WEST UNIVERSITY OF TIMIȘOARA
DOCTORAL SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION

ABSTRACT OF THE DOCTORAL THESIS

Supply Chain Management and Financial Performance

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ABSTRACT

The onset of the fourth industrial revolution since 2011, simultaneously with the conceptualisation of the Industry 4.0 paradigm, marked the transition of the global economy into a new era, defined by digitisation and extensive use of technologies. In this context, the starting point of the transformations is marked by production and logistics processes, which have undergone major transformations at operational and managerial level. The transition from automation implemented during the second industrial revolution to digitalization and extensive use of technologies in the current context presents a major challenge for companies' resource management.

The PhD thesis *aims* to identify the relationship between supply chain-specific resources and activities and financial ones, and how they are correlated in order to propose strategies that maximise economic growth and financial performance through enhanced supply chain performance.

The overall research objective of the proposed PhD thesis "Supply chain management and financial performance" was to identify the relationship between supply chain performance and economic growth, respectively, financial performance. The achievement of this objective relates to two distinct aspects. On the one hand, we have carried out the supply chain approach at the macroeconomic level, to reveal the typology of the relationship with economic growth. On the other hand, the relationship between supply chain performance and company financial performance is analysed through a microeconomic approach. A series of specific research objectives of the PhD thesis have been outlined, to capture economic growth and financial performance through the prism of indicators influenced in a direct way by logistics issues and to propose strategic directions in supply chain management for enhancing economic growth and financial performance, as follows:

⇒ integrating some overall reflections on the Industry 4.0 paradigm at supply chain level:
- analysis of the implications of the Industry 4.0 paradigm on supply chain management, considering micro and macroeconomic approaches
- review of the literature on the applicability of lean, agile and leagile practices and their development in the context of the fourth industrial revolution, respectively the selection of the most relevant studies by authors in this field, as methodological benchmarks for the proposed analyses

⇒ contextualising the relationship between supply chain performance and economic growth:
  - outlining the theoretical framework on the relationship between supply chain performance and economic growth, by identifying specific indices
  - empirical analysis of the relationship between supply and distribution chain performance and economic growth, preceded by the identification of the most robust research methodologies applicable to the proposed empirical analyses

⇒ empirical analysis of the relationship between supply chain performance and financial performance of automotive companies

⇒ consideration of the implications of the current industrial paradigm, the evolution of cost and flexibility-oriented practices and a strategic foresight in the context of contemporary world challenges

⇒ outlining strategic directions for supply chain management to promote economic growth and financial performance of companies.

The proposed research *addresses* both academics and practitioners, both in the public and private sectors. Firstly, by addressing supply and distribution chain management in the context of Industry 4.0, the proposed PhD thesis constitutes a highly relevant investigation from a theoretical perspective, capturing all the implications of the new revolution, from the presentation of relevant technologies, to the assessment of process transformation to mark the leagile typology and respectively to the detailed examination and use in the empirical analysis of a significant number of logistics factors collected from the Logistics Performance Index (LPI) and Global Competitiveness Index (GCI) studies. Secondly, from an empirical perspective, the case studies represent in-depth examinations of the relationship between logistics factors and economic growth and financial performance.

In an academic context and from a practical perspective, we believe that the products of the scientific investigation can be *exploited from multiple perspectives*. From a *macroeconomic perspective*, public sector entities can assess, through the analysis carried out, the results of current strategies and identify the potential for expansion through the implementation of the proposed strategic directions. Moreover, the current legislative framework can be subject to an efficiency analysis, for example through customs procedures, investment in transport infrastructure or policies for the continuous development of human capital skills. At the microeconomic level, the study can serve as a valuable tool for stakeholders of companies' financial performance. Thus, for internal stakeholders, the results

of the analysis can be a starting point for considering the relationship between logistics factors and financial performance already at the stage of operational processes and procedures at company level. Consequently, the transition can be made from an approach that evaluates the results achieved, to a pro-active strategy that incorporates the financial implications of decisions in the operational area. In this way, the company can develop the agility to make informed decisions, implementing predictive analytics to avoid potential losses, exploit opportunities to reduce costs and differentiate itself in the market, in the context of ensuring sustainability. For external parties, the research can be used as a model for analysis as the approach used is based exclusively on public data of multinational companies, available to any investor, competitor, supplier, creditor, employee, or competitor.

The originality of the PhD thesis is highlighted by:

- ⇒ complex approach, from a theoretical and empirical perspective of the link between supply chain performance and economic growth, respectively financial performance;
- ⇒ reviewing the state of knowledge in the field by considering the latest perspectives on the relationship between supply chain performance and economic growth, respectively financial performance of companies;
- ⇒ robustness of the results obtained: thus, the case studies developed in the PhD thesis include a variety of econometric models: fixed and random effects model and principal components analysis. The empirical analyses include an extensive selection of data collected for a range of 35 countries and companies (in the automotive industry), so that the results obtained can be interpreted as a whole. In terms of industrial and technological aspects, there is an extensive references describing the new industrial context and suggesting innovative conceptual approaches. However, we have identified in the studies carried out a lack of use of quantitative empirical perspective to assess the relationship between the new industrial order (at the logistical level) and economic and financial outcomes. Examining the construction of supply and distribution chain performance indices through the lens of the relationship with economic and financial aspects is also a step forward in deepening our understanding of the field;
- ⇒ furthermore, the integration of strategic directions based on the theoretical aspects identified and the empirical results obtained, adds originality to the scientific approach. The proposed PhD thesis outlines policy implications at both national (macroeconomic) and company level by considering possible strategic directions based on case study results. Consideration of the recent context, the Covid-19 pandemic (and the financial

crisis it generated) and the impact generated at macro and microeconomic level is an additional value added to the proposed research.

Investigating economic growth and financial performance from the perspective of logistics factors is a topical issue in research, in analyses carried out by various national and international organisations and it is one of the priorities of companies in the industrial sector. The context and developments in current economic phenomena have drawn attention to the investment in production and logistics, which are needed to remain competitive in the global market. At the macroeconomic level, a competition has been generated, based on the development of infrastructure, institutions and human capital and the promotion of innovation through legislative, fiscal, technological, and educational initiatives.

Unlike at the beginning of the millennium, when rapid technological development was able to attract customers by itself, in the current context, the end customer is no longer willing to sacrifice innovation or cost as key elements underlying his purchasing decision. Thus, market expectations have transformed the singularity of competitive advantage into a multi-faceted concept. Competitive advantage is the company's ability to simultaneously optimise multiple aspects, such as innovation, product quality and cost, product access and the ability to deliver the product within the expected timeframe. The elements listed above therefore involve not only keeping the company up to the technological and innovation standards of the moment, but also balancing the operational aspects of production and logistics, aiming at cost and flexibility levels in line with market expectations.

Moreover, the context of the 2020-2023 period, marked by the Covid-19 pandemic, has emphasised the importance of competitiveness supported by logistics factors in the markets. On the one hand, the onset of the pandemic has challenged global supply and distribution chains in the industrial sector to continue their operational activities in the light of the difficulties created by supply-demand imbalances. The efficiency of customs procedures, the ease of organising shipments at competitive prices, the quality of trade and transport infrastructure, the competence and quality of logistics services and the timeliness of shipments were placed in unprecedented contexts at the onset of the pandemic. While multinational companies benefited from the flexibility generated by a global presence to support operations in the worst affected countries, local companies faced major difficulties. Most small and medium-sized enterprises have not benefited from flexibility in operations, in working with multiple suppliers or having considerable financial reserves, and this disadvantage has the potential to widen the gap with competitors with multinational status.

Currently, companies that have experienced a drop in market demand are forced to restore their operations to pre-pandemic levels once demand picks up. Likewise, companies that have experienced steady demand but have implemented drastic measures to cope with the limitations of this period must redefine their internal operational standards to ensure a consistent standard of quality, regardless of fluctuations that may occur.

The motivation for the choice of the theme of the scientific approach is derived from theoretical and empirical analyses and recent macro and microeconomic reports that have increased the focus on logistics issues. *The PhD research topic is relevant in the current economic context, as performance and process optimisation in the supply chain are essential elements for the success and competitiveness of a company.* The rise of companies that have placed supply chain management at the centre of their strategy has signalled the shift of logistics potential into the realm of competitive benefits that can be leveraged. By focusing the research on companies in the automotive industry we assess supply and distribution chains that are by far characterised by the highest process complexity, considering that the 100 selected companies supply components to major car manufacturers. The demand of this market and the related logistical expectations imply unique degrees/levels of planning, efficiency, and performance. The evolution of the automotive industry is a topical issue both in the context of the changes brought about by Industry 4.0 and in the context of sustainability and the interest in advancing electric technologies over fossil fuel-based ones. To cope with these simultaneous transitions, identifying exploitation opportunities to save or reduce losses at the supply chain level are competitive advantages to maintain and increase financial performance.

The references of the PhD thesis includes both international and national articles, most of them in the field of social and economic sciences. The scientific papers/articles, books, reports, and legislation cited in the PhD thesis focus on three main issues: the supply chain in the context of the fourth industrial revolution, including related technological and performance measurement concepts, methodologies for assessing economic growth, and methodologies for assessing financial performance at company level. The use of a selection of engineering papers is justified by the need to deepen the understanding of contemporary technological issues in order to formulate strategic directions in the field. *This theme has also been taken up in scientific articles published during the doctoral research and presented at international scientific conferences.* During the doctoral research, five articles related to the PhD thesis were published, including 1 scientific article published in an ESCI-indexed journal and 4 scientific articles published in scientific journals indexed in international databases. Dissemination of research results was also achieved through 7 participations in international conferences, of

which 3 participations in international conferences held outside Romania and 4 participations in international conferences held in Romania.

The research methodology includes state-of-the-art empirical econometric methods, respectively statistical models and data set modelling tools such as: correlation analysis, multiple statistical models (fixed and random effects model, least squares method) and principal component analysis. The empirical methods used in the proposed PhD thesis are qualitative (content analysis, respectively contextualization of the Industry 4.0 paradigm at the supply chain level) and quantitative, contributing to the two proposed objectives, i.e. analysis of the relationship between supply chain and economic growth and analysis of the relationship between supply chain and companies' financial performance.

The statistical data samples selected for analysis are representative and of significant size, providing an opportunity to place the two case studies carried out in the context of current literature. Thus, 35 countries were selected: the European Union Member States, the United Kingdom, and 7 other developed economies (according to the "Logistics Performance Index" and the "Global Competitiveness Index" rankings). The data selection is consistent with the selected literature, particularly in terms of regulatory literature. The second case study, which aims to analyse the relationship between supply chain and financial performance, includes 100 multinational companies in the automotive industry, based in the above-mentioned countries (most of them). The exceptions are companies that, although headquartered in other countries, have significant global activities.

The data sources used for the empirical analyses carried out are collected and processed from official, internationally recognised statistics, such as the World Bank for the economic growth indicators and the Logistics Performance Index, and the World Economic Forum for the Global Competitiveness Index. Statistical data for the companies analysed were collected from published annual reports available online on the website of each selected company. The empirical analyses resulting from the scientific approach are robust due to the varied research methods and tools applied. Stata statistical software was used for the econometric analyses and the construction of graphical representations, the process of collecting and processing the databases into panel datasets was carried out in Microsoft Excel spreadsheets, and Microsoft Word was used for the drafting of texts specific to the scientific papers.

The elaboration of the present scientific approach, targeting the macroeconomic and microeconomic levels, provides a holistic perspective on the current situation, the success of organisations being dependent on the ability to reconcile and synchronise public and private sector strategies. The study of the macroeconomic sphere allows us to detect, first of all, the

degree of adoption and implementation of supply chain factors that can support economic growth. Secondly, there is the possibility to monitor the revision of current policies by identifying gaps in legislative, fiscal or technological process integration strategy. The analysis of supply chain performance in automotive manufacturing companies facilitates an in-depth understanding of the Industry 4.0 paradigm, mainly focused on asset and inventory management, information that can be leveraged by any stakeholder within multinational companies.

The results of the empirical studies may prove useful for future theoretical and empirical research, both in the public and private sectors.

Firstly, *macroeconomic research* can provide a solid basis for assessing economic growth through the lens of logistical factors, so that stakeholders can obtain a realistic assessment of the degree of implementation of the elements that strengthen economic performance. Moreover, by addressing the logistical factors influenced and transformed by the new industrial paradigm, it is possible to identify the benefits as well as the limitations of current policies, whether of a legislative, fiscal or private sector investment nature. This can determine whether the macroeconomic level is setting the right trajectory for development, or whether more advanced policies are needed to synchronise with private sector requirements. The 35 countries included in the analysis also provide a starting point to strengthen a comparative analysis between industrial development programmes such as "Industry 4.0" in the European Union, "Smart Manufacturing" in the United States and "Made in China 2025" in China.

Secondly, *the microeconomic study* covering companies in the automotive industry has potential for expansion or replication. We can, for example, add to the analysis manufacturers of raw materials essential to the industry. Also, the inclusion of automotive manufacturers would allow a holistic view of the supply chain of this sector. We can then assess the two main types of suppliers - raw materials and components, resulting in a comprehensive analysis of car manufacturers, whose efficiency in supply chain processes depends to a large extent on the performance of component and logistics manufacturers. In addition, the analysis method can also be applied to other industrial sectors, allowing the comparison of different logistical factors that can influence a company's financial performance. At the same time, such research can provide a comprehensive insight into the factors relevant for sustaining the main industrial sectors.

The PhD thesis is structured in four chapters, the first of which delineates the terminological parameters, the next two chapters contain the empirical analyses, and the last

chapter is dedicated to presenting the implications at the policy level adopted both at national (macroeconomic) and company level, by considering possible policy directions, based on the results of the case studies.

Chapter 1. Reflections on supply and distribution chain management in the context of the fourth industrial revolution places the research in the context of the fourth industrial revolution, contextualising the Industry 4.0 paradigm at the supply chain level. The chapter starts by delineating the terminology of the Industry 4.0 paradigm and assessing its implications in the supply chain, with the aim of identifying the underlying principles and the value added generated. As part of the research carried out, we examined the strategies adopted by various advanced and emerging economies in applying the Industry 4.0 concept. This can be either an active objective promoted by legislation or a private sector-initiated direction of a process harmonisation nature. The analysis of the implications at microeconomic level implies a deeper analysis of the technological elements that are decisive factors for market differentiation and competitive advantage. We also carry out an assessment of the progress of the application of lean and agile methods in the supply chain, based on the Industry 4.0 paradigm. The related subchapters reveal the distinct evolution of lean and agile methods over the last decade in the context of the emergence of a set of new tools with the potential to transform the application of these methods in the operational context of logistics. Moreover, the adoption of the lean concept facilitates the full transition of lean and agile practices in the context of Industry 4.0, in line with market expectations.

Chapter 2. Contextualising the relationship between supply and distribution chain performance and economic growth addresses the relationship between supply chain performance and economic growth. Starting from the contextualisation of established models for assessing supply chain performance, the first section of this chapter sets out the theoretical foundation for the case study research methodology. The SCOR model represents the conceptual framework that places elements of the Industry 4.0 paradigm and the approach to lean, agile or leagile practices in an operational context at the level of the company and its logistics partners. Through detailed analysis of the Logistics Performance Index (LPI) and the Global Competitiveness Index (GCI), the study considered the most commonly used measures of logistics performance as key aspects of the supply chain. Endogenous growth theory presents the initial premise for the selection of economic growth indicators. The empirical analysis of the relationship between supply chain performance and economic growth starts with the description of the data sets selected for the case study, i.e. for 35 countries, for the period 2010-2018, considering the fixed and random effects model and principal components analysis.

Specifically, the dependent variables collected from the World Bank Open Data platform, calculated as a percentage of Gross Domestic Product (GDP), are: Exports of goods and services (EXP); Imports of goods and services (IMP); Domestic flow of Foreign Direct Investment (FDII); External flow of Foreign Direct Investment (FDIO) and Value added in industry (including construction) (IND). The independent case study variables are based on the World Bank studies "Connecting to Compete, The Logistics Performance Index" and "Global Competitiveness Report". Thus, the independent variables collected from the LPI include: Overall LPI score (LPI); Efficiency of customs and border control procedures (CUST); Quality of trade and transport infrastructure (INFR); Ease of arranging shipments at competitive prices (INTS); Competence and quality of logistics services (QUAL); Ability to ensure traceability of freight shipments (TRT) and Frequency with which shipments arrive at the consignee within scheduled or expected delivery times (TIM), while the independent variables collected from the GCI are the scores for: Institutional environment (P1); Infrastructural environment (P2); ICT adoption environment (P3); Macroeconomic stability environment (P4); Human capital health (P5); Human capital skills (P6); Product market (P7); Labour market (P8); Financial system (P9); Market size (P10); Business dynamism (P11) and Innovation capability (P12). The data collected for the case study represent percentage values and include the 28 EU Member States (including the UK) and 7 other countries, namely Canada, China, Hong Kong, India, Japan, South Korea, United States of America. The fixed and random effects model involved two types of analysis: an analysis considering LPI indicators as independent variables and an analysis considering GCI indicators as independent variables. Thus, each of the 5 dependent variables was matched with 2 different models in order to identify, in a comprehensive manner, the relationship between LPI and GCI factors and economic growth. Principal component analysis (PCA) involved the construction of two separate models to reduce the data set. For the sub-sample of European Union (EU) member countries, the random effects models showed a dependence of exports, imports and value-added industry on the level recorded in the previous year. The level of exports to EU member countries increases with the ease of organising international shipments at competitive prices, the competence and quality of logistic services and the frequency with which shipments reach their recipients within the estimated delivery time. Infrastructure and market size have a negative influence on exports, but for EU Member States these two pillars have proven to be statistically significant in determining the level of exports of goods and services. Imports are directly influenced by the frequency with which shipments reach their recipients according to the estimated delivery time and the innovation capacity. At the other end of the spectrum, health and market size are pillars

of the GCI that limit the level of imports. Foreign FDI flows are negatively influenced by the infrastructure and health pillars. FDI outflows are directly influenced by the ability to track and trace shipments and the frequency with which shipments reach their destinations within the estimated delivery time. The results of the study revealed that some pillars of the GCI have a direct influence on economic growth (institutions, labour market, financial system), while others have an indirect influence (macroeconomic stability, health, skills). Generalising and considering the countries included in the analysis, our findings indicated that the pillars of the GCI tend to have a direct relationship with imports, exports and FDI flows. Thus, a favourable institutional environment, including political stability, the rule of law, efficient public administration and transparency in regulatory processes, can create an attractive business climate for foreign investors. A well-developed infrastructure, i.e. transport networks, telecommunications and energy infrastructure, can also facilitate international trade and exports. The use of modern technology can enable businesses to access new markets and engage in international trade more efficiently. At the same time, foreign investors are attracted to countries with macroeconomic stability, as it reduces the risk of volatility and can contribute to sustainable business growth, complemented by the availability of a skilled and healthy workforce. An efficient labour market with well-trained and flexible workers can help boost competitiveness and exports. Investment in education, training and health care can increase the skills and productivity of workers, which can encourage foreign direct investment and exports. A well-developed product market with strong domestic and external demand can attract foreign investment and increase exports. At the same time, access to finance and efficient financial services can support foreign investment and exports. The ability of companies to innovate and adapt quickly to market changes can boost exports and foreign direct investment.

Chapter 3. Contextualising the relationship between supply chain performance and companies' financial performance is based on the theory proposed by DeSmet (2018), outlining a LAD triangle that includes: service, cost and cash. Starting from the three dimensions, theorists and practitioners can evaluate the company's financial, operational and strategic decisions. The case study analyses 100 companies in the automotive industry for the period 2010-2019; similar to the previous chapter, the empirical analysis considers the fixed and random effects model and principal components analysis. The companies come from 16 sub-sectors that produce components for the automotive industry either exclusively or as a high proportion of their turnover. The dependent variables selected for the case study represent financial performance indicators commonly used in theory and practice to assess company performance, namely: Return on Assets (ROA); Return on Total Assets (ROTA); Return on

Capital Employed (ROCE); Return on Equity (ROE) and Return on Sales (ROS). The independent variables included in the case study are indicators calculated on the basis of financial information published by companies to reflect issues directly related to LAD (considering the structure of company assets and stocks), respectively: Fixed Assets to Total Assets Ratio (FATA); Fixed Assets Turnover Rate (SAFA); Asset Structure Ratio (ITA); Inventory Turnover Rate (ITO); Asset Turnover Rate (TATO); Fixed Assets Turnover (FATO) and the Ratio of Accumulated Depreciation to Fixed Assets Value (FADE). The results of the case study indicate that asset utilization efficiency - expressed by fixed asset turnover rate (SAFA), asset turnover rate (TATO) and fixed asset turnover (FATO) - and storage and distribution efficiency - expressed by inventory turnover rate (ITO) - are the most relevant variables in the constructed models. The results of the study are in line with the literature findings that a lean supply chain generates sustainable financial performance. Sustainable performance is also driven by the efficient use of supply chain assets - the use of fixed assets to generate sales, efficient asset structuring and effective inventory turnover. These features contribute to improved financial results by minimising costs and promoting flexibility and adaptability of the LAD in line with market expectations. When looking at companies in the fast-moving automotive industry, the concept of leagile is all the more relevant as plants, equipment, R&D investments, and inventories are core issues for these companies. With regard to asset management and inventory turnover indicators, the results confirm that organisations perceive supply chain management as essential to secure a competitive advantage in a volatile market. From an asset management perspective, companies should look at business efficiency in relation to the useful life of assets. Finally, optimising the operational activity of companies can be achieved by assessing the supply chain, including planning, sourcing and performance.

Chapter 4. Strategic planning and policy development for effective supply chain management outlines the policy implications at both national (macroeconomic) and company level, formulating possible strategic directions for promoting:

⇒ economic growth, targeting:

- institutions: simplifying customs procedures and border controls (where appropriate), promoting strategic partnerships, modernising institutions and the legislative framework, implementing quality standards;
- infrastructure: improving the quality of transport infrastructure, developing supply chains to ensure competitive trading conditions;
- innovation: automation and digitisation of supply chain processes, use of predictive analytics technologies, innovation in services and customer relations;

- human capital: skills development, continuous training, effective leadership.

⇒ financial performance of companies, considering:

- supply chain structure: optimisation of supply chain activity, optimisation of distribution network, use of emerging technologies, adaptability;
- asset structure: making "smart" investments in infrastructure and equipment, optimising asset lifecycle, reducing asset ownership and maintenance costs; coordinating planning, production and distribution between the different entities in the supply chain to optimise the use of resources and reduce operational time and costs;
- Optimal inventory structuring: implementation of inventory management methods such as Just-in-Time (JIT) and lean to minimise excess inventory and reduce associated costs, use of advanced IT systems and inventory management solutions to monitor and control inventory in real time, implementation of key performance indicators (KPIs) and constant monitoring of inventory management performance.

The results of the scientific approach revealed that in the current context, at both macro and microeconomic levels, supply chains require an unprecedented level of flexibility to adapt to uncertainty and volatility. At the macroeconomic level, policy makers have been put in the position of having to make decisions and changes to internal and external flows in a context of short and long-term uncertainty. In this challenge, responses at the global level can be categorised into economies that have focused on maintaining stability at the national level, avoiding cooperation with other economies, and economies that have invested considerable effort and resources to maintain a level as close as possible to pre-pandemic normality, in which institutions function effectively at the national and international level. The analysis showed that financial performance and economic growth are correlated with supply chain performance.

KEYWORDS: supply chain; Industry 4.0; Logistics Performance Index; Global Competitiveness Index; economic growth; financial performance; stock structure; fixed effects model; random effects model; principal components analysis

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