemic public debt and limited fiscal space. These structural constraints, coupled with the economy's heavy reliance on small and medium-sized enterprises, often characterized by low capital reserves and restricted access to credit, hindered firms' ability to withstand prolonged periods of economic inactivity (Manteu et al., 2020).

Consequently, as noted by Carvalho et al. (2022), the Portuguese experience reflects "the trade-off between ex-ante preparedness and ex-post stringency". The country's delayed exposure to the virus allowed for anticipatory action, enabling the government to impose stringent measures at an earlier stage of contagion than many peers. While this proactive stance may have been effective in reducing initial infection rates and preventing the collapse of the healthcare system, it also meant that restrictions were in place for longer. In effect, Portugal's early lockdown compressed the immediate health shock but prolonged the duration of stringent containment measures, amplifying their cumulative economic impact. This dynamic illustrates the inherent policy tension in managing systemic crises: measures that maximize early health protection can, in the absence of substantial compensatory economic support, exacerbate the scale and persistence of economic disruption.

Therefore, this dynamic highlights Portugal's relevance as a case through which to investigate the broader economic implications of a systemic crisis.

3. External shocks and their propagation

A central concept underpinning this dissertation is the supply chain, which encompasses all parties involved in the production and delivery process, including manufacturers, suppliers, transporters, warehouses, retailers, and even end consumers. Within each organization, it also incorporates all functions directly or indirectly engaged in fulfilling customer requests (Chopra & Meindl, 2007). However, supply chains are rarely straightforward; they often involve intricate networks with numerous interconnected parties.

Within this network, firms can occupy upstream or downstream positions, which significantly shape their roles and vulnerabilities. Upstream positions refer to entities or activities closer to the sourcing and production of raw materials. These firms, such as suppliers of intermediate goods or raw materials, are critical for ensuring the flow of inputs needed for production. Downstream positions refer to activities closer to the end consumer, encompassing entities responsible for the distribution and delivery of finished goods. These firms, such as retailers or distributors, are directly affected by changes in consumer demand and market trends (Bolea et al., 2022; Singer & Donoso, 2008).

The position of a firm within the supply chain is crucial for understanding its exposure to shocks, its role in propagating disruptions, and the strategies needed to mitigate risks. For instance, upstream disruptions may lead to delays and shortages downstream, while downstream shocks may trigger reduced orders and production slowdowns upstream (Sharma & Modgil, 2013).

As the number of participants increases, the density of the supply chain links grows, requiring heightened levels of coordination among various actors (Islam, 2023). This complexity can give rise to significant challenges, including inefficiencies and vulnerabilities to exogenous disruptions or even the propagation and amplification of shocks.

Upstream and downstream positions shape the type and immediacy of disruptions experienced. However, the geographical orientation of the downstream channel, whether primarily serving domestic or international markets, further defines the scope of exposure. Firms integrated into international markets are generally more susceptible to shocks than those operating solely within domestic boundaries, as they are affected by both foreign and domestic disturbances. Shocks that negatively affect the domestic market, such as a national lockdown or a fall in local demand, will impact all firms, irrespective of their market orientation. In contrast, shocks originating in foreign markets, such as supply chain blockages abroad or restrictions in key export destinations, directly affect only internationally oriented firms (Borino et al., 2024).

3.1 Why is the COVID-19 shock singular?

The study of external shocks and their propagation within production networks has garnered significant attention in the literature, encompassing a diverse range of events, from localized disruptions to broader systemic shocks.

Early research, such as Chopra and Sodhi (2004)'s examination of the impact of a fire at a semiconductor plant owned by Philips in New Mexico, highlighted the ripple effects of single-plant disruptions on global supply chains. Subsequent studies have expanded the scope to include large-scale events such as wars, trade disputes, and natural disasters, each presenting unique challenges and propagation dynamics. For instance, the economic repercussions of the ongoing war in Ukraine have been analysed by Korovkin et al. (2024), while the US-China trade war has been studied by Peng et al. (2024). Similarly, the Great East Japan Earthquake of 2011 has been explored by Carvalho et al. (2021), and the impact of Hurricane Sandy on supply chains has been investigated by Kashiwagi et al. (2021).

These events differ in their nature and the persistence of their effects. Natural disasters and conflicts often result in the destruction of physical infrastructure and capital, leading to long-lasting and regionally uneven economic consequences (Barrot & Sauvagnat, 2016; Glick & Taylor, 2010). Trade wars, on the other hand, often result in the imposition of persistently higher tariffs, which reshape global trade flows over extended periods (Peng et al., 2024).

The COVID-19 pandemic represents an exception within this body of evidence, producing supply chain disruptions of unprecedented scale and systemic impact. Three features distinguish this shock: (i) the persistence of prolonged and unpredictable restrictions; (ii) the simultaneous imposition of lockdowns across multiple countries; and (iii) its dual manifestation as both a supply shock and a demand shock.

First, the evolving trajectory of the pandemic meant that restrictions were repeatedly adjusted in response to infection dynamics, thereby generating prolonged uncertainty (as discussed in Chapter 2), in contrast with the more predictable timelines typically associated with other external shocks. Second, unlike events that are geographically contained or originate from a defined epicenter, the pandemic disrupted production both across and within borders without a single focal point, creating what can be described as a "cloud" of disruption (Meier & Pinto, 2024; Silva & Almeida, 2024). Third, the crisis simultaneously constrained supply and suppressed demand. Supply-side pressures arose from mobility restrictions, mandatory business closures, and logistical bottlenecks. At the same time, demand collapsed as consumer confidence eroded, household incomes declined, and unemployment rose. The virtual standstill in face-to-face services such as tourism further depressed private consumption and external demand (Banco de Portugal, 2020a; Carvalho et al., 2022). The crisis also revealed the fragility of just-in-time inventory models and the risks associated with over-reliance on geographically dispersed suppliers (Pujawan & Bah, 2022).

3.2 Empirical evidence on COVID-19-induced disruptions

A growing body of literature has examined the economic repercussions of the pandemic across diverse contexts, with particular attention to three themes: the role of supply chains in transmitting shocks, the scope and geography of demand exposure, and the heterogeneity of impacts across industries.

With respect to supply chains, literature has focused primarily on how network structure, particularly supplier diversification, evolved through the crisis and whether such adjustments strengthened resilience. Niu et al. (2023) analyse US customs import data to study firms' strategic responses, documenting a marked shift towards supplier diversification and substantial changes in shipment patterns in the post-crisis period. Similarly, Lafrogne-Joussier et al. (2023) examine the effects of China's lockdowns on French firms and find declines in both domestic and export sales among affected firms. Their study also shows that pre-crisis geographic diversification of inputs offered only limited protection, whereas higher inventory levels helped firms to manage disruptions more effectively. Turning to domestic supply chains, Silva and Almeida (2024) provide evidence for Brazil of a strategic move towards more decentralized and geographically dispersed networks in response to pandemic pressures. In related work on resilience, Chacha et al. (2024) show that diversified domestic supply chains mitigated the effects of international trade shocks in Kenya, underscoring the importance of network structure and suggesting that disruptions can reshape domestic linkages. By contrast, Khanna et al. (2022) study Indian supply chains and find that access to complex and well-connected suppliers facilitated adaptation to lockdowns, while arguing that complexity *per se* does not necessarily reduce vulnerability to shocks.

The geography and scope of demand have also attracted considerable attention. Chacha et al. (2024) show that domestic sales in Kenya fell sharply at the peak, whereas exports and imports declined less and recovered more quickly, surpassing pre-pandemic levels in the second half of 2020. Moreover, direct Kenyan importers were most vulnerable, while direct Kenyan exporters experienced smaller declines and a faster rebound. In contrast, adopting an aggregated perspective for Portugal, Carvalho et al. (2022) conclude that purchases with foreign bank cards fell significantly more during the great lockdown and, although domestic consumption and transaction counts recovered over the summer, purchases by overseas clients remained well below trend. Consistent with this pattern, using a global sample, Borino et al. (2024) find that internationally engaged firms were more likely than purely domestic firms to face difficulties in both accessing inputs and selling outputs. Nevertheless, these firms undertook more robust resilience actions, suggesting that global connectedness and participation in international trade can, overall, promote resilience to large shocks.

The literature further underscores the heterogeneity of COVID-19's impact across industries, rejecting any one-size-fits-all account of disruption (Niu et al., 2023; Silva & Almeida,

(2024). Silva and Almeida (2024) report that manufacturing suffered the largest losses in payment inflows, while the sectors most adversely affected in terms of outflows included wholesale and retail trade, administrative and support services, education, and accommodation and food services. Carvalho et al. (2022) document disproportionate contractions in Portugal's Leisure and Tourism, Restaurants and Catering, Transportation and Car Rentals, and Fashion and Beauty, largely driven by mobility restrictions and the collapse in demand for non-essential services. By contrast, food retail and pharmaceutical services experienced temporary surges associated with precautionary stockpiling and the prioritization of essential goods.

Therefore, this dissertation aims to contribute to the existing body of research in two main ways. As discussed earlier, Portugal offers a particularly compelling case study for this analytical framework, for several reasons. Nevertheless, when examining the impact of COVID-19 in the Portuguese context, the existing literature tends to adopt an aggregate perspective, focusing on themes such as firms' financial stability, industry-wide spillover effects, and labor market adjustments (Banco de Portugal, 2020b; Capella-Ramos & Guri, 2022; Manteu et al., 2020). Even the most closely related contribution by Carvalho et al. (2022) relies on sector-level transaction aggregates.

While these contributions are valuable in establishing the broad contours of the crisis, they provide limited insight into the micro-level mechanisms through which supply chain dislocations and geographically segmented demand shocks transmit across industries and along production stages. Notably, the literature has not yet produced firm-level evidence on the relationship between pre-existing input-output structures and the magnitude or persistence of COVID-19 disruptions in Portugal.

Moreover, as far as I am aware, Portugal-focused research has paid little attention to how supply-chain structure and firms' openness and integration into foreign markets are associated with different levels of exposure to external shocks, vulnerability, and recovery trajectories.

By addressing these gaps, this dissertation contributes novel firm-level evidence on the associations between structural supply chain features, international market dependence, and firms' observed outcomes during both the immediate shock and the recovery phase of the COVID-19 pandemic.

4. Data

Despite its theoretical plausibility, the role of an economy’s production network as a channel for the transmission of shocks remains largely underexplored, particularly when it comes to using data to map inter-firm relationships (Carvalho et al., 2021). Input-output analysis has traditionally served as a fundamental tool in investigating the spillover effects of the pandemic on supply chains, with many studies placing considerable reliance on aggregate input-output tables (Barrot & Sauvagnat, 2016; Barrot et al., 2021).

This dissertation uses a monthly transaction-level payment dataset available at Banco de Portugal’s Microdata Research Laboratory (BPLIM), specifically the E-fatura dataset, covering the period from 2017 to 2022 (BPLIM, 2025).

This dataset comprises the full population of non-financial entities with headquarters or permanent establishments in Portugal and is available at *Banco de Portugal* through a collaborative agreement with Statistics Portugal (INE).² The E-fatura database from INE contains anonymized information on transaction pairs, including the anonymized tax identification numbers of both the issuer and the acquirer, the invoiced value in euros, and the nationality of the acquirer. This file is complemented by another one prepared by BPLIM that enriches the transactional data with firm-level characteristics, including the start date of the firm’s activity, geographical location based on the Nomenclature of Territorial Units for Statistical Purposes (NUTS III), sectoral classification based on the Portuguese Classification of Economic Activities - Revision 3 (CAE Rev.3), firm size category, and the number of employees.

In accordance with BPLIM’s access policies, this granular data is only available to internal researchers. Instead, access was provided to customized aggregated firm-level anonymized data prepared specifically for this project. For each firm, monthly variables were constructed capturing total sales volume as well as disaggregated flows, distinguishing between final consumer sales, inter-firm transactions and exports. In addition, the dataset incorporates information on purchase volumes, the number of domestic suppliers, the share of sales and purchases by CAE Rev. 3, as well as firm-specific characteristics, including geographical location (NUTS III), sectoral classification (five-digit CAE Rev. 3), firm size, and number of employees.

Given the importance of inflation, particularly in the context of the economic volatility observed in recent years, all monetary variables were converted from nominal to real terms using the monthly Consumer Price Index (Base 2012) published by INE (2025). The deflation of monetary values ensures that observed changes in sales, purchases, and related variables reflect real economic activity rather than fluctuations in price levels. This is particularly important for longitudinal analyses, where unadjusted nominal data could lead to misleading interpretations of firm performance and inter-firm dynamics over time.

²See BPLIM’s Github.

In the process of constructing monthly firm-level variables, some inconsistencies were identified. First, a subset of firms reported non positive sales in certain months. Negative entries may be justified by sales returns, transaction reversals, or cancellations. For this reason, these observations were kept in the data. On the other hand, observations with zero sales were dropped as they contain no transactional information and would otherwise distort averages and growth measures. In addition, 6,308 observations with missing values for firm characteristics were excluded from the sample. Firms operating in sectors T (Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use) and U (Activities of extraterritorial organizations and bodies) were likewise excluded due to the minimal volume of data reported for these sectors.

5. The sectoral impact of the COVID-19 crisis

As noted by Carvalho et al. (2022), Portuguese firms were affected through several channels: mandatory shutdowns in some sectors, household income shocks that constrained consumption, and behavioral shifts driven by health concerns. The magnitude and duration of the implications of these effects were, however, uneven across sectors, reflecting underlying differences in their production structure, degree of essentiality, exposure to face-to-face interactions, and technological adaptability.

This chapter provides an aggregate-level analysis of the pandemic's impact on firm sales across the Portuguese economy, pursuing two main objectives: (i) to corroborate and extend the findings of Carvalho et al. (2022) with a different data source; and (ii), to identify the sector most affected by the crisis.

Carvalho et al. (2022) measure the impact of the pandemic using consumer payment data aggregated at the sectoral level. By contrast, the present study draws on monthly firm-level sales data, aggregated at the CAE Rev.3 section level (Level 1)³, which embed both demand- and supply-side conditions. This approach enables the identification of disruptions stemming from shifts in final expenditure as well as from upstream bottlenecks. In doing so, the analysis complements and extends the findings of Carvalho et al. (2022) by incorporating a supply-side perspective.

Furthermore, it is important to note that this chapter does not attempt to identify the specific mechanisms through which the shock was transmitted at the firm level. Instead, it maps the sector most severely affected, providing a basis for subsequent single-sector microeconomic analysis. Such an approach avoids the methodological and computational challenges of a full firm-level network analysis of the entire economy, while also mitigating the risk that sector-specific dynamics are obscured within broader aggregate patterns.

The methodology follows the event-study framework of Carvalho et al. (2022), with the empirical specification defined as:

$$\ln(y_t) = \alpha + \delta_1 \cdot t + \delta_2 \cdot t^2 + \lambda_m + \sum_{k=0}^{34} \beta_k \cdot covid_{\tau+k} + \varepsilon_t \quad (5.1)$$

where $\ln(y_t)$ represents the logarithm of the monthly sales of each sector at time t ; α is the constant; $\delta_1 \cdot t$ and $\delta_2 \cdot t^2$ capture a general linear time trend and a quadratic time trend, respectively; λ_m is the month fixed effects included to control for seasonal fluctuations in sales across the calendar year; $covid_{\tau+k}$, $k \in 0, \dots, 34$ are monthly dummy variables, corresponding to the period from March 2020 (τ) to December 2022, which allow the model to estimate month-specific

³Figures present the number of observations per sector, and Table B1 reports each sector's share of total sales in 2018.

deviations from expected sales trajectories during the pandemic, conditional on seasonality and time trends; and ε_t that denotes the error term.

When tracing sectoral sales over time, it is necessary to account for the main components of time-series variation: seasonality, trend, and cycle. Modeling these elements ensures that the pandemic shock is identified more accurately and not conflated with predictable seasonal patterns or structural changes. Unlike Carvalho et al. (2022), our model controls for seasonality through month fixed effects and incorporates both linear and quadratic time trends to capture systematic changes in sales independent of the pandemic.

To address the core empirical question posed in this chapter, the analysis is based on the evolution of the estimated coefficients β_k , which measure the monthly impact of the COVID-19 shock on sector-aggregated sales and capture the cyclical component of those series. Each coefficient on the month-specific dummy is interpreted as the deviation of realized sales from their counterfactual (expected) level in that month. The trajectory of the β_k coefficients is then plotted for each economic sector in Portugal, providing a sector-by-sector visual depiction of both the depth (vulnerability) and the duration (recovery) of the COVID-19 impact.

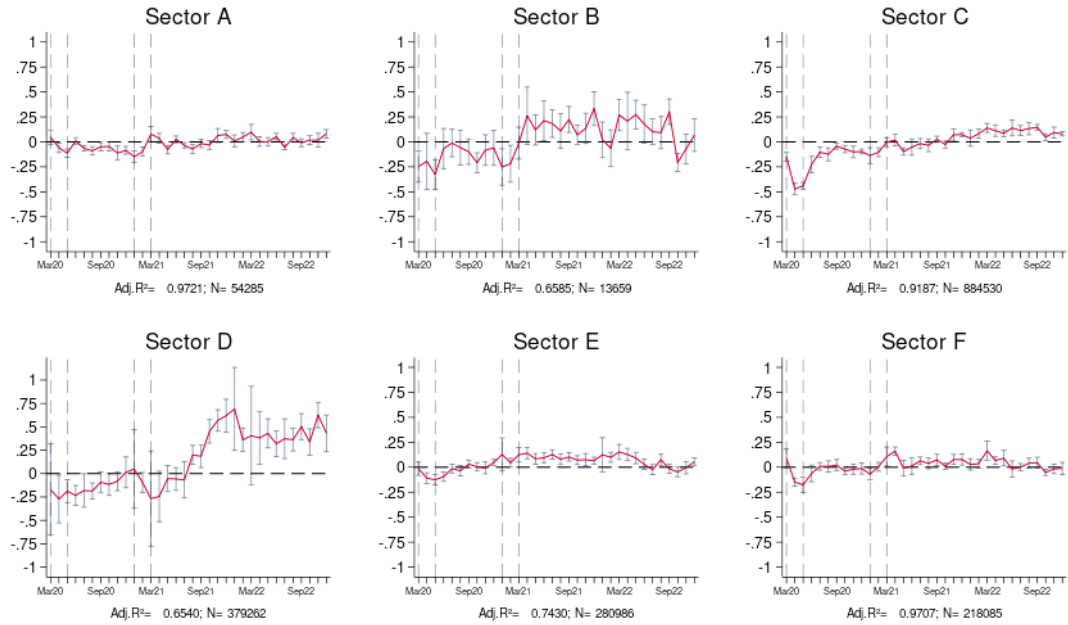


Figure 3: *Event study estimates by sector* (A) Agriculture, farming of animals, hunting and forestry; (B) Mining and quarrying; (C) Manufacturing; (D) Electricity, gas, steam, cold and hot water and cold air; (E) Water collection, treatment and distribution, sewerage, waste management and remediation activities; (F) Construction. The figure displays the point estimates of the coefficients β_k from Equation (5.1), along with the corresponding 95% confidence intervals. Each coefficient represents the estimated monthly deviation from the expected sales trajectory relative to the pre-pandemic period, conditional on seasonality and long-run trends. The four vertical dashed lines delineate the two lockdown periods: March–May 2020 and January–March 2021. The Adjusted R^2 and number of observations are reported below each panel. *Source:* Author's calculation.

First, despite accounting for just 1.6% of national sales in 2018, the **primary sector** was comparatively insulated from severe economic disruptions. Based on Figure 3, the *Agriculture sector* (Sector A) exhibited stability throughout the pandemic. This pattern could reflect its status as an essential activity, which may have limited operational disruptions. It may also be attributable to relatively inelastic domestic demand and to supply chains that are typically shorter and more localized, plausibly reducing exposure to border closures and international logistics constraints. By contrast, although accounting for less than 0.25% of total sales in 2018 (see Table B1), the results for *Extractive industries* (Sector B) show significant volatility.

As Figure 3 indicates, the **secondary sector** faced a more complex set of pressures. The *Manufacturing sector* (Sector C) experienced a significant initial contraction, a 37.63%⁴ drop in April 2020 compared to expected pre-pandemic levels, plausibly driven by a combination of supply- and demand-side shocks. On the supply side, global supply chain disruptions constrained input availability. Simultaneously, demand collapsed due to uncertainty and the suspension of production in downstream industries (Lebastard & Serafini, 2023). Nevertheless, the sector presented a relatively robust recovery from mid-2020 onwards, reflecting the adaptability of Portuguese manufacturing firms.

Electricity and gas (Sector D) and *Water supply and waste management* (Sector E), although both classified as essential services, displayed divergent trajectories during the pandemic period. Sector E experienced relatively modest declines during the initial lockdown phase, followed by a steady and consistent recovery, indicative of a stable demand structure and limited operational disruption. By contrast, Sector D recorded a more pronounced contraction, particularly in the aftermath of the second lockdown, before undergoing a sharp rebound, with growth exceeding pre-pandemic levels. Nevertheless, caution is warranted when interpreting these latter results. The confidence intervals surrounding the estimated COVID-19 effects for Sector D are notably wide, which may reflect the volatile nature of the energy sector, combined with considerable heterogeneity in firm-level responses within this industry. The sector is particularly sensitive to fluctuations in global energy markets, which experienced substantial instability during the pandemic. This volatility intensified in 2022, plausibly driven by global supply chain constraints, geopolitical tensions, and surging demand during the recovery phase, all of which may have contributed to the post-pandemic revenue growth observed in this sector (Kuik et al., 2022).

Construction (Sector F) emerged as one of the most resilient segments throughout the pandemic period. While temporary disruptions were observed during the initial lockdown, the sector was largely exempt from the most stringent restrictions and continued to operate under adapted safety protocols. As a possible result, it quickly stabilized and managed to return to pre-pandemic levels even during the second lockdown phase. Notably, in several months of 2021 and 2022, the sector sales not only recovered but surpassed their expected counterfactual trajectories.

⁴ $(\exp^{-0.4718} - 1) * 100 = 37.63\%$

For example, in April 2021, sales were 17.50% higher than the projected non-pandemic baseline, and in March 2023 this positive gap reached 17.98%. This sustained growth can be attributed to several interrelated factors. First, the sector benefited from the reactivation of previously delayed public and private investment projects, which had been paused during the initial uncertainty (Alsharef et al., 2021). Second, favorable financing conditions, including low interest rates and targeted support under the European Union Recovery and Resilience Facility, helped stimulate construction activity, particularly in infrastructure and housing. Third, the pandemic induced significant behavioral and lifestyle shifts, including increased time spent at home, a heightened focus on residential comfort, and a revaluation of living space. These changes led to a surge in demand for home improvements, renovations, and new residential developments, especially in suburban and peri-urban areas (Alsharef et al., 2021).

The **tertiary sector**, accounting for approximately 66% of total sales in 2018, displayed the worst and more persistent of pandemic-related impacts.

The similar response trajectories of *Administrative and Support Services* (Sector N), *Other Service Activities* (Sector S), *Real Estate Activities* (Sector L), *Transportation and Storage* (Sector H), and *Wholesale and Retail Trade* (Sector G) to the COVID-19 pandemic were characterized by a sharp initial contraction after the first national lockdown, followed by a gradual and uneven recovery (see Figure 4). In particular, sectors N and S⁵ are labor-intensive, reliant on physical presence and have localized demand, making them acutely vulnerable to mobility restrictions and social distancing measures. In addition to direct constraints on their activity, both sectors were indirectly impacted by downturns in adjacent sectors, further compounding their economic contraction, given that they are very reliant on subcontract services.

With regard to Sector L (Real Estate Activities), the initial decline can be attributed to the temporary suspension of property transactions, restrictions on in-person viewings, and delays in legal and administrative procedures. However, the underlying demand for housing remained resilient, supported by historically low interest rates and increased household savings accumulated during periods of restricted consumption. Furthermore, the previously discussed factors, namely, heightened attention to residential comfort and the revaluation of living space, help explain why, during the second lockdown, the sector did not experience renewed contraction (Alsharef et al., 2021). Instead, it followed a trajectory of recovery, ultimately reaching and exceeding pre-pandemic levels.

Lastly, the more heterogeneous composition of Sectors H and G helps to explain their intermediate responses to the pandemic shock.⁶ Within these sectors, sub-components, such as non-essential retail and passenger transport experienced substantial declines, driven by mandated

⁵Sector N: Activities including cleaning, security, staffing services, and administrative support; Sector S: Personal services including hairdressing, beauty treatments, repair services, and community organizations.

⁶Given the relatively low coefficient of determination and the wide confidence intervals, the estimates for Sector H should be interpreted with caution, reflecting its substantial internal diversity.

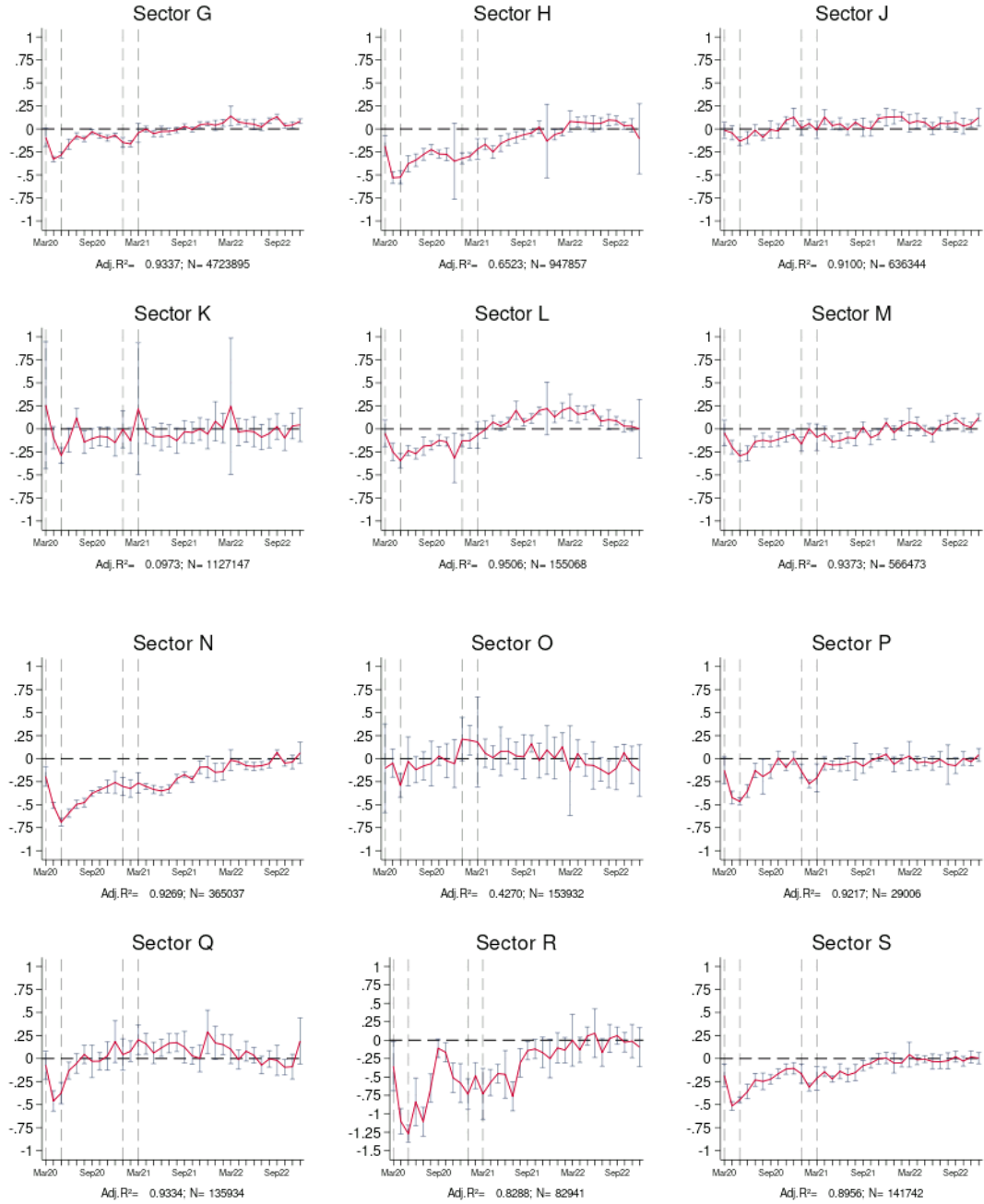


Figure 4: *Event study estimates by sector* (G) Wholesale and retail trade; repair of motor vehicles and motorcycles; (H) Transportation and storage; (J) Information and communication activities; (K) Financial and insurance activities; (L) Real estate activities; (M) Consultancy, scientific and technical activities; (N) Administrative and support service activities; (O) Public administration and defense, compulsory social security; (P) Education; (Q) Human health and social work activities; (R) Arts, entertainment, sports and recreation activities; (S) Other service activities; The figure displays the point estimates of the coefficients β_k from Equation (5.1), along with the corresponding 95% confidence intervals. Each coefficient represents the estimated monthly deviation from the expected sales trajectory relative to the pre-pandemic period, conditional on seasonality and long-run trends. The four vertical dashed lines delineate the two lockdown periods: March–May 2020 and January–March 2021. The Adjusted R^2 and number of observations are reported below each panel. *Source:* Author's calculation.

closures and stringent travel restrictions. In contrast, essential retail, particularly supermarkets and food wholesalers, remained fully operational and in some cases benefited from heightened consumer demand (Carvalho et al., 2022). Likewise, freight and logistics services, especially those connected to the distribution of essential goods and the expansion of e-commerce, played a critical role during the crisis and, in certain instances, gained strategic prominence (Li et al., 2023). The contrast between essential and non-essential services within these sectors helps to explain its relatively swift recovery compared to other tertiary sectors. However, this internal heterogeneity may also account for the fact that overall activity did not surpass pre-pandemic levels.

By contrast, sectors such as *Financial services* (Sector K), *Information and communication* (Sector J), and certain professional services such as *Consultancy* (Sector M) proved markedly more resilient. These sectors were comparatively well-positioned to transition to remote work environments and digital service delivery, thereby maintaining continuity of operations with minimal productivity loss (Pabilonia & Redmond, 2024).

The protective role of digital infrastructure in mitigating economic disruption is also visible on *Education* (Sector P). Although the sector was more significantly affected during the early stages of the pandemic due to the closure of schools and universities and the suspension of in-person instruction, it adapted relatively quickly. The deployment of remote learning platforms, hybrid models of teaching, and targeted investments in digital infrastructure enabled the sector to resume much of its activity by the second half of 2021 (Assunção Flores & Gago, 2020).

Additionally, sectors *Health* (Sector Q) and *Public administration, defense, and social security* (Sector O) present a distinct pattern, indicating a shift from crisis management to expanded operational capacity. These services are less responsive to short-term market demand and more responsive to state budgeting priorities. Their sustained or even increased activity during the pandemic demonstrates how countercyclical public investment can stabilize economic performance and ensure continuity of essential services. Sector Q, directly responsible for the healthcare response, experienced an initial downturn likely due to the postponement of non-urgent medical procedures and the reallocation of resources (Carvalho et al., 2022). However, as the crisis unfolded, the sector expanded significantly in both scale and scope. The positive monthly deviations in 2021 do not merely reflect a return to normal operations but rather an intensification of healthcare services, including widespread testing, vaccination campaigns, contact tracing, and emergency medical care.

Arts, entertainment, sports and recreation activities (Sector R) was among the hardest hit, though its peak decline was 12.13 percentage points smaller than in Sector I (Figure 4). Losses in this sector stemmed from restrictions on gatherings, event cancellations, and a structural

⁷Sector O represented less than 0.87% of total sales in 2018 (see Table B1). The low explanatory power of the model (adjusted $R^2 < 0.50$) further indicates substantial heterogeneity or the presence of idiosyncratic shocks within the sector. Accordingly, the sector's dynamics are not examined in greater depth.

reliance on face-to-face participation.

Finally, we single out *Accommodation and food services* (Sector I), which will be subject to more detailed analysis in the next sections. This sector was the most severely affected, with sales falling by around 84% in April 2020 relative to pre-pandemic levels (Figure 5). Recovery was slow and appears to have been completed only by late 2021. Beyond emerging as the sector most vulnerable to the pandemic shock, Sector I is of particular relevance in the Portuguese context, given the country's pronounced dependence on international and domestic tourism and hospitality (see Chapter 2), its deep integration into supply chains, and its marked exposure to mobility restrictions and shifts in consumer behaviour, driven by heightened health-related risk aversion and uncertainty (INE, 2020). Moreover, as parts of the literature exclude hospitality to avoid distortions arising from its extreme trajectory, concentrating on this sector offers an opportunity for a targeted investigation of shock dynamics (Chacha et al., 2024).

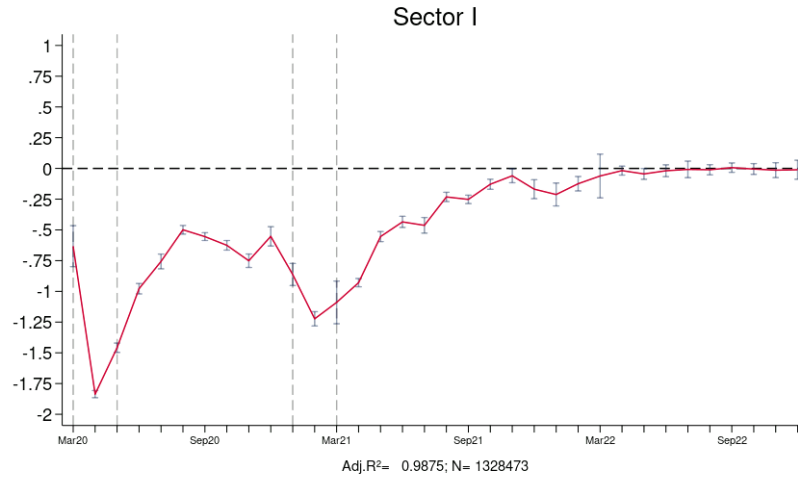


Figure 5: *Event study estimates by sector (I) Accommodation and food service activities.* The figure displays the point estimates of the coefficients β_k from Equation (5.1), along with the corresponding 95% confidence intervals. Each coefficient represents the estimated monthly deviation from the expected sales trajectory relative to the pre-pandemic period, conditional on seasonality and long-run trends. The Adjusted R^2 and number of observations is reported below the graph. *Source:* Author's calculation.

A common feature across Portuguese economic activities is the reduced severity of the second lockdown's effects relative to the first. This outcome likely reflects an element of institutional learning, with containment measures becoming more targeted, better policy coordination, and both firms and public services demonstrating greater preparedness.

The results show the importance of including a trend component. Apart from Sectors D, E, H, K and Q, all remaining sectors exhibit a statistically significant linear and/or quadratic trend.⁸

⁸From an empirical perspective, sectors such as D, H, K and K display wide confidence intervals around the monthly coefficient estimates, indicating a high degree of estimation uncertainty and underlying volatility. This may also reflect the presence of outliers or irregular shocks, which reduce the likelihood of detecting consistent

In conclusion, as demonstrated by Carvalho et al. (2022) in their analysis of the Portuguese context, the results of the analysis further corroborate the presence of considerable heterogeneity in the pandemic's economic effects across sectors within the Portuguese economy. Although tertiary activities characterized by higher levels of digitization or designated as essential services displayed relative resilience, the tertiary sector as a whole was heavily affected by the COVID-19 shock. By contrast, the primary and secondary sectors proved comparatively less sensible to the shock, benefiting from more stable patterns of demand and lower exposure to direct consumer contact.

Therefore, these findings provide robust empirical support for the critique advanced by Silva and Almeida (2024), highlighting the limitations of uniform policy responses in the face of sectoral differentiated economic impacts. They underscore the necessity for differentiated, sector-specific policy frameworks, not only for immediate mitigation but also for fostering sustainable and inclusive recovery. Designing policy instruments that are tailored to the structural characteristics and vulnerabilities of each sector is therefore essential for strengthening economic resilience in the face of future systemic disruptions.

long-term patterns. By contrast, Sector E exhibits a relatively stable post-pandemic trajectory, with coefficients fluctuating within a narrow band around the pre-pandemic baseline, suggesting an absence of sustained upward or downward movement.

6. Resilience and vulnerability - firm-level analysis

For the purpose of analyzing structural vulnerabilities and informing discussions on policy responses, it is essential to understand how shocks manifested at the firm level, particularly through buyer–supplier networks and demand flows. This chapter adopts a microeconomic perspective, focusing on *Accommodation and Food & Beverage Services* Sector in order to examine how the COVID-19 shock was transmitted across different channels.

This analysis addresses two questions: (i) whether the most pronounced effects were associated with domestic or international demand; and (ii) whether impacts differed across the two supply-chain channels: upstream or downstream.

By analyzing disaggregated firm-level channels (international and domestic demand channels, and upstream and downstream supply chain channels) across the full pandemic period, it becomes possible to capture the heterogeneous effects across distinct market interfaces and isolate the relative importance of demand-side versus supply-side transmission.

To this end, the analysis draws on the empirical strategy proposed by Chacha et al. (2024) and focuses on the cyclical component of firm outcomes, disaggregated into exports, domestic sales (to final consumers and other firms), and inter-firm transactions (both sales and purchases). It is conducted through a graphical examination of the estimated coefficients, β_k , which provide a visual representation of both the depth and the duration of the impact across each channel.

Using firm level data, we first estimate the regression on the full sample and, then, separately for the two subsectors within Sector I: Accommodation Services (CAE 55), encompassing hotels, guesthouses, short-stay apartments, "alojamentos locais", and camping parks; and Food & Beverage Service Activities (CAE 56), comprising restaurants, cafes, catering services, and beverage-serving establishments such as bars and pubs (INE, 2007).

Our econometric specification is similar to that used in the previous chapter. However, since we have firm-level data we are now able to control for firm heterogeneity and subsector specific seasonality. The estimated equation is:

$$\ln(y_{it}) = \alpha + \delta_1 \cdot t + \delta_2 \cdot t^2 + \lambda_{ms} + \phi_i + \sum_{k=0}^{34} \beta_k \cdot covid_{\tau+k} + \varepsilon_{it} \quad (6.1)$$

where $\ln(y_{it})$ represents the logarithm of four alternative firm-level outcomes: sales to final consumers, inter-firm transactions, exports and domestic sales. $\delta_1 \cdot t$ and $\delta_2 \cdot t^2$ capture a general linear and quadratic time trends, respectively; λ_{ms} captures fixed effects at the month-subsector level to control for subsector seasonal variation, and ϕ_i denotes firm fixed effects to control for unobserved time-invariant heterogeneity; $covid_{\tau+k}$, $k \in 0, \dots, 34$ are monthly dummy variables, corresponding to the period from March 2020(τ) to December 2022, which capture the evolution of firm performance relative to the pre-pandemic period; and ε_{it} is the error term.

These subsectors share several characteristics, including their joint role as the backbone of the national tourism value chain, frequent co-location in regional clusters such as the Algarve, 'Grande Lisboa', and the Porto Metropolitan Area, and a common prevalence of micro and small firms⁹.

Table 1: Descriptive statistics for the Accommodation (CAE 55) and Food and Beverage Service Activities (CAE 56) subsectors

Subsector	Accommodation	Food and Beverage
Number of firms	12,835	45,067
Number of observations	459,432	1,883,133
<i>Monthly Averages (Standard deviation)</i>		
Total sales	55,160.11 (286,865.50)	24,341.63 (194,605.80)
Exports	24,290.19 (161,358.90)	156.27 (5,128.20)
Sales to final consumers	15,133.25 (90,894.72)	18,720.78 (94,811.56)
Sales to firms	13,621.02 (108,662.70)	5,406.69 (147,308.20)
Purchases from firms	32,781.22 (254,246.10)	15,760.15 (100,104.30)
# National direct acquiring firms	15.43 (56.48)	42.66 (183.71)
# National direct selling firms	31.18 (39.29)	29.95 (25.71)
Number of employees	10.64 (37.39)	7.47 (50.05)
Firm age	13.18 (14.54)	15.42 (16.59)

Note: The table presents mean firm-level characteristics, with standard deviations reported in parentheses. All monetary values are expressed in real terms (euros, base year 2012). Figures are calculated over the period 2017–2022. *Source:* Author's calculations.

However, as shown in Table 1, although firms in *Food & Beverage activities* (CAE 56) account for almost 80% of the sample, average monthly sales in *Accommodation* (CAE 55) are more than twice those recorded in CAE 56. A similar pattern holds for inter-firm purchases, which are also over twice as high in CAE 55. These figures indicate higher per-firm revenue intensity in *Accommodation*, consistent with the sector's orientation towards higher-spending tourists and longer customer engagement.

A more granular disaggregation of the sales data within Sector I reveals additional hetero-

⁹Based on data from 2018 and 2022, over 50% of firms in the sub-sector sample were located in the Algarve, 'Grande Lisboa', or the Porto Metropolitan Area, and more than 80% were classified as micro or small enterprises (Author's calculations).

geneity. *Accommodation* services demonstrate a strong reliance on exports, with international sales accounting for nearly half of total revenue. By contrast, *Food and beverage services* are predominantly dependent on domestic final consumption. While this may partially reflect genuine differences in client composition, encompassing not only tourists and excursionists (day visitors) but also the regular consumption patterns of local residents and the working population, it is also shaped by limitations in statistical reporting. Indeed, although just under 30 % of firms in the CAE 56 sample report any export activity, this proportion is more plausibly a reflection of classification practices than an accurate measure of international demand.

In Accommodation, the nationality of guests is routinely recorded, allowing international demand to be classified as export activity. However, meals and beverages consumed by foreign visitors are not typically disaggregated in the data, and are instead recorded under domestic consumption. This statistical artifact results in a systematic underestimation of the international exposure of CAE 56 (*Food and beverage services*), with exports officially reported at an average of only €156 per month. This misrepresentation is particularly problematic given that CAE 56 forms a key component of the tourism value chain. For this reason, and in light of the methodological limitations described, export data for *Food & Beverage Services* are excluded from the domestic versus international analysis in order to preserve analytical consistency.

6.1 Domestic and International channels

According to INE (2020), the balance of tourist flows, defined as the difference between inbound (or “receptor”) tourism and internal tourism—remained positive even during the pandemic years. In 2018, inbound tourism, which refers to the expenditure of non-residents within the national territory and is recorded as exports in the national accounts, accounted for approximately 65.4% of total tourism consumption and represented 22.3% of Portugal’s total exports of goods and services. Meanwhile, internal tourism also constituted a vital component of Sector I’s revenue base: domestic travel was responsible for the remaining 34.6% of total tourism expenditure in that same year.

This dual structure, where both external and internal tourism play substantial roles in overall sectoral performance, exposes the sector to significant vulnerability in the face of external demand shocks. In light of this, the present subsection investigates whether the adverse effects of the COVID-19 pandemic manifested more acutely through international or domestic sales channels, focusing exclusively on the *Accommodation subsector* (CAE 55), for the reasons outlined previously.¹⁰

¹⁰At the same time, in order to reflect the full diversity of experiences within Sector I—and in particular the structural and functional distinctions between its two principal subsectors—a more detailed examination of heterogeneity within the domestic sales channel, including a comparative analysis of Accommodation and Food and Beverage services, is provided in Appendix A.

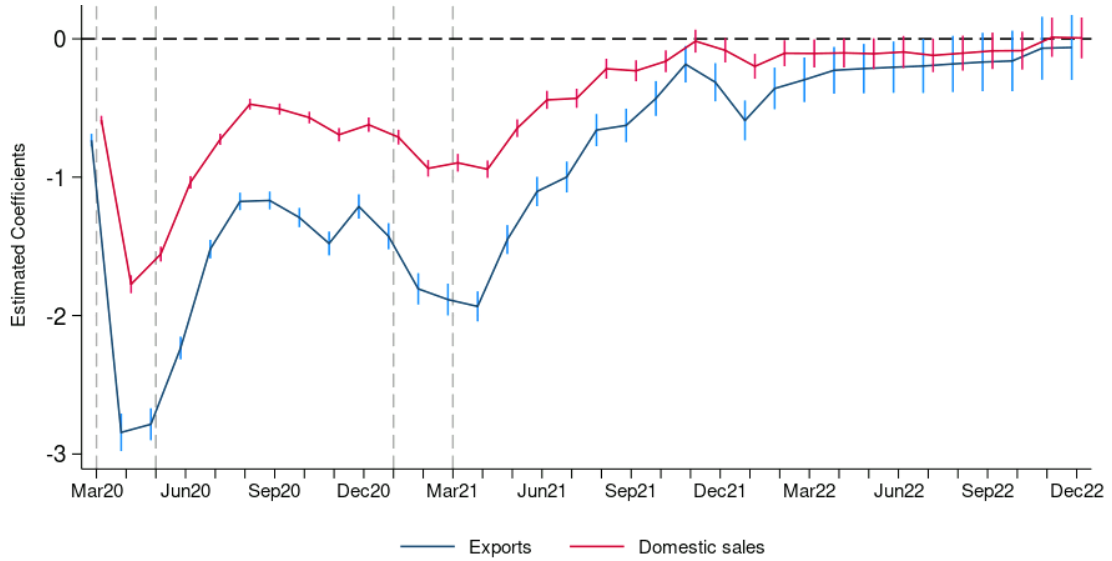


Figure 6: *Event study estimates by Firm-level outcome: International and Domestic sales*

The figure presents the point estimates of the coefficients β_k from Equation (6.1), along with their corresponding 95% confidence intervals. Standard errors are clustered at the firm level. Coefficients represent the estimated monthly deviations from expected pre-pandemic trajectories for two firm-level outcomes of Accommodation (CAE 55): exports (depicted in blue) and domestic sales, comprising both final consumer and inter-firm sales (depicted in red). All estimates control for seasonal and firm fixed effects and time trends. The adjusted R^2 values for the corresponding regressions are 0.7684 for exports and 0.7014 for domestic sales. The number of observations for the corresponding regressions are 215,071 for exports and 439,974 for domestic sales; *Source*: Author's calculations.

As illustrated in Figure 6, international sales experienced the most pronounced contraction following the initial pandemic shock. In April 2020, exports in the *Accommodation subsector* fell by approximately 94.18%¹¹ relative to their pre-pandemic trajectory. This decline was 11.15 percentage points higher than that observed in domestic sales during the same month, highlighting the disproportionate vulnerability of international sales to the shock.

This divergence appears consistent with differences in structural and behavioral factors. The *Accommodation subsector* is structurally reliant on international demand and is therefore particularly sensitive to cross-border mobility restrictions, disruptions to air connectivity, and fluctuations in foreign consumer confidence (Banco de Portugal, 2020b). Although domestic sales were also adversely affected, international channels were hit more directly by border closures, mandatory quarantines, travel bans, and heightened uncertainty regarding health risks. In such circumstances, discretionary leisure travel tended to decline, and export revenues fell accordingly. These constraints precipitated immediate and severe losses from foreign markets, compounding the downturn already driven by contracting domestic demand.

While both domestic and international sales experienced a second downturn during the winter lockdown of 2021, the nature and intensity of this contraction differed markedly from the first. The second decline was significantly less severe. This more moderate response appears

¹¹ $(\exp^{-2.8442} - 1) * 100 = 94.18\%$

consistent with patterns of institutional learning and behavioral adaptation observed among both policymakers and market participants. On the policy front, the public health response during the second wave was more targeted and predictable, allowing firms to adjust operations with greater flexibility. Many businesses had by then adopted recognized health and safety protocols (such as the “Clean & Safe” certification or negative COVID-19 test requirements), which played a key role in restoring consumer confidence in tourism-related services (ECDC, 2020; Turismo de Portugal, 2024). In addition, there was evidence of behavioral substitution from international to domestic tourism, as Portuguese residents redirected their travel plans to local destinations amid ongoing international travel restrictions. This shift in demand, which often favored rural or low-density areas perceived as safer, supported a degree of spatial diversification in internal tourism and temporarily bolstered demand in non-traditional regions (Marques et al., 2022).

Nevertheless, the second contraction in export activity, while less abrupt, exhibited greater volatility and a more prolonged recovery. In contrast to domestic sales, which followed a relatively gentle descent and did not experience a distinct trough, international channel suggests the persistent effects of international travel restrictions and the asynchronous reopening of key tourism source markets. Although Portugal began to stabilize its domestic health situation in early 2021, major origin countries, notably the United Kingdom, France, and Germany, continued to experience elevated infection rates and maintained stringent travel controls, which likely produced two specific setbacks. The first occurred in November 2020, coinciding with a renewed surge in COVID-19 cases across Europe. In response, several governments reinstated lockdowns and border restrictions, leading to another wave of cancellations and subdued winter travel demand (Daventry, 2020). The second disruption arose in January 2022, driven by the rapid spread of the Omicron variant. This wave triggered the reintroduction of testing requirements and entry restrictions across multiple European countries, causing additional disruptions during what is typically a peak season for international tourism (BBC News, 2021).

The roll out of mass vaccination campaigns in early 2021 played a pivotal role in restoring consumer confidence and revitalizing tourism-related economic activity. Improved public health conditions, coupled with increased predictability of travel regulations, encouraged a rebound in advance bookings, often supported by flexible cancellation policies, which contributed to the gradual stabilization of the sector from September 2021 onward. While domestic sales achieved full recovery earlier, both international and domestic channels ultimately returned to pre-pandemic levels by the final quarter of 2022.

The asymmetric pace of recovery between these two channels reflects underlying structural differences, over and above cross-country heterogeneity in the timing of the lifting of restrictions. One plausible explanation lies in the underlying trend components embedded in the data. Domestic sales exhibit a statistically significant linear time trend ($\delta_1 = 0.0029$), suggesting a

path-dependent growth trajectory. By contrast, international sales display no statistically significant temporal trend, suggesting that their fluctuations are episodic and appear closely linked to external shocks, such as travel restrictions, geopolitical uncertainty, and shifts in global consumer confidence.

In conclusion, the findings align with Borino et al. (2024) and Carvalho et al. (2022) in identifying the international sales channel as both the most vulnerable and the most resilient. Owing to its heightened exposure to external shocks and global disruptions, the international channel exhibits greater volatility and cyclicity in firm-level performance. By contrast, the domestic channel tends to play a stabilizing role, although its trajectory is shaped by slower-moving structural factors.

6.2 Upstream and downstream channels

While the preceding analysis has focused primarily on the demand dimension of Sector I, it is essential to recognize that a substantial proportion of the sector's revenue and operational flows is also generated through inter-firm transactions, encompassing both upstream procurement and downstream business-to-business (B2B) sales. These inter-firm dynamics reflect the sector's deep integration within broader commercial and service ecosystems, involving both tourism-adjacent industries and intra-sectoral interdependencies.

On the downstream side, the primary B2B clients of Sector I include travel agencies and event management firms (Sector N), as well as wholesale distributors, such as food retail platforms, catering suppliers, and ready-to-eat meal providers (Sector G). In 2018, these sectors accounted for 17.85% and 17.32% of Sector I's total inter-firm sales, respectively.¹² Interestingly, the third-largest recipient of B2B sales was Sector I itself, comprising 12.54% of total inter-business transactions¹². This intra-sectoral exchange reflects strong complementarities between accommodation and food service providers, such as hotels subcontracting catering for corporate events, or restaurants coordinating with lodging establishments to deliver bundled service offerings. However, it is important to note that many of these transactions, although formally classified as B2B, are in practice closely tied to final consumer sales (Mengu, 2018). In such cases, inter-firm exchanges often represent intermediary stages in the provision of services to end consumers, rendering them highly susceptible to shifts in consumer behavior.

On the upstream side, input purchases are highly concentrated. In 2018, over 45% of Sector I's procurement originated from Sector G (Wholesale and retail trade), fact that can be justified by the need of food, beverages, hygiene supplies, and packaging.¹² A further 9.77% came from Sector C (Manufacturing), which can comprise furniture, equipment, linens, and processed foodstuffs¹². This supplier concentration exposes firms to a range of supply-side vulnerabilities, including input price shocks, logistical bottlenecks, and cross-border disruptions.

¹² Author's calculations .

Accordingly, the present section explores the role of these supply chain channels, both upstream and downstream, in shaping the adverse effects of the pandemic on Sector I. By examining how input dependencies and inter-firm demand dynamics evolved during the crisis, the analysis seeks to offer a more comprehensive understanding of the pandemic's transmission mechanisms within and across sectors.

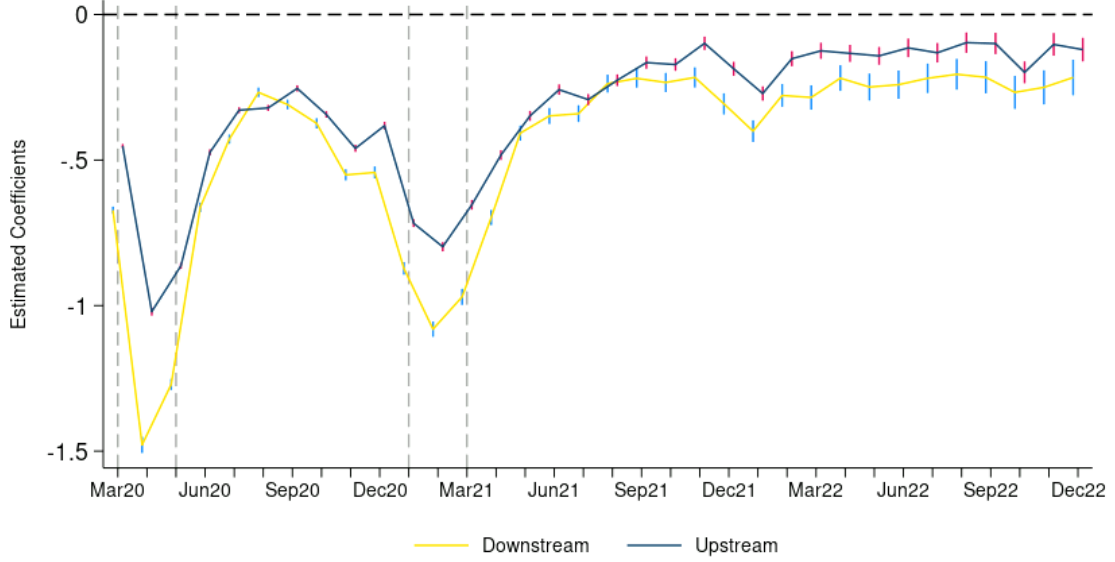


Figure 7: *Event Study Estimates by Firm-Level Outcome: Upstream and Downstream Transactions*. The figure presents the point estimates of the coefficients β_k from Equation (6.1), along with their corresponding 95% confidence intervals. Standard errors are clustered at the firm level. These estimates represent the monthly deviations from the expected pre-pandemic trajectories of inter-firm sales (depicted in yellow) and inter-firm purchases (depicted in blue). All estimates are conditional on seasonal and firm fixed effects and time trends. The adjusted R^2 values for the corresponding regressions are 0.8 for downstream and 0.8264 for upstream. The number of observations for the corresponding regressions are 2,044,163 for downstream and 2,330,917 for upstream. *Source*: Author's calculations.

The empirical estimates presented in Figure 7 highlight a marked asymmetry in how Sector I firms adjusted to the COVID-19 shock, with a sharper contraction in downstream B2B sales than in upstream purchases. In April 2020, B2B sales collapsed by over 77.20% relative to the counterfactual scenario, while upstream purchases declined less sharply, resulting in an estimated gap of approximately 13.23 percentage points. This divergence reflects both the sudden nature of the demand-side shock and the structural rigidity of input procurement systems.

As mentioned before, B2B sales activity in Sector I can be interpreted as a proximate extension of final consumption, given their strong component of relationships based on subcontracting arrangements (Mengu, 2018). Consequently, demand shocks at the consumer level, such as those triggered by pandemic-related restrictions, are rapidly transmitted through these. If final consumption contracts, firms downstream have fewer incentives to outsource, leading to immediate declines in inter-firm transactions. This mechanism underscores the strong consumption-based transmission channel through which shocks propagate across Sector I's business net-

works. Additionally, in service sectors such as Accommodation and Food and beverage, where outputs are largely perishable and non-storable, sales lost during lockdowns cannot be postponed or recovered, thereby amplifying revenue losses during periods of operational suspension (Mengu, 2018). This characteristic magnifies the economic impact of shocks, since firms in these sectors operate with time-sensitive, fixed capacity and are unable to shift unmet demand forward in time.

In contrast, upstream purchasing behavior adjusted more gradually. Several quasi-fixed input requirements, such as utilities, insurance, basic staff levels, and cleaning services, create baseline procurement levels that are not immediately responsive to demand fluctuations. In other words, rigidities in input procurement can constrain firms' ability to adjust supply in response to sudden demand fluctuations (Graham & Harris, 1999). From a behavioral perspective, procurement decisions are lagged and adaptive rather than forward-looking under uncertainty. While sales collapsed in real time in response to exogenous demand shocks and policy restrictions, input purchases reflected a delayed internalization of output expectations. This temporal mismatch, where purchasing reacts only after observing persistent demand decline, amplifies adjustment asymmetries.

These dynamics were confirmed again during the second national lockdown in early 2021, where downstream sales fell steeply, while input purchases again declined more modestly.

Disaggregated analysis, illustrated in Figure 8, further reveals differences between subsectors: *Food & Beverage Services* experienced steeper contractions than *Accommodation Services* in both upstream and downstream dimensions, with gaps exceeding 6.5 percentage points during lockdowns. These divergences are consistent with differences in the sectoral composition of inter-firm channels.

On the downstream side, CAE 56 (Food and Beverage Services) is primarily connected to Sector G (Wholesale and Retail Trade), which accounted for 22.71% of its B2B sales in 2018. Relationships with food wholesalers and catering platforms, which typically operate on short contractual cycles, may have rendered these firms particularly vulnerable to abrupt cancellations during periods of heightened uncertainty. Such short-term contractual arrangements limit the scope for risk-sharing or deferred adjustment, thereby amplifying the immediate impact of demand shocks on liquidity and operational continuity.

By contrast, Accommodation (CAE 55) is more closely connected to Sector N (Administrative and Support Service Activities), which represented 38.42% of its B2B sales in 2018. In this case, the role of travel agencies and intermediaries, often operating with longer planning horizons and pre-booked arrangements, may have permitted a degree of rescheduling and adjustment. This intertemporal flexibility acted as a partial buffer, reducing the scale of immediate transaction losses and allowing firms to smooth the impact of the shock over time.

Upstream purchasing patterns further reinforce the asymmetry between the two subsectors.

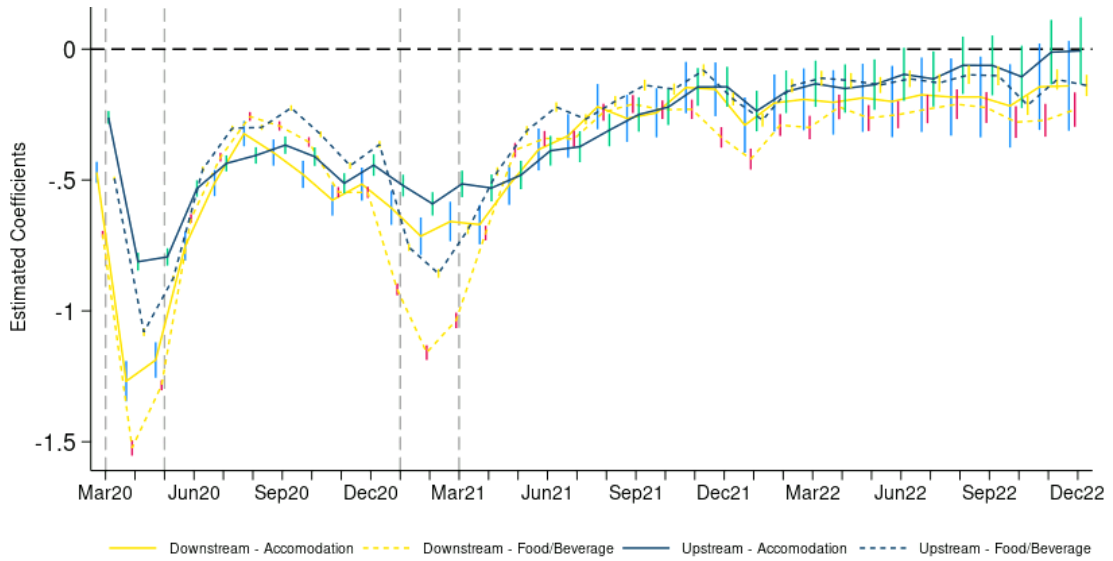


Figure 8: *Event Study Estimates by Firm-Level Outcome: Inter-firm Interactions Disaggregated by Subsector*. The figure presents the point estimates of the coefficients β_k from Equation (6.1), alongside 95% confidence intervals. Standard errors are clustered at the firm level. These estimates represent the monthly deviations from expected pre-pandemic trajectories in inter-firm sales (yellow lines) and inter-firm purchases (blue lines). Subsectoral distinctions are made using solid lines for CAE 55 (Accommodation) and short-dashed lines for CAE 56 (Food and Beverage Services). All estimates control for seasonal and firm fixed effects and time trends. The adjusted R^2 values for the corresponding regressions are 0.7237 (CAE 55) and 0.8064 (CAE 56) for downstream and 0.8131 (CAE 55) and 0.8131 (CAE 56) for upstream. The number of observations for the corresponding regressions are 325,436 (CAE 55) and 1,718,704 (CAE 56) for downstream and 457,114 (CAE 55) and 1,873,783 (CAE 56) for upstream. *Source*: Author's calculations.

Although both rely substantially on inputs from Sector G (Wholesale and Retail Trade), the composition and flexibility of these dependencies differ markedly. In *Food & Beverage Services* (CAE 56), more than half of all input purchases originated from Sector G in 2018 (a proportion significantly higher than in CAE 55) with this dependence concentrated largely on flexible and perishable goods, predominantly food and beverages.¹³ While *Accommodation* (CAE 55) also procures such items at scale, a significant proportion of its upstream expenditure is directed toward more rigid and contractually anchored services, such as regular infrastructure maintenance (Sector F), representing 15.92% of input purchases, and insurance services (Sector K), comprising 12.09%. These categories represent quasi-fixed operational commitments that are less elastic in the short term and less amenable to abrupt cost reductions during crises. They are essential for maintaining hotel infrastructure and regulatory compliance and, as such, cannot be readily scaled down in response to declining demand. This upstream composition provides CAE 55 with a degree of baseline procurement stability, which mitigates the extent of supply-side contraction during periods of disruption.

In terms of overall recovery, the downstream and upstream channels of both subsectors

¹³Sector G accounted for 57.48% of CAE 56's total input purchases in 2018, compared with 22.38% in CAE 55 (Author's calculations).

appeared to converge over time, although only the channels of Accommodation (CAE 55) ultimately returned to pre-pandemic levels, and the nature of the adjustment differed between them.

The recovery paths within Sector I highlight a marked heterogeneity: whereas the rebound of CAE 56 was shaped by gradual demand stabilization, that of CAE 55 was more closely tied to discrete external triggers. In *Food & Beverage Services* (CAE 56), downstream sales showed strong positive trends, while upstream purchases displayed a weaker and more gradual adjustment, consistent with progressive alignment of procurement to stabilizing demand. By contrast, CAE 55's recovery was less continuous and more event-driven, particularly after the vaccine rollout in early 2021. While downstream sales exhibited no significant trends, upstream purchases followed a clear upward trajectory, reflecting restocking, the reactivation of operations, and renewed supply contracts.¹⁴

Taken together, these asymmetries illustrate that the sector's vulnerability to systemic shocks cannot be inferred solely from its exposure to consumer demand. It also depends on the elasticity, composition, and contractual structure of its inter-firm transactions. The speed and depth of both contraction and recovery therefore reflect not only demand-side pressures but also the structural capacity of the sector's supply and distribution networks to absorb, adapt to, and recover from external disruptions.

¹⁴CAE 55's upstream purchases displayed a statistically significant positive linear trend ($\delta_1 = 0.0050$).

7. Firm Heterogeneity in Mitigation and Resilience

While it is essential to examine the channels through which external and systemic shocks transmit, it is equally important to consider how these shocks are experienced unevenly across firms, depending on their specific characteristics, most notably their position within the value chain and the composition of their markets.

Existing research has primarily highlighted the short-term amplification of shocks, particularly within the context of global supply chains. Notable contributions, such as those by Niu et al. (2023) and Lafrogne-Joussier et al. (2023), provide valuable insights into cross-border vulnerabilities. However, despite the possibility that shocks propagate differently within them due to institutional, geographic, and sectoral proximity, domestic production networks often remain underexplored. Moreover, even when international markets are the focus, attention is frequently directed towards aggregate demand effects, with less emphasis placed on firm-level heterogeneity related to the geographical diversification of demand.

Furthermore, much of the literature limits its scope to vulnerability at the onset of a shock, neglecting the equally important dimension of long-term resilience - the capacity of firms not only to recover, but to adapt and evolve in response to systemic disruptions (Chacha et al., 2024; Khanna et al., 2022; Lafrogne-Joussier et al., 2023; Niu et al., 2023). As pointed out by Niu et al. (2023), a comprehensive understanding of supply chain resilience demands a focus on post-shock adjustment processes and the potential for structural changes following disruption.

By integrating firm-level data on supply chain characteristics and export dependence with observed patterns of both disruption and recovery, this chapter seeks to fill these gaps by addressing two questions. First, which firm-level characteristics were associated with lower observed vulnerability during the crisis and with stronger signs of recovery thereafter? Second, to what extent did firms exhibit changes in these characteristics during or after the disruption? More concretely, were post-pandemic configurations similar to pre-pandemic structures, or do the data point to adjustments in supply chains and demand portfolios that may suggest longer-term transformations?

To approach these questions, the analysis considers two complementary sets of firm-level attributes. The first relates to the firms' export dependency. Firms with greater reliance on international markets may display heightened sensitivity to disruptions in cross-border mobility, volatility in foreign demand, and the asynchronous recovery of key source markets. By contrast, firms primarily oriented toward domestic demand may appear less exposed to such risks, though also less able to benefit from rapid rebounds in global tourism flows.

The second set of attributes concerns two structural characteristics of supply chains, following the approach proposed by Chacha et al. (2024). *Diversification* refers to the number of suppliers a firm maintains upstream, indicating the breadth of its sourcing network. *Complex-*

ity captures the number of distinct sectors from which a firm procures inputs, thereby reflecting the heterogeneity of its upstream transactions. While Chacha et al. (2024) examines both upstream and downstream channels, this study restricts attention to the upstream dimension. This decision is guided by two considerations. First, in both subsectors examined, downstream sales to other firms account for less than 25 per cent of total revenues, with the sector as a whole being heavily reliant on final consumer demand. Second, upstream procurement represents a structural necessity: regardless of fluctuations in demand, firms continue to require inputs to sustain operations.

The empirical strategy compares the impact of the COVID-19 shock across firms with different levels of these attributes. This approach requires categorizing firms into distinct groups for each variable under investigation, based on firm-level distributions calculated from the pre-pandemic period, using annual data from 2017, 2018, and 2019.

For supply chain characteristics, firms are classified into “low” or “high” groups according to the extreme quartiles of the subsectoral distribution, thereby capturing more pronounced differences in supply chain structure. Specifically, firms in the top quartile of their subsector (above the 75th percentile) are defined as having “high” levels of a given characteristic, while those in the bottom quartile (below the 25th percentile) are classified as “low”.¹⁵ This approach creates a sharper contrast between groups, thereby strengthening the identification of the effects.

For export dependency, the analysis departs from a simple high–low dichotomy by introducing a third group: firms with no dependence in the pre-pandemic years. This decision is both empirically and substantively justified. Empirically, the no-export category is non-trivial, accounting for more than 38% of the sample. In addition, excluding this group or arbitrarily assigning its members to the “low export” category would risk obscuring distinct behavioral patterns and potentially conflating fundamentally different strategic orientations. Group boundaries for high and low export dependency are determined by the median of the average annual export share over the period 2017–2019.¹⁶ It is important to note that this analysis is restricted to the *Accommodation* subsector (CAE 55) for the reasons outlined in Section 6.1, namely the weaker reliability of export data for *Food & Beverage Services* (CAE 56).

In terms of econometric strategy, the analysis departs from Chacha et al. (2024) by estimat-

¹⁵The thresholds are defined as follows: for *diversification*, high diversification corresponds to firms whose annual average number of upstream suppliers during the pre-pandemic years lies above the 75th percentile for the two-digit sector classification [p(75) of CAE 55 = 31.172; CAE 56 = 33.820], whereas firms are classified as having low diversification if they fall below the 25th percentile [p(25) of CAE 55 = 8.5; CAE 56 = 16.528]. For *complexity*, high complexity is assigned to firms whose annual average number of distinct upstream sectors during the pre-pandemic years lies above the 75th percentile [p(75) of CAE 55 = 14; CAE 56 = 12.667], while those below the 25th percentile [p(25) of CAE 55 = 7.667; CAE 56 = 9] are considered to have low complexity. Quartiles are calculated excluding zero observations (43 Accommodation and 139 Food & Beverage firms), as these reflect the absence of the characteristic rather than its intensity.

¹⁶The threshold for export dependency groups is 22.1%.

ing separate regressions for firms in each group, rather than interacting firm-level characteristics with time dummies within a single model.¹⁷ The resulting trajectories are then compared across groups over time.

Therefore, the following econometric specifications are employed being the equation 7.1 focus on the export dependency analysis and the equation 7.2 on the supply chain characteristics:

$$\ln(y_{total_{it}}) = \alpha + \phi_i + \sum_{k=0}^{34} \beta_k \cdot covid_{t+k} + \varepsilon_{it} \quad (7.1)$$

$$\ln(y_{national_{it}}) = \alpha + \phi_i + \sum_{k=0}^{34} \beta_k \cdot covid_{t+k} + \gamma_1 \cdot exp + \gamma_2 \cdot cons + \varepsilon_{it} \quad (7.2)$$

where $\ln(y_{total_{it}})$ represents the logarithm of total sales and $\ln(y_{national_{it}})$ the logarithm of sales to national firms both purged of seasonality and trend¹⁸; α is the constant; ϕ_i denotes firm fixed effects to control for unobserved time-invariant heterogeneity; the series of month-specific dummy variables from March 2020 to December 2022 ($covid_{t+k}$), which capture the evolution of firm sales relative to the onset of the pandemic; two control variables: $\gamma_1 \cdot exp$ is a control variable for export status (a dummy equal to 1 if the firm is an exporter) and $\gamma_2 \cdot cons$ captures the share of sales to domestic final consumers outside the business-to-business network; and ε_{it} is the error term.

The choice of dependent variable differs between the two specifications in line with their distinct analytical objectives. Total sales are used in the export-dependence analysis, as export exposure affects the overall revenue base of firms. By contrast, in the supply-chain characteristics analysis, the dependent variable is restricted to national inter-firm sales, ensuring that the estimates capture specifically B2B dynamics. To account for differences in market orientation that could otherwise confound the estimates, two additional controls are introduced: *exp*, a dummy for export status, which captures the distinct demand shocks, mobility restrictions, and recovery patterns faced by internationally oriented firms; and *cons*, which measures the share of sales to domestic final consumers outside the inter-firm network. This distinction is important, as consumer-facing firms were disproportionately affected during the pandemic, while business-to-business sales often followed different disruption and recovery trajectories. Nonetheless, even with these controls, using total sales would conflate inter-firm transactions with consumer and export activity, making the restriction of the dependent variable the more appropriate option.

¹⁷By constructing groups on the basis of pre-pandemic, time-invariant characteristics, the approach avoids potential absorption of group differences into firm fixed effects in a single pooled regression, thereby providing a clearer picture of heterogeneous dynamics.

¹⁸These variables are obtained as the residual from a regression on seasonality dummies and a quadratic trend.

7.1 Export dependence

Export dependence constitutes a structural attribute that shapes observed variation in how firms experience shocks, as it interacts with the channels through which disruptions are transmitted. Results from Chapter 6 suggest that firms integrated into international tourism flows exhibited sharp revenue declines when cross-border mobility was restricted, yet also appeared to benefit more strongly once restrictions eased and global demand began to recover. By contrast, firms primarily oriented toward the domestic market were less exposed to international disruptions but displayed more limited recovery dynamics during the rebound phase.

This section compares firms with high export dependence, low export dependence, and no export activity in order to analyze patterns of vulnerability and recovery across these groups.

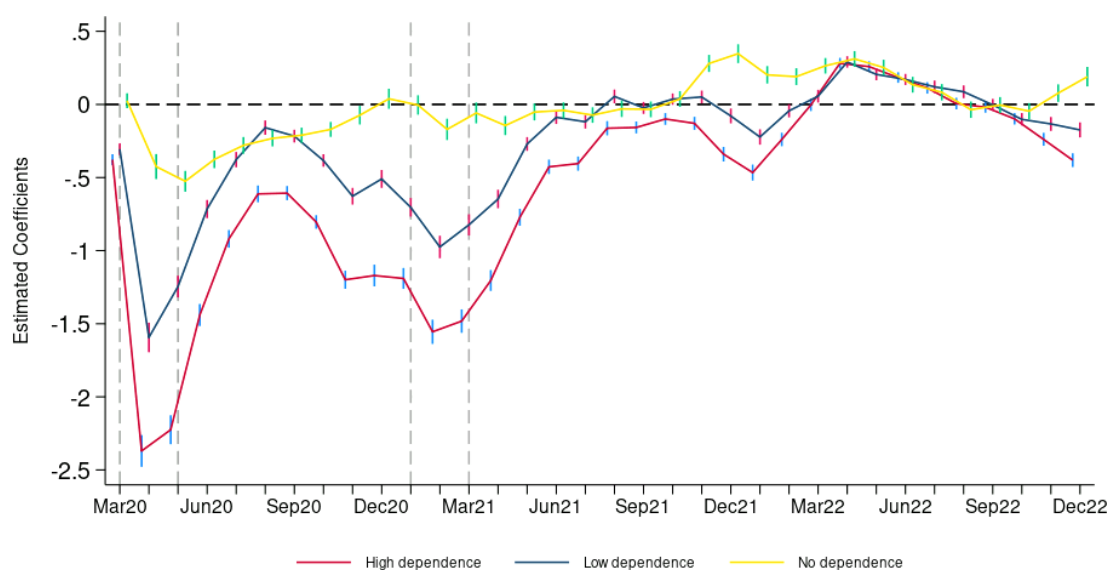


Figure 9: *Event study estimates of total sales by Export dependency group: No dependence, Low dependence and High dependence* The figure presents the point estimates of the coefficients β_k from Equation (7.1), along with their corresponding 95% confidence intervals. Standard errors are clustered at the firm level. These coefficients represent the estimated monthly deviations from expected pre-pandemic trajectories of three groups. The adjusted R^2 values for the corresponding regressions are 0.7667, 0.6427 and 0.6099 and the number of observations are 147,354, 147,171 and 113,939 for High, Low and No dependence, respectively. *Source:* Author's calculations.

As shown in Figure 9, high-dependence exporters experienced the steepest collapse in sales during the first and second lockdowns than those observed for low-dependence exporters and non-exporters. Given that exports account, on average, for more than 50% of total sales in the high-dependence group (Table B2), this heightened vulnerability suggests a structural exposure to international tourism flows, cross-border mobility restrictions, and the asynchronous reopening of major source markets. Low-dependence exporters also recorded marked downturns, although their troughs were less severe and less persistent.

By contrast, non-exporters faced the smallest contraction in relative terms, suggesting that exclusive reliance on domestic demand provided a partial buffer against the abrupt halt in for-

eign arrivals. Moreover, in the second lockdown, the estimated coefficients are either statistically insignificant or only marginally negative. This pattern highlights two points. First, the removal of the usual seasonal demand impulse - most notably Carnival (February 2021) and Easter (April 2021), which were either canceled or held under strict restrictions on gatherings - generated an additional departure from pre-pandemic seasonality. Since the series were seasonally adjusted and detrended, the negative coefficients observed for these months may reflect the absence of the typical seasonal uplift.

Second, the results point to the influence of firm-size effects and within-group heterogeneity. Indeed, the incomplete recovery of the domestic channel in the first half of 2021 and the lack of statistical significance in the group's coefficients are consistent rather than contradictory. The sales aggregate is disproportionately influenced by large firms: sharp contractions among a few depress the mean even when the median shifts little. By contrast, as shown in Table B2, non-exporters are smaller on average, employing fewer workers and generating lower sales, so numerous modest declines dilute the aggregate effect. This composition yields a small average impact and relatively large standard errors.

In the recovery phase, following the mass vaccination rollout in September 2021, the low-dependence group reached pre-pandemic total sales levels earlier than the high-dependence group, despite the latter ultimately exhibiting the strongest rebound. This stronger rebound may reflect the rapid return of foreign demand once travel restrictions eased in key markets. Non-exporters, by contrast, experienced a slower post-vaccination upturn, consistent with their reliance on the domestic market, which had already stabilized earlier in the recovery but lacked the additional boost generated by resurgent international tourism.

It is also noteworthy that in late 2021 and early 2022 both the high- and low-dependence groups contracted, in contrast to the expansion observed among non-exporters. This divergence is consistent with the previously argued behavioral substitution from international to domestic tourism. As discussed in Section 6.1, the first quarter of 2022 was marked by the rapid spread of the Omicron variant across Europe, disrupting what is typically a peak season for international arrivals and prompting Portuguese residents to redirect travel towards domestic destinations, thereby widening the gap between groups. However, this effect was temporary: from spring through summer 2022, *Accommodation* sales rose sharply across all dependency categories, irrespective of their reliance on foreign markets.

Finally, fixing export-dependency groups *ex-ante* has clear advantages (most notably, mitigating contemporaneous endogeneity), but it also carries implications that warrant explicit consideration: category switching and differential exit from the sample.

Firms that “switch” category during the analysis window (for example, “No” exporters that begin exporting, as evidenced by the positive average exports of the No-export group in Table B2) introduce classical measurement error into the treatment variable.

This issue is compounded by incomplete reversion to pre-pandemic market composition during the recovery. Relative to 2019, the 2022 average annual export share of the High-dependence group fell by more than 10pp, whereas the Low- and No-dependence groups rose by approximately 5pp and 8pp, respectively.¹⁹ Moreover, the proportion of exporting firms in the sample increased by more than 6%, indicating a broad-based shift towards intermediate export dependence across firms.²⁰

Additionally, the further the observation period is from the original classification window, the greater the likelihood of switching, implying that attenuation bias is most pronounced towards the end of the sample. This can partly account for the dissonant behavior observed in the final quarter of 2022: the sharp declines among Low/High dependence exporters may understate the true gap, and differences between No and Low/High dependence groups may appear less pronounced than is suggested by the Figure 9.

Lastly, if the probability of firm exit differs across or within groups, survivors in 2021–2022 may be less representative of their *ex-ante* type. Such attrition can distort group means and either inflate or deflate dispersion, with direct consequences for standard errors and statistical inference. Relative to 2019, 1,248 firms ceased reporting during the study period, reducing the sample size across all groups between 10% and 20%.

7.2 Supply chain characteristics

The COVID-19 pandemic highlighted diversity and complexity as structural attributes that may be associated with differences in how firms adjusted procurement, maintained operations, and navigated recovery from disruption. As noted by Chacha et al. (2024), a broader supplier base (diversity) is linked to reduced reliance on individual vendors and greater flexibility in responding to shocks, while sourcing across a wider range of sectors (complexity) may provide a form of diversification when disruptions are unevenly distributed across industries. Whether these attributes are related to similar patterns of vulnerability and recovery in the Portuguese tourism sector, however, is an empirical question that this section investigates.

As illustrated in Figure 10, high-diversification firms experienced a sharper contraction during lockdowns than their low-diversification counterparts. This greater vulnerability can be linked to their larger scale and more complex supplier networks (Table B3), which may have been associated with higher coordination costs and fixed procurement commitments, thereby constraining their ability to scale down operations swiftly during a synchronized global shock.²¹

¹⁹In 2019, the average annual export share of the High-dependence group was 59.56%, which fell to 48.37% in 2022. Over the same period, the average annual export share of the Low-dependence and No-dependence groups rose from 7.22% and 0% to 12.55% and 7.67%, respectively (Author's calculations).

²⁰Between 2019 and 2022, the share of exporting firms increased from 59.68% to 65.83%.

²¹To ensure that the results were not driven by the vulnerability of larger firms in the extreme quartiles, a robustness check was conducted by splitting groups at the median within each two-digit sector. The findings remained

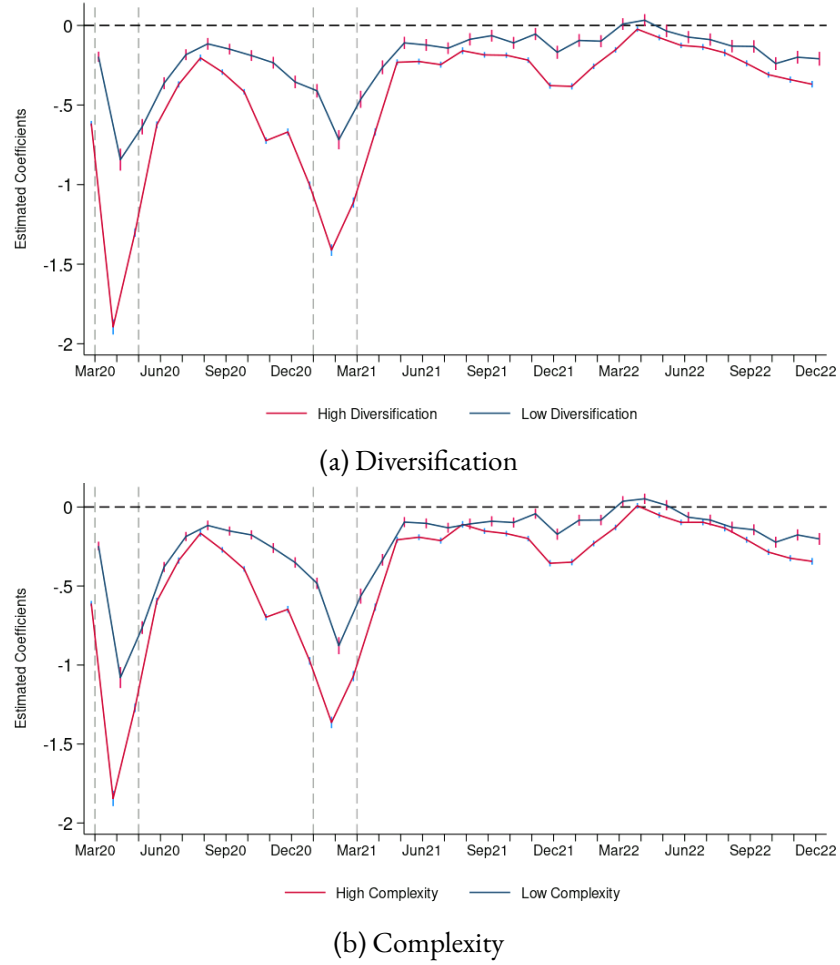


Figure 10: *Event study estimates of domestic sales by group of (a) Diversification and (b) Complexity* The figure presents the point estimates of the coefficients β_k from Equation (7.2), along with their corresponding 95% confidence intervals. Standard errors are clustered at the firm level. These coefficients represent the estimated monthly deviations from expected pre-pandemic trajectories of two groups: High, shown in red, Low, shown in blue; The Adjusted R^2 values for the corresponding regressions are: High = 0.7894 and Low = 0.7973 for the Diversification, and High = 0.8067 and Low = 0.7918 for the Complexity. The number of observation for the corresponding regressions are: High = 656,932 and Low = 263,996 for the Diversification, and High = 699,796 and Low = 320,636 for the Complexity. *Source:* Author's calculations.

Because suppliers across regions were simultaneously disrupted, the usual buffering gains from diversification were limited. By contrast, smaller, less diversified firms, often more locally embedded, could renegotiate selectively or substitute inputs more swiftly, tempering the depth of contraction.

Subsector-specific estimates reinforce this pattern. In *Food & Beverage Service Activities* (CAE 56) and in *Accommodation* (CAE 55), the results broadly mirror the aggregate, with the exception of the low-diversification group in CAE 55. For this group, no statistically significant lockdown effect is observed, a result consistent with procurement among smaller accommodation firms being concentrated in essential, quasi-fixed inputs that are less responsive to

unchanged.

short-term demand fluctuations.

Findings for complexity are analogous. High-complexity firms experienced larger declines during lockdowns, a pattern that can be associated with their broader set of upstream sector linkages: as the span of linkages widens, so too does the likelihood that at least one critical input market transmits severe disruption, amplifying negative spillovers along the supply chain. During COVID-19, concurrent shocks across multiple input markets eroded the risk-spreading benefits normally associated with sectoral diversity, producing compounding constraints instead. Additionally, in the *Accommodation* subsector, the low-complexity group again shows no statistically significant lockdown effect, a result consistent with procurement being concentrated in quasi-fixed inputs, similar to the low-diversification case.

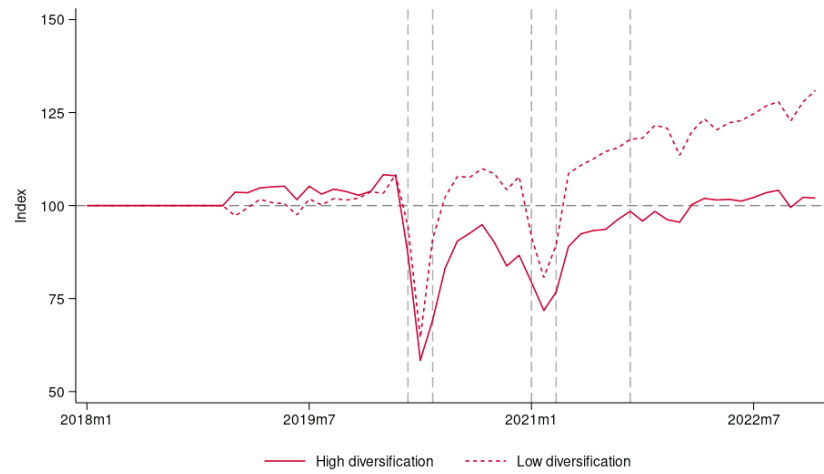
Nonetheless, across both supply chain characteristics, the high groups demonstrated a faster and more robust rebound in domestic sales compared with their low counterparts. The scale and scope of their supplier relationships were associated with a quicker ramp-up of operations during the demand rebound. However, by late 2022, both high and low groups had broadly converged to pre-pandemic trajectories, indicating that the advantage conferred by these supply chain characteristics was most visible in the immediate post-reopening period, even though the low groups continued to exhibit smaller negative impacts.

Therefore, in contrast to Chacha et al. (2024), who find that upstream diversification and supply-chain complexity mitigated losses and supported recovery across a broad Kenyan sample, the evidence for Sector I in Portugal points the other way. However, the divergence can be justified by largely structural and operational reasons. First, the sectoral scope differs substantially. Chacha et al. (2024)'s analysis covers a broad cross-section of manufacturing and service industries, where inputs are more substitutable and procurement can be adjusted flexibly. By contrast, Portuguese tourism (Sector I) features high fixed-cost structures, reliance on quasi-fixed inputs, and perishable, non-storable outputs, which curtail short-run procurement flexibility and blunt the expected benefits of diversification and complexity during a sudden demand collapse.

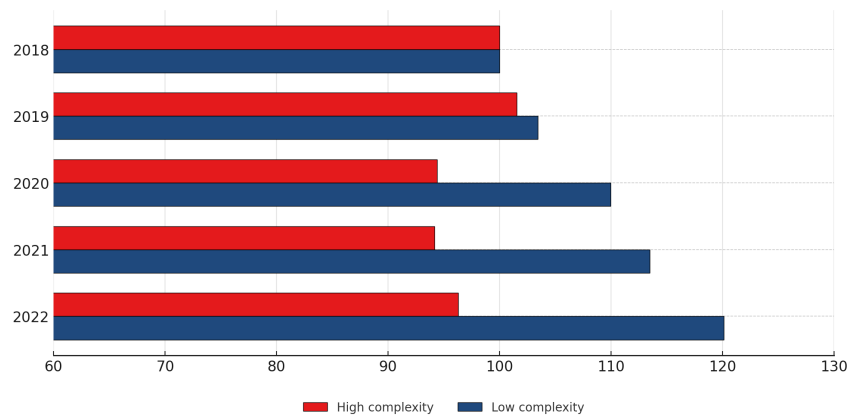
Second, the pandemic's impact in Portuguese tourism was overwhelmingly demand-driven rather than supply-driven, as it is reinforced by the strong impact of COVID-19 on the direct demand of Sector I ($\gamma_2 < -1.7$). The near-total halt in tourism flows coincided with sharp sales declines, while essential input requirements remained broadly unchanged. High-diversification and high-complexity firms, typically larger, with more staff, higher baseline procurement, and more complex coordination and contractual obligations (see Table B3), appeared less able to scale down quickly and were observed to experience greater vulnerability.

A further distinction concerns the group definitions and the 'switching' problem outlined in the previous section. Whereas Chacha et al. (2024) employ a month-by-month classification that traces real-time adaptation in supply-chain attributes, the present study classifies structural

groups using fixed pre-pandemic thresholds, which do not capture adjustments firms may have made during or after the shock.



(a) Diversification



(b) Complexity

Figure II: *Evolution of the Diversity and Complexity Index (Base Year = 2018)* Panel (a) presents the monthly index of the number of national buyers, benchmarked against the corresponding months in 2018. Indices are disaggregated by diversity group, with the high-diversity group shown as a solid line and the low-diversity group depicted as a short-dashed line. Panel (b) presents the annual index of the number of sectors from which a firm procures inputs, benchmarked against 2018. Indices are disaggregated by complexity group, with the high-complexity group shown in red shading and the low-complexity group in blue shading. The period covered extends from January 2018 to December 2022. *Source:* Author's calculations.

To assess whether this methodological gap contributes to the divergent findings, and to address potential endogeneity from unobserved within-period adjustments, the analysis is complemented with a normalized-index approach tracking the monthly evolution of diversification²² and the annual evolution of complexity from 2018 to 2022, using 2018 as the base year.²³

²²Each monthly observation is compared to the corresponding month in 2018. For example, the index for March 2020 is benchmarked against March 2018, and so on.

²³Diversification is derived from transactional supplier activity, which can adjust rapidly as firms pause, add,

As shown in Figure [II](#), although the high group gradually reverted to its pre-pandemic level of the supply-chain characteristic under analysis, the low group recorded index values in 2021–2022 well above 100. This suggests that the high group’s configuration largely reflects pre-existing robustness and stability, whereas it seems that the low group undertook active adaptive reconfiguration, progressively building more diverse and complex supply networks after the initial shock. These dynamics have important implications for interpreting the earlier regression results, particularly for the recovery phase. The apparent post-vaccination advantage of the low group under the static classification should be treated with caution: some firms initially classified as low may have substantially altered their supply-chain structures during the crisis. Such “switchers” cease to reflect the group’s original structural profile, and their improved performance may bias estimates by making the low group appear more resilient than it was in structural terms.

Overall, the results indicate a consistent pattern: firms with broader supplier networks tended to show greater exposure during the demand collapse but also displayed shorter recovery paths. The data further suggest that firms with initially narrower supplier bases expanded their networks and strengthened inter-sector linkages in the post-pandemic period. These adjustments point to the relevance of scalable supply arrangements, as opposed to static configurations, in shaping observed recovery dynamics.

or switch suppliers - so a monthly index captures these short-run dynamics. Complexity reflects the breadth of upstream sectors, which changes more slowly and is observed noisily at high frequency due to lumpy purchases and intermittent sector appearances - monthly measures would be sparse and volatile.

8. Conclusion

This dissertation analyses how Portuguese firms were affected by a systemic and external shock, the COVID-19 pandemic. The focus is on the role of supply-chain structures and international market dependence in shaping both vulnerability (the depth of the initial downturn) and resilience (the trajectory of recovery). Accordingly, we estimate an event-study design using monthly payment-level data for all Portuguese firms between 2017 and 2022.

The results reveal pronounced heterogeneity across economic activities. Primary and secondary sectors were comparatively less exposed, supported by more stable demand and limited direct contact with consumers. In contrast, the tertiary sector was strongly affected, with the exception of activities with high digitalization or essential-service status. Within this context, Accommodation and Food & Beverage Services (Sector I) emerged as one of the most impacted sector of the Portuguese economy. Despite its economic significance, it remains relatively understudied in the literature, thereby justifying its detailed examination in the present study.

The adjustment of transmission channels within Sector I exhibited significant heterogeneity. The international demand channel proved the most volatile, reflecting border closures and heightened uncertainty, whereas domestic demand acted as a partial buffer and recovered more steadily as restrictions eased, consistent with the substitution towards internal tourism. Downstream sales contracted almost contemporaneously with lockdowns, underscoring the dependence on final consumer demand, while upstream purchases adjusted more gradually, reflecting quasi-fixed input commitments and adaptive procurement. Sectoral vulnerability to systemic shocks is thus closely associated with both demand pressures and the elasticity, composition, and contractual structure of inter-firm transactions.

Within Sector I, firms that were more dependent on exports before the pandemic were those that experienced the largest drop in sales compared to firms with low or no dependence on exports, although they subsequently demonstrated greater resilience during the recovery phase. On the upstream margin, broader and more complex supplier networks were linked to sharper initial contractions, potentially due to coordination costs and procurement rigidities, but also to quicker recovery paths once demand returned. Evidence suggests that firms with fewer suppliers subsequently expanded their networks and deepened inter-sector linkages in the post-pandemic period.

Taken together, the results point to two key implications for Sector I. First, resilience in market exposure appears stronger when domestic demand acts as a countercyclical buffer, complemented by selective and well-managed international engagement that enables firms to benefit from recovery once mobility resumes. Second, firms with scalable supplier networks—lean in structure but adaptable when demand returns—show greater flexibility than those relying on permanently broad procurement footprints. However, it is important to note that both implic-

ations underline the limitations of uniform support measures and the importance of tailoring interventions to the structural characteristics of firms as well as to the nature of the shock.

In sum, this dissertation has identified robust empirical correlations between firm characteristics, supply-chain structures, and patterns of vulnerability and recovery. In doing so, it contributes to the academic literature and provides evidence to inform debates on economic resilience in small open economies. The contribution is particularly timely given the European Union's increasing emphasis on safeguarding critical supply chains, reducing high-risk dependencies, and strengthening stability through enhanced resilience and strategic autonomy (Attinasi et al., 2024; European Commission, 2013).

However, the study's conclusions are subject to some limitations, which also open avenues for future research. The focus on tourism-related activities places greater weight on demand-side dynamics, limiting the role of downstream inter-firm sales in the analysis. Expanding the scope to supply-driven sectors would enable a fuller exploration of downstream effects. Further studies should explore more granular measures of sales and purchases concentration to assess the depth of firm dependencies. Similarly, limited geographic disaggregation, particularly within Food & Beverage subsector, and the inability to separate domestic from international purchases constrained a more detailed understanding of sourcing patterns. Finally, the lack of explicit data on inventories prevented an assessment of their buffering role. These boundaries do not undermine the core findings; rather, they highlight the specificity of the tourism context and point to concrete extensions.

A. Domestic channel - in-depth analysis

As discussed in Section 6.1, the relatively swift and stable recovery trajectory of domestic sales, alongside the comparatively milder contraction observed during the lockdown periods, suggests that internal demand served as a partial buffer against the economic disruption triggered by the COVID-19 pandemic. To further investigate the underlying sources of this observed resilience, it is analytically valuable to disaggregate the domestic sales channel into two distinct components: sales directed to final consumers (final demand) and inter-firm transactions (intermediate demand, often referred to as chain demand).

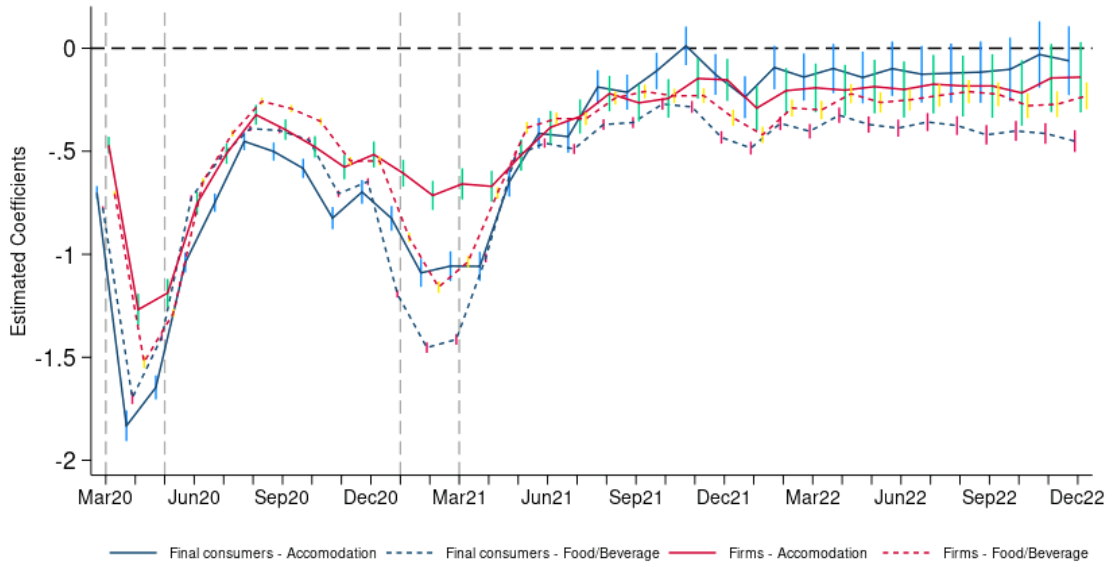


Figure A1: *Event Study Estimates by Firm-Level Outcome: Domestic Sales Disaggregation by Sub-sector*. The figure displays the point estimates of the coefficients β_k from Equation (6.1), along with their corresponding 95% confidence intervals. Standard errors are clustered at the firm level. These estimates represent the monthly deviations from the expected pre-pandemic trajectories for two types of domestic sales within Sector I: final consumer sales (depicted in blue) and firm-to-firm sales (depicted in red). The lines distinguish between sub-sectors, with CAE 55 (Accommodation) shown as solid lines, and CAE 56 (Food and Beverage Services) shown as short-dashed lines. All estimates are conditional on seasonal and firm fixed effects and time trends. The adjusted R^2 values for the corresponding regressions are 0.6933 (CAE 55) and 0.78 (CAE 56) for final consumer sales and 0.7237 (CAE 55) and 0.8064 (CAE 56) for inter-firms sales. The number of observations for the corresponding regressions are 377,867 (CAE 55) and 1,800,482 (CAE 56) for final consumer sales and 325,436 (CAE 55) and 1,718,704 (CAE 56) for inter-firms sales. *Source*: Author's calculations.

As illustrated in Figure A1 in solid lines, within Accommodation subsector, both channels exhibit broadly similar dynamics throughout the pandemic period, reflecting their shared exposure to domestic mobility restrictions and consumption behavior. Nevertheless, a few notable differences emerge.

Sales to final consumers were slightly more affected during the main periods of contraction, most prominently in April 2020, where the decline reached approximately 84% below the pre-

pandemic trend, compared to 71.88% for firm-to-firm sales.²⁴ Following the mass vaccination campaigns in early 2021, final consumer sales recovered more rapidly and more strongly than firm-to-firm transactions. Despite having experienced a decline in demand up to December 2020, it subsequently demonstrated a swift and robust recovery.

This divergence on vulnerability and recovery reflects the relatively higher sensitivity of final consumption to direct lockdown measures, heightened behavioral caution, and reductions in discretionary household spending, particularly given that the sector under analysis is closely tied to leisure-related activities, which are typically among the first to be curtailed during periods of uncertainty. In contrast, business-to-business transactions may have been partially shielded by longer-term contractual obligations, efforts to maintain supply chain continuity, or delayed adjustment mechanisms.

Whereas Section 6.1 examined only the Accommodation subsector (CAE 55), the present analysis broadens the scope to a comparative assessment of CAE 55 (*Accommodation*) and CAE 56 (*Food and Beverage Service Activities*). This extension is motivated by their structural and behavioral heterogeneity and by the availability of data that are not subject to the limitations affecting the export series.

Contrary to what happens in Accommodation, within the Food and Beverage Services subsector, the performance of final consumer sales did not consistently exhibit the most severe contraction. This is particularly evident in the immediate aftermath of the first lockdown, during which final consumer sales rebounded more rapidly. This short-term advantage coincided with the swift operational adaptation of many food service providers, who adopted alternative service models such as takeaway, home delivery, and click-and-collect. These innovations enabled businesses to sustain customer engagement despite the widespread restrictions on in-person dining (Costa, 2021). This adaptability helped mitigate the immediate impact of the crisis and facilitated an earlier recovery phase by aligning with shifting consumption patterns and localized demand. However, this advantage proved to be temporary, as final consumer sales in CAE 56 (Food and Beverage) experienced a more abrupt decline during the second lockdown period compared to CAE 55 (Accommodation), followed by a relatively stable trajectory over the medium term, albeit one that never returned to pre-pandemic levels.

Another divergence within Section I is that, unlike the Accommodation subsector, Food and Beverage Service Activities did not exhibit a stronger recovery in domestic sales, given that none of the channels achieved the prepandemic levels. This pattern can be partially explained by differences in regulatory treatment. Food and beverage establishments were subject to more stringent and prolonged restrictions, including mandatory closures, early curfews, and limitations on indoor service. In contrast, Accommodation providers were, in some cases, permitted to remain partially operational, offering housing to healthcare workers or individuals in excep-

²⁴ $(\exp^{-1.832984} - 1) * 100 = 84\%$; $(\exp^{-1.268785} - 1) * 100 = 71.88\%$

tional circumstances, as outlined in ‘Decreto n.º 3-C/2021, de 22 de janeiro’ (2021). These differences in regulatory regimes translated into varying degrees of operational continuity across the two subsectors.

Structural factors also shaped the divergent recovery paths. For *Accommodation* (CAE 55), the absence of statistically significant linear or quadratic time trends in domestic final-consumer sales supports an interpretation of an event-driven recovery coincided with discrete policy shifts such as the vaccination rollout and the progressive relaxation of travel restrictions. The sharp initial contraction followed by a swift rebound is consistent with highly reactive, shock-sensitive demand. By contrast, *Food and Beverage Service Activities* (CAE 56) exhibit both a statistically significant linear trend ($\delta_1 = 0.00127$) and a positive quadratic trend ($\delta_2 = 0.00954$) in final-consumer sales, indicating a more structurally grounded, gradually evolving recovery driven by internal adaptation and market adjustment rather than by discrete exogenous shocks. The inherently gradual nature of this mechanism helps explain why the sector did not return to pre-pandemic sales levels within the sample period.

It is also noteworthy that, unlike *Accommodation*, inter-firm transactions in *Food and Beverage Service Activities* were less adversely affected than sales to final consumers in 2022. This pattern suggests that the subsector’s recovery depended more on contractual and supply-chain adjustments, such as stable B2B relationships, institutional demand, and platform-mediated intermediation, than on an immediate rebound in discretionary household spending.

Accordingly, when assessing the ability to adapt and maintain operations during acute disruption, final-consumer sales emerge as the weakest channel across both subsectors. Their heightened sensitivity to regulatory constraints, behavioral responses, and reductions in discretionary expenditure rendered them particularly susceptible to demand shocks. In contrast, when evaluating the capacity to return to pre-crisis performance levels, a clear divergence is apparent. Only the *Accommodation* subsector displays meaningful signs of resilience across its domestic channels, whereas *Food and Beverage Service Activities* (CAE 56) show no such recovery in absolute terms. Despite evidence of gradual adaptation and structural adjustment, both domestic channels in CAE 56 remained persistently below their pre-pandemic benchmarks throughout the observation window.

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B. Annexes

Methodological note

All supplementary materials not reproduced in the main text are available in a public repository hosted on a ([GitHub repository](#)). The repository includes the complete version of the regressions and graphs (folder 'outputs') and the scripts used to construct figures and tables (folder 'work_area'). Any confidential or access-restricted data (microdata obtained via BPLIM) are not redistributed and remain subject to the provider's terms of use.

Tables

Table B1: Relative Contribution of Each Sector to Aggregate Sales in 2018 (percentage)

CAE Rev. 3 Section (Level 1)	% Sales
Wholesale and retail trade (G)	34.3474
Manufacturing (C)	22.0819
Financial and insurance activities (K)	5.6865
Transportation and storage (H)	5.6093
Electricity and energy (D)	5.2055
Construction (F)	4.2676
Administrative and support service activities (N)	3.5652
Information & communication activities (J)	3.5363
Consultancy, scientific and technical activities (M)	3.2812
Accommodation and food service (I)	3.0765
Human health (Q)	2.8502
Agriculture (A)	1.3419
Real estate activities (L)	1.2314
Water (E)	0.8829
Public administration and defence; compulsory social security (O)	0.8682
Arts, entertainment, sports and recreation activities (R)	0.7904
Education (P)	0.5672
Other service activities (S)	0.5533
Mining and quarrying (B)	0.2572

Note: (A) Agriculture, farming of animals, hunting and forestry; (B) Mining and quarrying; (C) Manufacturing; (D) Electricity, gas, steam, cold and hot water and cold air; (E) Water collection, treatment and distribution, sewerage, waste management and remediation activities; (F) Construction; (G) Wholesale and retail trade; repair of motor vehicles and motorcycles; (H) Transportation and storage; (I) Accommodation and food service activities; (J) Information and communication activities; (K) Financial and insurance activities; (L) Real estate activities; (M) Consultancy, scientific and technical activities; (N) Administrative and support service activities; (O) Public administration and defence, compulsory social security; (P) Education; (Q) Human health and social work activities; (R) Arts, entertainment, sports and recreation activities; (S) Other service activities *Source:* Author's calculations.

Table B2: Descriptive Statistics by Export dependence group: No dependence, Low dependence and High dependence

Group	No	Low	High
Number of firms	3,447	2,773	2,774
Number of observations	114,130	147,171	147,362
<i>Monthly Averages (Standard deviation)</i>			
Total sales	15,824.20 (148,327.30)	24,195.27 (80,905.06)	127,211.60 (467,030.30)
Exports	642.61 (18,509.60)	2,459.66 (13,570.17)	70,249.75 (276,899.50)
Purchases from firms	12,183.61 (206,308.80)	15,072.73 (120,480.90)	72,359.84 (385,376.50)
Number of employees	2.55 (11.39)	6.36 (12.79)	23.56 (61.68)

Note: The table presents mean firm-level characteristics, disaggregated by degree of export dependence, with standard deviations in parentheses. Export dependence groups are defined according to the mean of the annual share of exports in total sales during the pre-pandemic period (2017–2019): No dependence (= 0), Low dependence (< 22.10%) and High dependence (> 22.10%). All monetary values are expressed in real terms (euros, base year 2012). Figures are calculated for the period 2017–2022. *Source:* Author's calculations.

Table B3: Descriptive statistics by supply chain characteristic groups: Low and High diversity or complexity

	Diversity		Complexity	
	Low	High	Low	High
Number of firms	11,213	11,204	13,106	12,071
of Accommodation (CAE 55)	2,229	2,227	2,272	2,328
of Food & Beverage (CAE 56)	8,954	8,977	10,834	9,743
Number of observations	374,901	676,482	421,663	731,912
<i>Monthly Averages (Standard deviation)</i>				
Total sales	5,815.44 (53,179.48)	78,206.83 (348,746.40)	6,693.65 (63,682.75)	71,616.87 (43,814.01)
Purchases from firms	3,890.76 (65,447.21)	47,768.18 (249,718.10)	4,763.92 (67,100.66)	43,814.01 (247,938.20)
Share from Sector G (%)			51.20 (31.25)	53.40 (22.65)
Share from Sector C (%)			9.27 (14.04)	10.00 (11.05)
Share from Sector F (%)			1.14 (8.07)	2.83 (9.55)
Share from Sector I (%)			2.32 (10.20)	3.97 (10.10)
Share from Sector K (%)			8.13 (20.46)	5.97 (9.07)
Number of employees	1.68 (6.18)	19.78 (87.39)	2.07 (6.09)	18.09 (84.14)
National acquiring firms	10.72 (7.01)	53.32 (42.57)		

Note: The table presents mean firm-level characteristics, with standard deviations in parentheses, disaggregated by diversity and complexity groups. Diversity is measured by the number of national acquiring firms, and complexity is measured by the number of distinct sectors from which a firm procures inputs. High and low groups correspond to the two extreme quartiles of each supply chain characteristic, excluding firms with null values; classifications are subsector-specific, covering Accommodation (CAE 55) and Food and Beverage Service Activities (CAE 56). Values are calculated for the period 2017–2022, with all monetary variables expressed in real terms (euros, base year 2012). *Source:* Author's calculations.

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