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Modelling framework of the Tandem Supply Chain Efficiency and Sustainable Financial Performance in the Automotive Industry*

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Abstract

The research examines the causal relationship between supply chain efficiency and sustainable financial performance based on the evidence from the literature dealing with a transition from financial decision-making based on the financial outcome, including financial rationale in supply chain design, operations, and management. The case study has included 100 companies selected from the automotive production sector over ten years, from 2010 to 2019. Methodologically, the study includes statistically fixed and random effects models, considering within

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the model parameters as dependent variables asset and efficiency-based ratios and as independent variables financial performance ratios related to returns on assets, equity, capital expenses, and sales. The selection of the fixed or random-effects model is accomplished by performing the Hausman test. The results of panel analysis indicate a causal relationship for the proposed models, highlighting the importance of efficiency ratios such as Fixed Assets Turnover Ratio, Total Assets Turnover Ratio, and Fixed Assets Turnover. From practitioners` perspective, the models` construction and the paper's results gain insight into strategic supply chain areas that can be prioritised for increased efficiency and corporate competitiveness, promoting sustainable financial performance through asset structure, asset efficiency, and inventory management.

***Key words**: supply chain, sustainable financial performance, corporate competitiveness*

***JEL classification:** G30, F63, G39*

1. Introduction

The paper aims to research the causal relationship between supply chain efficiency and sustainable financial performance. In the context of the fourth industrial revolution, which implies high-speed digitalisation and virtualisation, companies in the automotive sector are faced with the challenge of balancing order qualifying and winning criteria. As the current context implies transitioning from clearly defined lean and agile practices to a 'leagile' set-up, the company can balance supply chain efficiency and sustainable financial performance. Based on an extensive panel data set, the present research outcome is an overview of what factors to focus on, targeting diverse stakeholders, researchers and practitioners. The research includes 100 multinational companies with a global presence from the automotive and industrial sector, selected from 13 different countries and across all major sub-sectors that supply the original equipment market for car manufacturers and the replacement markets worldwide. Based on a reliable data set for top performers across the industry, the resulting analysis provides a valuable insight into what strategic directions must be focused on from a supply chain perspective to promote a company's sustainable financial performance. Based on a substantial literature review (Qi et al., 2016; Gligor et al., 2015; Lee, 2004; Chan et al., 2017; Naim and Gosling, 2011; Maropoulos et al., 2008; Hartini and Ciptomulyono, 2015) that puts together theoretical and empirical analyses from a modern perspective on the supply chain, the research is based on a 'leagile' concept rather than strictly 'lean' or 'agile' ones. The study is anchored in the full-scale approach to lean supply chain management, following Moyano-Fuentes et al. (2021). Starting from DeSmet's (2018) theory on the three cornerstones of supply chain performance – service, cost, and cash – the paper uses the learnings of recent research that emphasise the importance of supply chain for the company's long-term sustainable financial performance.

The paper hypothesis is that there is a causal relationship between supply chain efficiency (assessed by employing ratios based on assets' structure and efficiency ratios: Fixed Assets to Net Worth Ratio (FATA), Fixed Assets Turnover Ratio (SAFA), Inventory to Assets Ratio (ITA), Inventory Turnover Ratio (ITO), Total Assets Turnover Ratio (TATO), Fixed Assets Turnover (FATO) and Accumulated Depreciation to Fixed Assets Ratio (FADE)) and sustainable financial performance (assessed through return-based ratios: Return on Assets (ROA), Return on Total Assets (ROTA), Return on Capital Employed (ROCE), Return on Equity (ROE), and Return on Sales (ROS)).

Elgazzar et al. (2012) and Wagner et al. (2012) approach provides an overview of assets' structure and efficiency, aiming to consolidate the selected focus of the 10-year data analysis. The empirical case study, tailored to use ratios derived from the assets structure, can be used in conjunction with turnover and sales-based indicators to provide proxies for supply chain efficiency. Our case study has selected financial performance indicators that are accessible to both internal and external stakeholders. All the data used is publicly available for the listed companies. Return on assets ratios is our approach to connecting supply chain relevant figures (total assets, fixed assets, inventory, depreciation) with financial performance. Return on capital and equity includes the stakeholder's critical approach to analysing performance. And last but not least, return on sales is a financial indicator that most stock exchange websites display already calculated for interested parties, as it is a commonly used approach.

Moreover, the dependent variables in our case study represent various approaches to investigating asset structure and turnover, including a depreciation-based indicator as well. By calculating ratios – such as Fixed Assets to Net Worth Ratio (calculated as the ratio between fixed assets and total assets), Fixed Assets Turnover Ratio (calculated as the ratio between sales and fixed assets), Inventory to Assets Ratio (calculated as the ratio between inventories and total assets), Inventory Turnover Ratio (calculated as the ratio between inventory and turnover), Total Assets and Fixed Assets Turnover Ratio (calculated as the ratio between total aspects, respectively fixed assets, and turnover) and Accumulated Depreciation to Fixed Assets Ratio (calculated as the ratio between fixed assets and depreciation) – the authors attempt to touch on the importance of asset structure in industrial companies. The selected ratios and their use described in the methodology section of the paper are rather innovative in the field, frequently used by practitioners, but not until recently identified in the literature review.

Operational and strategic implications can be assessed based on the case study results, from insight derived from indicators related to assets structure, assets efficiency, warehousing and distribution efficiency, and inventory management. The analysis results are relevant for the automotive and industrial sectors and can support an objective assessment of supply chain opportunities. However,

the prioritisation of lean and agile practices, high or low inventory levels, and investment in plant and equipment must be analysed concerning the company's current data, indicators that are only available to internal stakeholders.

The current research attempts to contribute empirical evidence that practitioners could consider in elaborating efficient supply chain management that promotes sustainable financial performance through asset structure, asset efficiency, and inventory management. Therefore, our findings demonstrate our hypothesis that there is a positive causal relationship, by considering efficiency factors and applying the fixed and random effects models to estimate the causal link with financial performance. Overall, the research is a significant empirical assessment of the importance of supply chain efficiency in the context of current market expectations, focusing on accessible areas that can be further broken down into more area-specific assessments.

The paper is structured into six sections; the introduction, followed by the literature review, including the current state of the art, and the empirical study section. The remainder is outlined in four separate sections: material, methods, empirical data and analysis, results and discussion, followed by the conclusion and references.

2. Literature review

The literature review lays the foundation for our case study, starting by outlining the importance of assessing efficiency and performance. The authors identify key issues to address in the case study based on previous research that pinpoints currently relevant supply chain efficiency and financial performance aspects. Furthermore, a starting point for the econometrical study is the review of studies that have previously connected supply chain and financial aspects. Finally, theoretical studies that emphasise the evolving dynamics of the two fields complete the review.

Cook and Hagey (2003) conclude, from the analysis of 160 US-based companies, that 'over 85% of senior executives of companies declare that increasing performance in the supply chain is one of the top priorities but less than 10% of companies properly monitor performance'. Myerson (2012) highlights the importance of supply chain performance and efficiency indicators for increasing competitiveness and enhancing financial performance. The author's hypothesis for the cost-focused analysis is that efficiency in the supply chain is conducive to increased profitability, proper use of resources, and long-term cost reduction.

Son et al. (2016) have analysed reporting from 145 Fortune 500 companies to evaluate to what extent supply chain information is included. The empirical investigation reveals that nearly 60% of the reports on companies include supply chain information related to inbound and outbound aspects, most of them outlining

industry effects. The study demonstrates that companies with positive supply chain information tend to influence the analyst recommendations for buying, selling, or holding the stock. Based on this overview, the current paper attempts to find how supply chain efficiency and financial performance indicators already widely used by both internal and external stakeholders can be employed to reflect the positive correlation.

Research from the past decade signals the companies' transition from a purely lean or agile supply chain towards a balanced 'leagile' approach. Whether a company is leagile is harder to narrow down through supply chain efficiency or financial performance indicators as the strategy can look different at different points in time: a combination of lean and agile across the supply chain or an alternating lean and agile approach. The choice is dictated by the market requirements and their rapid evolution, requiring companies to either adapt cost-wise or efficiency-wise. Based on this need, our empirical work attempts to introduce several ratios for supply chain efficiency and financial performance and establish their relationship. We hypothesise that efficiency in the supply chain is a crucial driver for sustainable financial performance within companies in the automotive industry.

Qi et al. (2016) distinguish between 'order winner,' as the differentiator, the value creation that wins the customer, and 'order qualifier,' as the primary market entry criteria are met. Regarding the widely spread knowledge that cost increase is one of the implications of supply chain flexibility and agility, the authors argue that cost reduction is not confined to lean supply chains. Agile supply chains can also reduce costs through flexible processes in the framework and economies of scale. Gligor (2015) demonstrates that agile practices can mitigate environmental uncertainty's negative effect on 'supply chain fit.' While lean practices are notoriously associated with cost efficiency in academic literature, a link that is tested in most empirical research, Gligor et al. (2015) demonstrate that agility can also be positively associated with cost efficiency. Agile supply chains have as a prerequisite the focus on meeting customers' continuously changing needs. Empirical evidence indicates that cost-efficiency can be achieved in 'munificent, dynamic, and complex environments'.

Lee (2004) signals that a purely lean supply chain is in peril of not delivering what the customer wants today or will not adjust for what the customer wants tomorrow. While economies of scale and centralised distribution are consecrated ways to cut costs and, consequently, lower the price for the end customer, the end customer has modified his order winner criteria in today's fast-paced environment. Supply chain efficiency – a lean supply chain – is essential, but most often than not, it proves to be insufficient in securing a competitive advantage against rivals. The author argues that companies such as Wal-Mart, Dell, or Amazon have not thrived due to becoming increasingly efficient, but due to their differentiating factors: agility, adaptability, and alignment. According to the author, 'the best supply chains are

not just fast and cost-efficient, and they are also agile and adaptable, and they ensure that all their companies' interests stay aligned.' Chan et al. (2017) assess the effects of supply chain agility in fashion manufacturers from several countries and demonstrate benefits to the firm performance drawn from flexibility in strategy and manufacturing processes.

'Leagility' is a concept established in 1999 as combining lean and agile practices in SC's functions. The study of Naim and Gosling (2011) on the origin of the notion underlines that the work on the initial concept is highly quoted research as more and more researchers and managers are attempting to leverage the benefits of the two approaches. Maropoulos et al. (2008) also approach 'leagile' as a potentially functional combination of lean and agile that can work alternatively in the company's lifespan. Considering that supply and demand circumstances are dynamic, the company may have changing needs drawn from lean or agile supply chain management. Therefore, ensuring the supply chain strategy's overall flexibility is a prerequisite.

Hartini and Ciptomulyono (2015) have an extensive literature review focused on lean and sustainable manufacturing impact on company performance. The paper stands out as a collection of criteria and indicators for analysing supply chain leanness and sustainability and company performance from various perspectives. Key learning from the extensive literature is that companies that integrate lean and sustainable models can improve performance as evaluated through several indicators related to flexibility, sustainability, financial performance, order fulfilment, etc.

Elgazzar et al. (2012) link supply chain performance to financial strategy by introducing the 'Supply Chain Financial Link Index' (SCFLI), which assesses the efficiency of supply chain management and identifies improvements in supply chain operations that can, bottom-line, impact the strategic financial goals of the company. The authors have selected the Return on Assets (ROA) and Return on Equity (ROE) ratios for their financial performance assessment. Moreover, when outlining supply chain performance for the SCFL index, the research employs cost of goods sold, inventory cycle times, and fixed assets, among other indicators oriented towards service level (e.g., perfect order fulfilment, supply chain flexibility, supply chain adaptability, etc.). This research selects supply chain efficiency indicators anchored in the same area as the goal for assessing efficiency is centred around development, rather than management, due to the data availability. Since it is challenging to collect full-disclosure qualitative data for many companies related to flexibility, adaptability or order performance, the paper's case study focuses on measures that assess inventory management and investment in the overall supply chain assets. This approach allows our paper to base the analysis on 100 companies which is an empirical feat that sets us apart from similar studies in the field, which work with limited quantitative data.

Wagner et al. (2012) assess financial performance through ROA ratio, starting from the operational aspects of the supply chain. The authors define 'supply chain fit' as 'strategic consistencies between the products' supply and demand uncertainty and the underlying supply chain design.' The empirical research confirms that companies with better responsiveness in the supply chain yield higher financial performance. The case study is developed across industries and considers self-constructed scales for supply and demand uncertainty, supply chain responsiveness, and competitive intensity.

Myerson's (2012) empirical analysis estimates that 50 to 80 per cent of the sales cost is represented by supply chain costs. The author indicates the following Cost and asset management indicators that can be analysed regarding the supply chain: total costs in the supply chain and logistics (as percentages of income), costs for warehousing, distribution, and transport, costs with warranties and returns, the 'cash-to-cash' cycle, inventories, and assets turnover. Considering these specific costs, the transport infrastructure could also be considered relevant to the supply-chain efficiency, by its means of supporting economic activities, depending on the regional growth (Gherghina et al., 2018).

DeSmet (2018) brings forward a theoretical framework for the supply chain that includes service, cost, and cash. These three dimensions are the prerequisites of the author's hypothesis that companies can make financial, operational, and strategic decisions based on a bi-dimensional fundamental performance indicators approach. This approach implies that the remaining two can be employed for each dimension analysed to identify potential compromises that can be implemented. In this work, the indicators analysed and exemplified are Return on Capital Employed (ROCE), Earnings Before Interest and Taxes (EBIT), Return on Assets (ROA), Return on Equity (ROE), Return on Investment (ROI), fixed assets and inventory ratios. The author focuses on the Return on Capital Employed (ROCE) as a financial performance indicator that operational and financial departments can analyse to decide on strategic directions. The principle proposed is to analyse the possible compromises and select what leads to the company's optimal performance. It is empirically exemplified by compromising maintaining a high inventory level, associated with higher Earnings Before Interest and Taxes (EBIT). Return on capital employed in conjunction with Return on Assets and Return on Equity can provide a clear view of the company's sustainable performance. However, it is strongly recommended to compare this indicator within the same industry sector, as there are high variances from one to another based on the business's particularities and market expectations.

Kim (2018) classifies supply chain inventory into raw material inventory, work-in-process inventory, and finished goods inventory. The author identifies factors that can determine keeping the inventories' levels high or low, based on the expectations for expenses, earnings, and service level. Some of the outlined benefits

of maintaining a higher level of inventories are increasing the quality of customer service by minimising the risk of losing potential sales, avoiding disrupting the planned production process due to missing materials, saving costs associated with the delayed order processing, and increasing the ability to deal with fluctuating price increases for materials.

Feng et al. (2015) evaluate how the supply chains of retail and manufacturing companies behave under budgetary constraints. The case study implies that costs in the supply chain can be managed by revenue-sharing-and-buy-back, revenue-sharing, or buy-back types of contracts. The outcome of the empirical research is that profit allocation can be steered by the three approaches in supply chain contracting, mainly if limitations to a budget are in question. The analysis accounts for administrative costs and economic efficiency in deciding upon a contract in the supply chain, hence an operational approach.

Chan et al. (2017) assess how manufacturing flexibility and supply chain agility influence company performance as evaluated through financial performance, operational excellence, revenue growth, and customer relationship. The case study is based on 141 manufacturing companies from the fashion industry, 95% of the selection being garment manufacturers and not suppliers or buyers in the industry. The outcome of the studies shows that strategic and manufacturing flexibility are critical components that cannot be missed in manufacturing companies within this industry. Moreover, a diversified resource allocation approach to product development, sales, and marketing strengthen flexibility, agility, and financial outcome. Based on this research, the current paper understands the importance of collecting and assessing data in the specific sense of the industry selected – automotive – to capture the most relevant conclusions. The bottom line is that flexibility, agility, and performance are results that differ across industries, based on customisations from the market and stakeholder expectations.

Ramezani et al. (2014) propose an evolutionary shift from an operational approach in designing the supply chain to a financial one. While most research considers financial aspects as outcomes, the authors highlight how these aspects can be considered exogenous variables. The case study concludes that decision-makers, both internal and external, can benefit from this approach and yield overall better financial outcomes for the company. Although the analysis is limited to only three companies, the paper makes a valuable contribution to shifting the design of the supply chain towards a more proactive one. The present research adopts this approach by including in the supply chain efficiency variables ratios based on current, fixed, and total assets and turnover-based indicators. The forward-looking perspective is that considering current capabilities in designing operations and strategies, both internal and external stakeholders can adopt a financial perspective already in the construction phase instead of treating it as an analytical outcome.

Wuttke et al. (2013) evaluate how financial aspects in the supply chain can be employed by management in decision-making early in the process. Fundamental in operations management and finance, the paper also approaches a proactive attitude that implies that financial aspects can already be discussed in the supply chain design and operational phase. The study suggests that by introducing a financial perspective in managing the supply chain, the company's working capital and cost structure can be proactively optimised. This study is also an indicator of the shift in perspective: financial decision-making is not limited to analysing financial outcomes but rather a tool that can be implemented already in the operations – supply chain specifically in this assessment – to get a head start in efficiency and performance.

Based on the literature review, the case study hypothesis is represented by the existence of a causal relationship between supply chain efficiency and sustainable financial performance. The empirical study assesses supply chain efficiency by employing ratios based on assets' structure and efficiency ratios: Fixed Assets to Net Worth Ratio (FATA), Fixed Assets Turnover Ratio (SAFA), Inventory to Assets Ratio (ITA), Inventory Turnover Ratio (ITO), Total Assets Turnover Ratio (TATO), Fixed Assets Turnover (FATO) and Accumulated Depreciation to Fixed Assets Ratio (FADE). Financial performance is assessed through return-based ratios: Return on Assets (ROA), Return on Total Assets (ROTA), Return on Capital Employed (ROCE), Return on Equity (ROE), and Return on Sales (ROS).

3. Methods

The case study aims to empirically assess supply chain factors' impact on companies' financial performance. The analysis employs ratios based on assets structure, inventories, and turnover to evaluate supply chain efficiency and ratios based on return on assets, equity, capital, and sales to assess the financial performance of companies. The seven independent variables include references to the assets, inventories, and depreciation values of the selected companies used in ratios that underline the value-added generated in the supply chain. The indicators we have selected are the following: Fixed Assets to Net Worth Ratio (FATA), Fixed Assets Turnover Ratio (SAFA), Inventory to Assets Ratio (ITA), Inventory Turnover Ratio (ITO), Total Assets Turnover Ratio (TATO), Fixed Assets Turnover (FATO) and Accumulated Depreciation to Fixed Assets Ratio (FADE). As the literature review has outlined, performance in the supply chain has shifted from being an `order qualifier` to being an 'order winner' criterion, as market expectations have evolved to reflect the need for a supply chain that is 'leagile.' Therefore, Cost is not the ultimate metric to decide performance. The ability to adapt – using the supply chain assets to meet market requirements – can be equally important. Through the selection of independent variables, the case study includes the following perspectives: the use of supply chain assets such as plants, equipment,

inventory (FATA, ITA, FADE), the efficiency of such assets in generating sales (SAFA, TATO, FATO) and the efficiency of warehousing and distribution of the company's products (ITO). The case study hypothesis is that we can link these factors to the financial performance of companies, which is assessed through return-based ratios: Return on Assets (ROA), Return on Total Assets (ROTA), Return on Capital Employed (ROCE), Return on Equity (ROE) and Return on Sales (ROS).

As the literature review section evidenced, we witnessed a shift from treating financial decision-making as based on the financial outcome to including financial rationale in the supply chain design, operations, and management over the past decade. Since the present research anchors assessing supply chain efficiency in ratios based on asset structure, inventory management and turnover, the outcome of the case study is more suited for being used by both internal and external stakeholders, who can access the public data from the annual reports.

Table 1: Independent and dependent variables

Variable	Unit of Measure	Definition	Data Source
ROA	%	Return on Assets, calculated as a ratio between fixed assets and returns	Annual reports and financial statements annexes published by the selected companies
ROTA	%	Return on Total Assets, calculated as a ratio between total assets and returns	
ROCE	%	Return on Capital Employed, calculated as a ratio between capital expenses and returns	
ROE	%	Return on equity, calculated as a ratio between equity and returns	
ROS	%	Return on Sales, calculated as a ratio between sales and returns	
FATA	%	Fixed assets to net worth ratio, calculated as a ratio between fixed assets and total assets	
SAFA	%	Fixed Assets Turnover Ratio, calculated as a ratio between sales and fixed assets	
ITA	%	Inventory to Assets Ratio, calculated as a ratio between inventories and total assets	
ITO	%	Inventory Turnover Ratio, calculated as a ratio between inventories and turnover	
TATO	%	Total Assets Turnover Ratio, calculated as a ratio between total assets and turnover	
FATO	%	Fixed Assets Turnover Ratio, calculated as a ratio between fixed assets and turnover	
FADE	%	Accumulated Depreciation to Fixed Assets Ratio, calculated as a ratio between fixed assets and depreciation	

Source: authors` processing

The panel data collected for our 100 companies has been processed in the software Stata to construct Fixed Effects (FE) and Random Effects (RE) models. Starting from the summary of data and confirmation of the data integrity for our companies, years, and variables, FE and RE models have been constructed for each of the five dependent variables. The equations of the models are as follows:

$$\text{FE model: } Y_{company,time} = \alpha_{company} + \beta_1 X_{company,time} + u_{company,time} \quad (1)$$

$$\text{RE model: } Y_{company,time} = \alpha_{company} + \beta_1 X_{company,time} + u_{company,time} + \varepsilon_{country,time} \quad (2)$$

where $\alpha_{company}$ is the constant for each of the 100 companies included; $Y_{company, time}$ represents the dependent variable (5 different models for each dependent variable, including ROA, ROTA, ROCE, ROE, ROS); $X_{company}$, time represents the independent variables (the seven variables in the analysis are the following: FATA, ITA, SAFA, ITO, TATO, FATO, FADE); β_1 represents the coefficient for the independent variable; $u_{company, time}$ is the error term and $\varepsilon_{country, time}$ is the within-entity error term of RE models.

An OLS linear regression and a random-effects regression are applied, followed by the Breusch and Pagan Lagrange multiplier test for random effects to decide between the OLS linear regression and the random effects one. Besides, the following regressions have been modeled for the data: GEE Population-average regression, regression (on group means), Fixed-effects – FE (within) regression, and Random-effects – RE GLS regression. The authors apply the Hausman test to correctly select between FE and RE models, whose null hypothesis is that the preferred model is the RE one. The test checks if the unique errors ($u_{country, time}$) are correlated with the regressors, the null hypothesis is that they are not.

4. Empirical data and analysis

The case study's data set includes 100 multinational corporations with a global presence in the industrial automotive sector. The companies are based in 13 countries (United States, Canada, China, South Korea, France, Germany, Hong Kong, India, Italy, Japan, United Kingdom, Netherlands, Sweden), and over half of them are based in the United States. Moreover, the selection includes a multitude of automotive sub-sectors (tires, chemicals, interior components, electric components, mechanical components, glass components, wheels, engines, steel, audio systems, fuel systems, cabling systems, lighting systems, safety systems, thermic systems), including top performers from each area of the industry. All companies that have been included are listed on the stock exchange market and therefore are frequently under the scrutiny of many stakeholders that are looking at the same indicators as our research. The automotive industry is among the sectors most oriented towards

manufacturing and supply chain excellence, considering the high complexity that must be brought together for the final product – an automobile. While the first three industrial revolutions praised companies like Ford or Volkswagen for mechanisation, mass production, and automatisation, the fourth industrial revolution is focused on technological advances. Hence, a reactive approach to financial performance is passed on for a proactive approach that promotes financial decision-making as early on as possible in the manufacturing and supply chain. To compete in the continuously evolving automotive sector, the companies selected for the present research have to display supply chain efficiency that allows cost reduction and flexibility, and long-term sustainable financial performance.

The data collected has an annual frequency of ten years, between 2010 and 2019, and it is expressed in percentage values — table 1 displays the data selection, calculation method, and sources for our dependent and independent variables. The annual reports have been collected and processed during the year 2021 from the official companies' websites or the stock exchange website where they are listed, and most of them include these ratios already calculated. When the ratios were not available, they were calculated based on other financial information available in the Balance Sheets or Profit and Loss Statement. The study includes companies with a net income of up to 22,5 million euros and, considering the period of 10 years, we have companies that have registered losses in the period. All companies have a multinational presence, with at least 1000 employees globally, most of the data collected being for large corporations employing over 50000 people worldwide.

In this section, the results of the analysis are introduced on a structure based on the independent variable used for constructing the model, having, therefore, an outlook on the financial performance as expressed through Return on Assets (ROA), Return on Total Assets (ROTA), Return on Capital Employed (ROCE), Return on Equity (ROE) and Return on Sales (ROS). Practitioners and scholars can identify relevant areas of improvement in the supply chain that can boost financial performance. Starting from the OLS, GEE, and between regressions model, the FE and RE regressions results are analysed, concluding with selecting the most appropriate model based on the results of the Hausman test. Tables 2 and 3 present the data set's median values, standard deviations, and minimum and maximum values.

Table 2: Descriptive statistics for independent variables

Independent variable	Obs.	Mean	Std. dev.	Min	Max
FATA	1000	0.503	0.145	0.05	1
ITA	1000	0.130	0.072	0	0.51
SAFA	1000	2.599	1.894	0.02	27.17
ITO	1000	0.102	0.080	0	1.70
TATO	1000	1.139	0.610	0.01	12.19
FATO	1000	0.311	0.073	-0.08	2.27
FADE	1000	0.096	0.075	0	1.29

Source: authors` calculations

Table 3: Descriptive statistics for dependent variables

Dependent variable	Obs.	Mean	Std. dev.	Min	Max
ROA	1000	-0.012	0.966	-20	0.49
ROTA	1000	0.039	0.743	-15	0.98
ROCE	1000	0.186	3.043	-53.57	74.19
ROE	1000	-0.014	0.642	-6	14.04
ROS	1000	0.179	3.093	57.14	0.77

Source: authors` calculations

The analysis confirms a homogenous set of companies, as assumed in selecting critical players in the automotive sector. We consider the broad spectrum of sub-sectors representing either a large part of the original automotive equipment and replacement production or a less significant one; we have, as expected, some discrepancy between the minimum and maximum values.

Table 4 presents the results of the regression models applied for Return on Assets (ROA). Fixed and random effects yield similar R squared values and have similarly relevant coefficients, the Hausman test confirming the relevance of the Fixed Effects model. The Fixed Effects model highlights assets through ITA and FADE and the efficient use of assets through SAFA and FATO. The OLS regression for ROA has relevant R squared values, and the F test results confirm that all coefficients except for SAFA are different from zero. The associated regression coefficients and t statistics indicate ITA, ITO, TATO, and FADE. The population-averaged GEE model is confirmed by the null value of the probability, and the z-test marks relevant values for variables from the same ratios, including FATO. Overall, the statistically significant and robust results, regardless of the regression model employed, indicate that return on assets is affected by the inventory management (ITA, ITO) and fixed assets management in terms of their

Table 4: Regression results for the models with ROA as the dependent variable

	Random Effects		Fixed Effects		OLS		Between		GEE	
	Coef.	z-values	Coef.	t-values	Coef.	t-values	Coef.	t-values	Coef.	z-values
FATA	0.534**	-1.81	-0.479	-1.48	0.706*	-2.61	-1.132	-1.44	-0.534**	-1.81
ITA	-2.556*	-4.07	-1.698*	-2.23	-3.471*	7.00	-3.773*	-3.00	-2.551*	-4.07
SAFA	0.057	1.38	0.072**	1.62	0.014	0.36	-0.080	-0.66	0.057**	1.39
ITO	-1.564*	-2.35	-0.613	-0.74	-2.478*	-4.83	-2.677*	-2.07	-1.559*	-2.34
TATO	0.126	1.20	-0.045	-0.37	0.392*	4.28	0.767*	2.82	0.125	1.19
FATO	2.566*	4.65	2.426*	4.18	3.001*	5.27	3.122	1.11	2.565*	4.67
FADE	-8.753*	-21.50	-8.972*	-19.81	-8.568*	-23.12	-8.535*	-8.03	-8.754*	-2158.00
_cons	1.228*	6.25	1.168*	5.61	1.299*	7.33	1.385*	2.69	1.222*	6.27
R-squared	0.3487		0.3352		0.3565		0.3375			
F-test prob./Wald-test	0.0000		0.0000		0.0000		0.0000		485.69*	
Hausman test (prob.)	0.1231 (0.0000)									
Breusch Pagan Lagrange Multiplier test (prob)	419.44 (0.0000)									

*. ** indicates statistical significance at 1% and 5% levels. respectively

Source: authors` calculations

depreciation (FADE), while assets turnover (TATO and FATO) have a direct influence on ROA. Accordingly, the return on fixed assets would be increased if companies have less inventory, higher accumulated depreciation, and larger values of assets related to turnover.

Table 5 presents the results of the regression models applied for Return on Total Assets (ROTA). The relevant coefficients across all seven variables throughout the five models applied indicate a consistently negative impact on return on total assets from inventory ratios and accumulated depreciation to fixed assets ratio and a positive impact from fixed assets turnover ratio. According to the Hausman test results, the fixed effects regression holds relevant for the ROTA model, suggesting that company characteristics may have an impact on regression results. The statistically significant results (for some of the models employed) also indicate that the fixed assets to net worth ratio carry a negative effect on ROTA while the fixed assets turnover ratio has a positive impact on ROTA.

Table 6 presents the results of the regression models applied for Return on Capital Employed (ROCE). With the most relevant coefficients being centered around asset usage efficiency and warehousing and distribution, the fixed assets to net worth ratio (FATA) and turnover ratio related to fixed assets (SAFA) have a negative impact on ROCE. With the opposite influence, we have the inventory turnover ratio (ITO) and the accumulated depreciation (FADE), which are the variables highlighted to have a positive effect on the return on capital employed. The Hausman test assigns the random-effects model as being the relevant one.

Table 7 evidence the regression models applied for Return on Equity (ROE) results. As the Hausman Test results suggest, the random-effects model is more appropriate. The SAFA variable has some relevant coefficients and t-values, although it is not straightforward to assess the connection of the supply chain variables to ROE as a financial performance indicator. Considering the goodness of fit for the models employed (the F test and R squared values), regardless of the type of regression (OLS, FE, RE, between groups or GEE), the independent variables considered are not appropriate to explain the variance within return on equity, at least not for the database analysed in this study.

Table 8 highlights the results of the regression models applied for Return on Sales (ROS). The results point towards the fixed effects model. However, overall, the relevancy of coefficients and t-values remains insignificant or inconsistent for most independent variables, except for SAFA, for which statistically significant results indicate that they have a positive influence on return on sales. This connection is intuitive through the sales point of analysis marked both in ROS and SAFA ratios. The Inventory to Assets Ratio is also statistically significant for all regression models; however, its values indicate either a positive or a negative influence on the dependent variable.

Table 5: Regression results for the models with ROTA as the dependent variable

	Random Effects		Fixed Effects		OLS		Between		GEE	
	Coef.	z-values	Coef.	t-values	Coef.	t-values	Coef.	t-values	Coef.	z-values
FATA	-0.360**	-1.62	-0.330	-1.37	-0.497*	-2.40	-0.871	-1.40	-0.360**	-1.63
ITA	-1.908*	-4.00	-1.398*	-2.47	-2.575*	-6.80	-2.797*	2.81	-1.90*	-4.01
SAFA	0.049**	1.58	0.060**	1.81	0.011	0.37	-0.075	-0.78	0.049**	1.59
ITO	-1.253*	-2.47	-0.715	-1.16	-1.874*	-4.79	-1.968**	-1.91	-1.251*	-2.48
TATO	0.113	1.42	0.006	0.07	0.324*	4.65	0.622*	2.88	0.113	1.42
FATO	1.814*	4.40	1.673*	3.88	2.315*	5.33	3.145	1.41	1.813*	4.41
FADE	-6.609*	-21.58	-6.674*	-19.80	-6.655*	-23.53	-6.871*	-8.15	-6.609*	-21.67
_cons	0.921*	6.25	0.889*	5.74	0.988*	7.31	1.094*	2.68	0.921*	6.27
R-squared	0.3577		0.3470		0.3659		0.3507			
F-test prob./Wald-test	0.0000		0.0000		0.0000		0.0000		489.19*	
Hausman test (prob.)	0.1782 (0.0000)									
Breusch Pagan Lagrange Multiplier test (prob)	518.42 (0.0000)									

*. ** indicates statistical significance at 1% and 5% levels. respectively

Source: authors` calculations

Table 6: Regression results for the models with ROCE as the dependent variable

	Random Effects		Fixed Effects		OLS		Between		GEE	
	Coef.	z-values	Coef.	t-values	Coef.	t-values	Coef.	t-values	Coef.	z-values
FATA	-0.506*	-2.36	-1.465*	-4.83	-0.506*	-2.36	0.209	0.75	-0.481*	-2.29
ITA	0.942*	2.41	-1.785*	-2.50	0.942*	2.41	1.4*	3.14	0.972*	2.54
SAFA	-0.076*	-2.41	-0.128*	-3.06	-0.076*	-2.41	-0.016	-0.39	-0.074*	-2.39
ITO	0.824*	2.04	-1.211**	-1.56	0.824*	2.04	1.204*	2.26	0.846*	2.14
TATO	0.029	0.41	0.36*	3.13	0.029	0.04	-0.146	-1.51	0.024	0.34
FATO	-0.156	-0.35	-0.493	-0.91	-0.156	-0.35	0.995	1.00	-0.119	-0.34
FADE	2.372*	9.13	4.373*	10.32	2.672*	9.13	1.655*	4.38	2.635*	9.16
_cons	0.101	0.72	0.752*	3.86	0.101	0.72	-0.248	-1.36	0.087	0.63
R-squared	0.0915		0.0706		0.0915		0.0422			
F-test prob./Wald-test	0.0000		0.0000		0.0000		0.0031		99.93*	
Hausman test (prob.)	0.0000 (1.0000)									
Breusch Pagan Lagrange Multiplier test (prob)	0.00 (1.0000)									

*. ** indicates statistical significance at 1% and 5% levels. respectively

Source: authors` calculations

Table 7: Regression results for the models with ROE as the dependent variable

	Random Effects		Fixed Effects		OLS		Between		GEE	
	Coef.	z-values	Coef.	t-values	Coef.	t-values	Coef.	t-values	Coef.	z-values
FATA	-1.119	-1.05	0.593	-0.53	-1.118	-1.06	-0.945	-0.60	-1.118	-1.06
ITA	-0.366	-0.19	0.098**	-1.66	-0.272	0.14	1.729	0.68	-0.272	-0.14
SAFA	-0.276**	-1.76	0.077**	-1.77	-0.274	-1.77	-0.221	-0.90	-0.274**	-1.77
ITO	0.64	0.31	0.996	0.00	0.677	0.34	1.748	0.67	0.677	0.34
TATO	0.275	0.76	0.363	0.91	0.267	0.75	0.048	0.09	0.267	0.75
FATO	2.206	0.99	0.287	1.07	2.186	0.99	1.987	0.35	2.186	0.99
FADE	1.697	1.13	0.179	1.35	1.697	1.18	2.106	0.98	1.697	1.18
_cons	0.903	1.29	0.162	1.40	0.891	1.30	0.513	0.49	0.089	1.30
R-squared	0.0069		0.0050		0.0069		0.0050			
F-test prob./Wald-test	0.4448		0.2085		0.4416		0.9178		6.96	
Hausman test (prob.)	0.6072 (0.4512)									
Breusch Pagan Lagrange Multiplier test (prob)	0.02 (0.4512)									

*. ** indicates statistical significance at 1% and 5% levels. respectively

Source: authors` calculations

Table 8: Regression results for the models with ROS as the dependent variable

	Random Effects		Fixed Effects		OLS		Between		GEE	
	Coef.	z-values	Coef.	t-values	Coef.	t-values	Coef.	t-values	Coef.	z-values
FATA	1.793*	2.10	2.02*	2.34	-0.278	-0.28	-4.672	-1.40	1.877*	2.24
ITA	4.891*	2.56	6.048*	2.98	-4.222*	-2.30	-16.448*	-3.08	5.316*	2.78
SAFA	0.221**	1.86	0.214**	1.80	0.131	0.89	-0.327	-0.63	0.219*	1.88
ITO	0.789	0.38	0.618	0.28	-3.038**	-1.60	-12.163*	-2.21	0.769	0.37
TATO	-0.212	-0.68	-0.265	-0.81	0.896*	2.65	3.258*	2.81	-0.237	-0.76
FATO	-1.866	-1.20	-2.499**	-1.62	4.104*	1.95	11.767	0.98	-2.102	-1.39
FADE	-1.419	-1.20	0.707	0.59	-16.282*	-11.89	-35.424*	-7.84	-0.650	-0.56
_cons	-1.937	-3.30	-2.292	-4.14	0.906	1.38	5.752	2.63	-2.066	-3.46
R-squared	0.0223		0.0006		0.1423		0.1316			
F-test prob./Wald-test	0.0038		0.0020		0.0000		0.0000		21.61*	
Hausman test (prob.)	0.0000 (0.0000)									
Breusch Pagan Lagrange Multiplier test (prob)	1324.28 (0.0000)									

*. ** indicates statistical significance at 1% and 5% levels. respectively

Source: authors` calculations

5. Results and discussion

The case study analysis results indicate that the efficiency of using assets – expressed through variables Fixed Assets Turnover Ratio (SAFA), Total Assets Turnover Ratio (TATO), and Fixed Assets Turnover (FATO) – and warehousing and distribution efficiency – as expressed through variable Inventory Turnover Ratio (ITO) – are the most relevant variables across the five constructed models. The assets' structure (Fixed Assets to Net Worth Ratio (FATA), Inventory to Assets Ratio (ITA), Accumulated Depreciation to Fixed Assets Ratio (FADE)) has several relevant coefficients and t-values. However, overall, it is not strongly connected to the financial performance (assessed through return-based ratios: Return on Assets (ROA), Return on Total Assets (ROTA), Return on Capital Employed (ROCE), Return on Equity (ROE), and Return on Sales (ROS)).

The results align with the hypothesis and the expectations derived from the literature review that a 'leagile' supply chain supports sustainable financial performance. The results confirm previous studies conducted by Elgazzar et al. (2012) and Wagner et al. (2012), where supply chain efficiency is positively influencing the financial performance of the company. It is in the research's focus, for the use of practitioners, that this connection is empirically attested and can be a model easily adopted in practice. Similar to the results and demonstrated hypotheses of Myerson (2012), DeSmet (2018), Kim (2018), Feng et al. (2015), and Chan et al. (2017), the present paper outlines the aspects of asset structure, in particular, to guide the users towards the variables employed, that can be applied in the supply chain management.

The assets' structure, which is mainly conducive to cost, therefore the lean concept, is not the highlight factor for 'order winning' but rather an 'order qualifier.' What boosts performance in the long term is the efficient use of the assets in the supply chain – being able to employ the fixed assets to generate sales, have a healthy asset turnover, and efficient inventory management. These characteristics are conducive to improved costs and financial results but, most important to notice, are conducive to a flexible and adaptive environment. By selecting data from the rapidly evolving automotive sector, the 'leagile' concept proof is even more relevant as plants, equipment, R&D investment, and inventories make up these 100 companies' sought-after partners for the car manufacturers' replacement markets.

The study results, namely pinpointing that asset management and inventory management indicators represent the most relevant variables across the five constructed models, are essential considering their economic significance. The results can be appraised by both industry professionals and academics, considering the relationship between supply chain efficiency and sustainable financial development. Therefore, the results confirm that companies understand that supply chain management, both in managing flows and information, is crucial for having a competitive advantage in a volatile and turbulent market.

Managing inventories in a transparent manner help companies evaluate their erosions within the supply chain and permits healthy planning of future evolutions. Current technological development and digitalisation empower companies to track inventory management efficiency in real-time. In terms of asset management, companies should evaluate business efficiency in correlation with their useful life. Finally, companies can optimise their operational system by supply chain evaluation, including planning, sourcing, and performance.

6. Conclusions

The paper investigates the relationship between fostering sustainable financial performance through efficiency in the supply chain by employing fixed and random effects and econometric models. The results indicate how the seven supply chain factors focused on the use of assets, efficiency in the use of assets, and efficiency in the warehousing and distribution process, impact the five dependent variables represented by financial performance ratios.

First, we highlight that the relevant variables are based on Return on Assets, Return on Total Assets, and Return on Capital Employed for the three models, based on asset structure, efficiency in use and warehousing and distribution efficiency. For the models analysing the dependent variables Return on Equity and Return on Sales, the relevant results are exclusively in assets' efficiency, but overall, the models are not sufficiently relevant to give a clear strategic direction. The case study's hypothesis is confirmed, and the output analysis aligns with the knowledge collected in the literature review through theoretical and empirical research. The three categories of supply chain efficiency proxies are: how are assets employed in the supply chain (FATA, ITA, FADE); how efficiently are the assets used (SAFA, TATO, FATO); how efficient are the warehousing and distribution processes (ITO). Together they make up for a good understanding of areas targeted for a 'leagile' supply chain set-up that promotes sustainable financial performance.The paper concludes by outlining relevant strategic directions identified from the case study results. They can be considered by practitioners and academics alike to promote sustainable financial development by developing the supply chain efficiently.

The research is limited by the size of the dataset, considering that the supply chain ratios are mainly derived from assets and turnover indicators. These proxies offer a good overview, but for an in-depth analysis that can pinpoint critical areas in the supply chain, more specific ratios must be used. The disadvantage is that data for such ratios is generally not available in the companies' annual reports or publicly disclosed financial statements. Additionally, an option worth exploring in further research, for more insight into the financial performance dimension, considers

related cash-flow indicators that would yield more insight, mainly if used for smaller time snapshots, for example, quarterly data.

Moreover, future research opportunities for the relationship between supply chain efficiency and financial performance lie in the newly acquired perspective from the Covid-19 pandemic. Affected by the pandemic either in the supply or demand areas, many industries would be essential to assess the shift of the efficiency perspective and financial performance, if at all.The automotive industry is an exciting candidate for analysis since supply and demand have been affected. Assessing the effects on the ability to supply components to car manufacturers and mitigate the effects of reduced demand across original equipment and replacement markets can contribute significantly to the field. The key learnings would explain the phenomena amidst the pandemic and outline areas for improvement in the long run.

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Okvir za modeliranje Tandemske učinkovitosti lanca opskrbe i održive financijske uspješnosti u automobilskoj industriji

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Sažetak

U ovom radu istražuje se uzročna veza između učinkovitosti opskrbnog lanca i održivog financijskog rezultata na temelju dokaza iz literature koja se bavi prijelazom s financijskog odlučivanja na temelju financijskog ishoda, uključujući financijsku podlogu za oblikovanje opskrbnog lanca, poslovanje i upravljanje. Studija slučaja obuhvatila je 100 tvrtki odabranih iz sektora proizvodnje automobila tijekom deset godina, od 2010. do 2019. godine. Metodološki, studija primjenjuje statistički fiksne modele i modele slučajnih učinaka, uzimajući u obzir parametre modela kao zavisne varijable odnosa imovine i učinkovitosti te kao nezavisne varijable omjera financijske uspješnosti koje se odnose na povrat na imovinu, kapital, kapitalne troškove i prodaju. Odabir modela s fiksnim ili slučajnim efektima postiže se provođenjem Hausmanovog testa. Rezultati panel analize ukazuju na uzročnu vezu za predložene modele, naglašavajući važnost omjera učinkovitosti kao što su omjer obrta dugotrajne imovine, omjer ukupnog obrta imovine i obrta dugotrajne imovine. Iz perspektive praktičara, konstrukcija modela i rezultati rada stječu uvid u strateška područja opskrbnog lanca kojima se može dati prioritet za povećanje učinkovitosti i korporativne konkurentnosti, promicanje održivog financijskog rezultata kroz strukturu imovine, učinkovitost imovine i upravljanje zalihama.

Ključne riječi*: lanac opskrbe, održivi financijski rezultat, korporativna konkurentnost*

JEL klasifikacija: *G30, F63, G39*

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