

Stagnation in Motion: Mapping the Intermodal Export Logistics of Dacia and Ford Otosan in Romania

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Abstract. *The automotive industry represents a fundamental pillar of the Romanian economy, having recently surpassed a significant production milestone of over 500,000 vehicles annually. This paper examines the industrial and logistical dynamics of the two primary manufacturers, Automobile Dacia and Ford Otosan, following the complicated post-pandemic period of volatility and a strained logistical network. Current academic literature touches upon the broad stability of Eastern European manufacturing and its sustainable transition. However, this high-level perspective often overlooks the localized economic realities and logistical hurdles specific to Romania. This study addresses that gap by providing a much-needed empirical look at how transportation constraints are currently shaping regional performance. The research methodology utilizes a quantitative approach, employing regression analysis and statistical metrics such as the coefficient of variation to evaluate the correlation between corporate turnover and Gross Domestic Product at local, regional and national levels. The study seeks to answer how these production facilities influence surrounding economic development and to what extent infrastructure limitations hinder outbound distribution. Findings indicate that Automobile Dacia continues to provide a stable industrial baseline, yet it is Ford Otosan's recent scaling that has driven the most significant economic gains in South-West Oltenia. Although the 2025 Schengen accession effectively removed border-crossing bottlenecks, these logistical gains are being undercut by Romania's degrading national rail network. Another central contribution of this research is outlining the disconnect between industrial growth and infrastructure development, generating an imbalanced use of intermodal transportation and impeding finished vehicles' logistics efficiency. To remain a major European automotive industry player, Romania must close the gap between its record-breaking production volumes and the struggling road and rail transportation networks that move them.*

Keywords: finished vehicle logistics (FVL), logistics infrastructure paradox, intermodal transportation, regional development, economic impact, automotive industry, Romania.

Introduction

In 2024, the Romanian automotive industry reached a historic milestone, surpassing an aggregate output of 560,000 vehicles with 2025 being the fourth consecutive year with over half a million cars produced. This achievement represents more than just a recovery from the pandemic-induced volatility of the early 2020s, it marks the solidification of Romania as a relevant automotive manufacturing hub within the European Union. The sector's vitality rests on its 2 main pillars: Automobile Dacia, which remains the industry's stabilizing backbone in Mioveni, and Ford Otosan, whose Craiova facility has recently transformed into a high-growth engine for national production output.

While factory floors are operating at record efficiencies and capacity utilization rates frequently exceed 90%, the physical transport networks required to distribute these vehicles are struggling to keep pace, confirming the logistics infrastructure paradox. The recent accession of Romania into the Schengen Area in 2025 provided a long-awaited boost by eliminating border-crossing delays for road freight. Yet, these gains are being systemically undermined by a

deteriorating national rail network where average freight speeds have stagnated at roughly 15 km/h, according to most recent data provided by the national rail freight carrier, CFR Marfa (average commercial speed accounts for the total transit time, including scheduled stops and technical wait times). The national automotive sector is effectively outrunning the infrastructure meant to support it. This misalignment, relying on 21st-century manufacturing while depending on a 20th-century rail network, creates logistics risks that threaten the long-term viability of the automotive sector that no amount of industrial innovation can overcome on its own.

This research moves beyond aggregate national statistics to provide a more granular look at the regional influence of both Dacia (South Muntenia) and Ford (South-West Oltenia). Evaluating their local, regional and national contributions within the last decade enables an improved assessment of the relationship between their industrial growth and economic durability. The conducted analyses seek to better quantify how much of this manufacturing success actually stays in the region and how resilient these local economies are when the global market fluctuates.

To what extent do the diverging production dynamics of Dacia and Ford Otosan correlate with regional economic growth and how persistent infrastructure bottlenecks influence the efficiency gains expected from European logistical integration are the main research questions the paper addresses. The rapid scaling of production at Ford Otosan has a more direct and statistically significant correlation with regional GDP growth in South-West Oltenia compared to the impact of the more stabilized production baseline of Automobile Dacia in South Muntenia (Research Hypothesis 1). The logistical benefits of Schengen accession (reduced border lead times) are partially neutralized by the decline in internal rail infrastructure reliability, preventing the industry from reaching its optimal export potential (Research Hypothesis 2).

By addressing these questions, this paper seeks to provide a data-driven framework for understanding how to maintain the momentum of one of Central and Eastern Europe's most successful automotive industrial stories.

Literature review

The prevailing view of the Central and Eastern European automotive industry is that of a critical, yet peripheral, node in global value chains. Competitive advantage is traditionally derived from cost-efficiency and logistical proximity to Western markets (Geroacs & Pinkasz, 2019), with most authors pointing out their reliance on foreign direct investment and export-driven growth (Vakhal, 2023). In this context, this paper defines regional economic resilience as the capacity of a local economy, specifically South-West Oltenia and South Muntenia, to sustain industrial output and maintain economic stability despite systemic logistical or macroeconomic shocks.

While the dependent development status of Romania's economy is well-documented (Negrea & Cojanu, 2015), there is a noticeable lack of research addressing operational logistics issues when industrial growth outpaces underlying transportation infrastructure. Most studies look at big-picture macroeconomic trends (Butila & Boboc, 2025), but they often overlook this equally important logistic infrastructure paradox: Schengen accession has indeed streamlined freight dynamics, especially trucking shipments, but the increased volumes are showcasing other bottlenecks (incomplete motorway sections, deteriorating railway networks) as declining freight speeds are colliding with logistics operations predictability.

This paper intends to address this gap: instead of relying on broad national data, the current approach directly connects factory-level operations to regional economic performance, providing a more realistic assessment of Romania's industrial hubs. Furthermore it provides the means to determine whether these regions are truly developing and further driving sustainable economic

growth by triggering investments into better linking their regions logistics access with Romania's main road and rail infrastructure networks.

The growth of Romania's automotive sector is also intricately linked to its dense established network of multinational suppliers, primarily clustered in the Western and Central regions. This industrial concentration of the automotive sector was catalyzed by Renault and Ford's major investments, jointly adding up to almost 5 billion euros, in Mioveni (1999) and Craiova (2008). Since then Romania's local supplier base has grown significantly, top-tier automotive suppliers partnering with the French and American-owned brands and further attracting other key automotive industry players. Increased production at Ford's Craiova facility has created a dual effect: strengthening the Romanian automotive industry while exposing critical finished vehicle logistics (FVL)-related weaknesses. Because over 90% of domestic output is exported, Romanian infrastructure bottlenecks significantly impact both Dacia and Ford's delivery schedule predictability. Transit times are often volatile, as delays caused by congestion, accidents or severe weather conditions can typically add 1-2 days to standard routes (via road), though for high-capacity unit trains shipments can sometimes face even longer disruptions lasting up to 2-4 days (via rail).

To navigate logistical bottlenecks, automotive FVL is increasingly redesigning workflows to include intermodal rail or river transport (Loucanova et al., 2022). However, internal operational constraints (Thanou & Matopoulos, 2021) and the rigors of Just-in-Time manufacturing necessitate the reliability of road haulage to prevent supply chain disruptions (Rokicki & Szeberenyi, 2024). Contemporary automotive assembly relies on vast global supplier networks, making sophisticated risk mitigation and precise long-distance transport essential for factory performance (Putri et al., 2022). While outsourcing to logistics service providers (LSPs) can alleviate these pressures, its success depends entirely on service quality (Nagy et al., 2024). In this context, strategically located logistics hubs are essential, allowing manufacturers to balance cost and environmental goals without compromising the speed or consistency of their market deliveries (Fabry et al., 2024).

Most contributions focus on a broader or more aggregate overview, failing to capture the unique constraints encountered at specific manufacturing plant levels (Castro et al., 2025). Current literature on automotive supply chains seldom bridges the gap between inbound and outbound automotive supply chains, rarely examining the operational trade-offs required to integrate them, neglecting their critical synergies and leaving their complex integration underexplored.

Methodology

This study analyzes 10 years of micro- and macroeconomic primary and secondary data (2015–2024) to evaluate the roles of Automobile Dacia and Ford Otosan in achieving Romania's consistent car production volumes. While primary data were recorded in RON, values are reported in EUR to reflect the export-oriented nature of the sector, where Euro-denominated transactions predominate. Conversions were calculated using the annual average exchange rates published by the National Bank of Romania (BNR) for each year of the 10-year study period. BNR annual average exchange rates were rather stable, ranging from approximately 4.45 RON/EUR in 2015 to 4.97 RON/EUR in 2024. The research employs regression analysis and descriptive statistics to quantify both manufacturers' influence at local, regional, and national levels. Furthermore, empirical findings are used to examine the specific logistical hurdles Dacia and Ford face in finished vehicle distribution (FVL), providing a detailed look at the operational challenges inherent in exporting from the South Muntenia and South-West Oltenia regions.

A linear Ordinary Least Squares (OLS) regression was conducted using the Microsoft Excel Data Analysis toolset to quantify the economic impact of the automotive industry. The independent variable was defined as the combined annual turnover of Automobile Dacia and Ford Otosan, while the dependent variables represented economic performance measured at the county, regional, and national levels. By examining data from the past ten years, the model estimates the direct relationship between corporate revenue in Mioveni/Craiova and the corresponding GDP of Arges/Dolj county, the Muntenia/Oltenia region and Romania as a whole. The objective is to quantify the degree to which Dacia and Ford's financial results explain the variation observed in these three distinct economic tiers.

To evaluate the impact of both manufacturing plants on Romania's total output, descriptive statistics was applied to time series data from 2015–2024, including 5 and 10-year averages. Production metrics—specifically unit output, capacity utilization, and market share—were calculated individually and then aggregated to clarify each factory's role in the national sector. These quantitative results were complemented by qualitative empirical findings, which involved mapping the operational logistics of key distribution centers and intermodal hubs. By collating data on lead times, volumes, and freight capacities across road, rail, and maritime networks, direct observations were integrated with content analysis. This combined approach provides practical supply chain insights as well as a more holistic perspective on the supply chain dynamics of both Dacia and Ford within this case study.

Primary data is sourced from empirical research and field observations conducted throughout 2024 and 2025, including site visits to Automobile Dacia's and Ford Otosan's plants, as well as several Romanian port and intermodal terminals. At the Mioveni and Craiova factories, observations targeted production flow and the specific logistics of vehicle dispatch. By engaging directly with these operations and collaborating with partnering logistics service providers, a practical foundation for analyzing the complexities of finished vehicle logistics (FVL) in the Romanian automotive sector was enabled.

This study relies on secondary data integration, specifically focusing on corporate turnover and production volumes for Automobile Dacia and Ford Otosan. National and regional economic indicators, including Gross Domestic Product for counties (Arges/Dolj) and the regions (South Muntenia and South-West Oltenia) were extracted from official financial records and institutional databases. Primary documentation was sourced from the Ministry of Finance, the National Institute of Statistics, and the Romanian National Bank, supplemented by local insights from the City Halls and County Councils. To ensure a comprehensive analysis, these quantitative figures were cross-referenced with premium automotive industry reports, specialized business journals, and official corporate press releases, providing a multi-layered perspective on the sector's recent performance.

Results

Automobile Dacia's production site is located in Mioveni, within the county of Arges (AG) and the South Muntenia (SM) development region, one of Romania's 8 development regions. When Renault took over the Dacia plant (1999) the region was second in terms of GDP/capita, but as of 2024 the region is now only 6th (14,083 euros), just above South-West Oltenia (SWO) and North-East (Moldova), as shown by the National Institute of Statistics' territorial sustainable development indicators. Dacia's Alliance International Logistics Network (AILN) operations include managing finished vehicle logistics (FVL) as well as handling expeditions of Semi Knocked Down (SKD) or Completely Knocked Down (CKD) kits towards other manufacturing plants within the Renault Groupe. AILN operations leverage road connections around Bucharest (A0, A1, A2 and A3

highways) for deliveries within Romania (FVL), as well as rail and intermodal transportation (Curtici, railhead on the M200 main railway line and connection to Budapest via Hungarian border crossing at Lökösháza) for Central and Eastern European markets (FVL), with Constanta Port being the main gateway for overseas shipping (FVL and CKD/SKD kits).

The production facilities for Ford Otosan are situated in Craiova, the administrative seat of both Dolj county (DJ) and the South-West Oltenia (SWO) development region. Since Ford's 2008 acquisition of the plant, the region has undergone a significant economic turnaround: from being ranked last in Romania for GDP per capita, SWO has risen to 7th position as of 2024 (13,976 euros), according to territorial sustainable development metrics from the National Institute of Statistics. Ford's development region (SWO) is gaining ground as its economic activity metric is currently trailing the 6th and 5th ranked regions by margins of less than 1% and 4%, respectively. Ford's distribution logistics only handles FVL deliveries via Bucharest's interconnected highway network (A0-A3, road), the Curtici Cargo Center (rail and intermodal) and the Port of Constanta Port (rail and maritime shipping), of which more than 90% are exported. An overview of production sites, their regions and export hubs is shown in Figure 1.

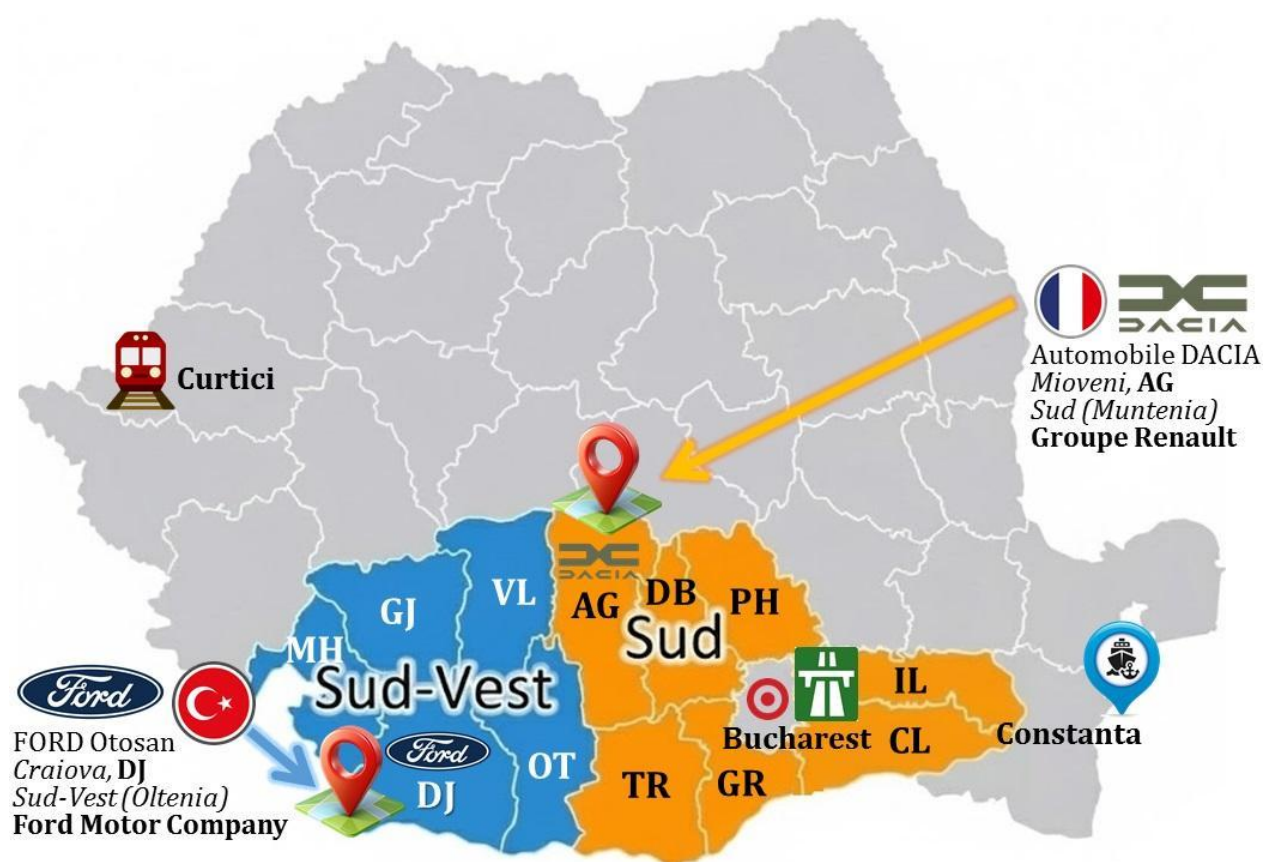


Figure 1. Dacia and Ford's Production Sites, Surrounding Region and Main Transportation Hubs

Source: Regional Development Agencies in Romania (adapted), authors' own research.

Mioveni (AG) is a town 15 km away from Pitesti, the seat of Arges county and the second largest city (141,275 inhabitants) in the region (SM) after Ploiesti, being the only 2 cities in the region with a population of over 100,000. Although Automobile Dacia is located in Mioveni (29,317 inhabitants), most mention the city of Pitesti when referring to the Romanian carmaker's plant location. With its 569,932 residents, the county of Arges shares a fifth of both the SM region's

area (19.91%) and population (19.89%). With around 9.76 billion euros, Arges is a consistent top 10 contributor to GDP and has the second-highest share (23.97%) in GDP within the SM region (2024), according to the National Institute of Statistics, as outlined in Table 1. While this data shows a strong economic link, the relationship is best characterized as a consistent association between the plant's operations and regional output.

Table 1. Macroeconomic Weight of Automobile Dacia within Regional and National GDP, 2015-2024

Metric/ Year	Automobile Dacia, Mioveni – turnover [billion EUR, conversion]	Arges county (AG) – GDP [billion EUR, conversion]	South (Muntenia) – GDP [billion EUR, conversion]	Romania (RO) – GDP [billion EUR, conversion]
2015	4.24	4.39	18.24	160
2016	4.62	4.83	20.48	167
2017	5.11	5.25	22.08	186
2018	5.31	5.74	24.11	206
2019	5.20	6.11	25.56	225
2020	3.78	5.86	24.94	221
2021	4.34	6.19	27.80	242
2022	5.21	7.54	32.53	282
2023	5.25	8.62	37.02	324
2024	5.58	9.76	40.72	351
mean	4.86	6.42	27.34	236.60
st dev	0.55	1.61	6.90	61.53
CV	0.11	0.25	0.25	0.26
min	3.78	4.39	18.24	160
MAX	5.58	9.76	40.72	353

Source: Automobile Dacia Annual Reports, National Institute of Statistics, authors' own research.

Dacia's production level in Mioveni has constantly been above 300,000 units with an all-time record in 2019 (349,528 units and 99.86% output ratio). The pandemic years (2020-2021) decreased volumes by 25% to only around 250,000 vehicles/year before regular outputs of above 300,000 units were reestablished (2022-2024). Despite the recent slightly decreasing tendency in production volumes, Dacia's turnover has been indirectly proportional to its produced output due to a higher share of its more expensive models (Duster, Jogger, Bigster) being built in Mioveni. In the last decade Dacia's contribution to the Arges county's gross value added has increased by almost 8% (from 34.6% in 2015 to around 42%, 2024). After being the leading economic driver of its region for over a decade (2005-2015, after the launch of the first Logan model), Dacia's contribution has been rather stable at local level (24%) and slightly decreasing at regional level due to an increasing number of businesses also producing economic benefits (mainly as partnering or service providers of Dacia). Dacia's consistency in economic impact is confirmed by similar values for the coefficient of variation (CV = 0.25) for its surrounding area (county and region) as well as overall contribution to Romania's GDP (0.26).

Craiova (the only city in its region with a population exceeding 100,000) has a demographic of 234,140 residents, a figure that accounts for 43% of the combined population of the five administrative centers within the South-West Oltenia (SWO) region: Mehedinti, Gorj, Olt, Dolj and Valcea. Based on 2021 census data, Dolj county (599,442 inhabitants) comprises 25% of the

South-West Oltenia (SWO) area and nearly a third (31.99%) of its total population of 1,873,607. Economically, Dolj maintains a dominant regional position with an estimate of 8.71 billion euros, 33.81% share within the SWO's GDP, an output significantly outpacing the region's second-largest economy, Gorj, of only 5.13 billion euros (National Institute of Statistics and National Bank of Romania annual average exchange rate conversion, 2024). Following Ford's capital investments and scaled production in Craiova, the firm's socio-economic contributions have expanded significantly, as evidenced in Table 2.

Table 2. Macroeconomic Weight of Ford Otosan within Regional and National GDP, 2015-2024

Metric/ Year	Ford Otosan, Craiova – turnover [billion EUR, conversion]	Dolj county (DJ) – GDP [billion EUR, conversion]	South-West (Oltenia) – GDP [billion EUR, conversion]	Romania (RO) – GDP [billion EUR, conversion]
2015	0.85	3.44	11.46	160
2016	0.82	3.54	11.22	167
2017	1.05	4.11	12.85	186
2018	2.27	4.76	12.36	206
2019	2.18	5.42	16.47	225
2020	2.45	5.43	17.65	221
2021	2.28	5.84	18.84	242
2022	2.76	6.31	21.68	282
2023	2.71	7.93	23.82	324
2024	3.78	8.23	26.19	351
mean	2.11	5.50	17.25	236.60
st dev	0.95	1.66	5.37	61.53
CV	0.45	0.30	0.31	0.26
min	0.82	3.44	11.22	160
MAX	3.78	8.23	26.19	353

Source: Ford Otosan Annual Reports, National Institute of Statistics, authors' own research.

In 2017, Ford generated over 1 billion euros in revenue, a figure that would double just one year later to 2.27 billion euros following a tripling of production output to nearly 150,000 vehicles in 2018 (National Bank of Romania annual average exchange rate conversions, 2015-2024). From 2018 to 2023, sales consistently surpassed the 2 billion euro mark, remaining resilient even through the pandemic years (2.45 billion euros in 2020 and 2.28 billion euros in 2021). By 2024, turnover nearly reached 4 billion euros, representing a 39% year-on-year increase. With a total turnover of 3.78 billion euros last year, Ford achieved record sales in Craiova, effectively expanding its economic output by 4.4 times over the last decade (since 2015). The importance of the Ford Otosan factory in Craiova has steadily grown within Dolj county, rising from roughly 25% in 2015 to approximately 46% in 2024, as well as in the Oltenia region, where it increased from around 12% in 2015 to 26% in 2024. This trend indicates that Ford's growth is highly correlated with the economic expansion of the surrounding area. Ford's economic footprint is further confirmed by a higher coefficient of variation (CV = 0.45) for its immediate vicinity (city, county, and region) when compared to its impact on national GDP (0.26). The growing prominence of car manufacturing and the automotive sector in Romania is highlighted by its top three exporters (Automobile Dacia, Star Assembly, and Ford Otosan) which serve as major players on both

national and European scales. Their economic contributions are reflected in the national GDP, which has seen consistent growth over the past decade (with the exception of the 2020 pandemic year), reaching record levels: exceeding 200 billion euros since 2018, 300 billion euros since 2023, and more than doubling in value (2.2 times) over the last 10 years. To quantitatively assess the relationship between the financial performance of Automobile Dacia and Ford Otosan against their associated regional and national economic indicators, a regression analysis was conducted, with the results detailed in Table 3.

Table 3. Macroeconomic Weight of Dacia and Ford, Regression Statistics (2015-2024)

Dacia	Mult R	Adj R ²	F	Sign F	Coef		Std Err	P-value	Low 95%	Up 95%
GDP AG	0.594	0.272	4.36	0.07015	β_0	-2.03	4.07	0.631	-11.43	7.36
					β_1	1.73	0.83	0.070	-0.18	3.65
GDP SM	0.562	0.231	3.71	0.09018	β_0	-6.86	17.87	0.710	-48.07	34.34
					β_1	7.03	3.65	0.090	-1.38	15.45
GDP RO	0.533	0.195	3.19	0.11187	β_0	-52.57	162.92	0.755	-428.2	323.13
					β_1	59.44	33.27	0.111	-17.29	136.19
Ford	Mult R	Adj R ²	F	Sign F	Coef		Std Err	P-value	Low 95%	Up 95%
GDP DJ	0.924	0.836	46.94	0.00013	β_0	2.12	0.54	0.004	0.87	3.38
					β_1	1.62	0.23	0.000	1.07	2.16
GDP SWO	0.910	0.808	39.02	0.00024	β_0	7.38	1.80	0.003	3.22	11.54
					β_1	4.90	0.78	0.000	3.09	6.71
GDP RO	0.912	0.812	39.95	0.00022	β_0	104.77	22.66	0.001	52.50	157.05
					β_1	62.32	9.85	0.000	39.58	85.06

Source: Authors' own research.

The results of the regression analysis indicate a moderate association between Automobile Dacia's performance and its local (Arges county), regional (South-Muntenia), and national (Romania) economic outputs. The models yield Pearson coefficients (Multiple R) ranging from 0.53 to 0.59 and adjusted R² values between 0.19 and 0.27. The F-statistics remain above 3.0 in all three instances, suggesting the model variation still exceeds unexplained error (values decrease when shifting from county to regional and national level), though with reduced statistical strength. The β_1 estimates across the three contexts (1.7, 7.0, and 59.4) show t-statistic values that are less robust, resulting in p-values between 0.07 and 0.11. Consequently, these relationships do not meet the standard threshold for statistical significance at the $p < 0.05$ level. This decreased precision is further reflected in the wider 95% confidence intervals (lower and upper 95%), which, in all three cases, include zero, indicating a higher degree of uncertainty in the resulting estimates. On the other hand findings of the regression analysis demonstrate a robust correlation between Ford Otosan's turnover and economic outputs at the local (Dolj county), regional (Oltenia), and national (Romania) levels. Each relationship yields Pearson coefficients of above 0.9 and adjusted R² values of over 0.8. Furthermore, the F-statistics indicate that the model's explained variance significantly outweighs the residual error. The coefficients produced t-statistics ranging from 3.91 to 6.85, achieving statistical significance at $p < 0.05$ across all three models, with the β_1 estimates proving notably precise (6.85, 6.24, and 6.32). This high degree of estimation accuracy is further supported by the 95% confidence intervals (both lower and upper bounds). The robustness of the primary regression models was further evaluated using time-trend and first-difference specifications in

order to account for potential spurious correlations inherent in time-series data. While the time-trend model controls for the consistent upward slope of the variables over the decade, the first-difference approach evaluates the relationship between annual growth rates to isolate direct, year-over-year associations. As summarized in Table 4, these checks clarify the distinction between long-term shared growth trends and direct annual economic associations for both Automobile Dacia and Ford Otosan.

Table 4. Dacia and Ford's Robustness Checks: Time-Trend and First-Difference Regression Results

Automobile Dacia (Dependent Variable)	Time-Trend Adj R ²	Time-Trend (p-value)	First-Diff (p-value)	Robustness Result
GDP AG	0.92	0.034	0.047	Robust Association
GDP SM	0.95	0.033	0.021	Robust Association
GDP RO	0.95	0.060	0.064	Moderate Link
Ford Otosan (Dependent Variable)	Time-Trend Adj R ²	Time-Trend (p-value)	First-Diff (p-value)	Robustness Result
GDP DJ	0.94	0.783	0.686	Trend-Dependent
GDP SWO	0.94	0.521	0.517	Trend-Dependent
GDP RO	0.92	0.858	0.793	Trend-Dependent

For Automobile Dacia, the results remained statistically significant even after detrending ($p = 0.047$ for Arges GDP and $p = 0.021$ for South-Muntenia GDP), suggesting a rather resilient annual association between turnover and regional economic performance. In contrast, while Ford Otosan's turnover shows a strong long-term alignment with regional growth, the significance in the first-difference model was reduced, indicating that its economic impact is characterized by a shared long-term trajectory rather than direct year-over-year fluctuations. Examination of automotive production trends over the last ten years (summarized in Table 5) reveals that Romania's car industry has remained more resilient than several EU counterparts. While production in countries such as Germany, Spain, Slovakia, and Poland has stagnated, and output in France and Italy has contracted by as much as 30-40%, Romania has faced comparatively more moderate impacts.

Table 5. Automobile Dacia and Ford Otosan Production Metrics in Romania, 2015-2024

year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Mioveni output [units]	320457	313883	335262	349528	259099	257405	314678	322086	309432	297182
capacity utilization [%]	91.55	89.68	95.78	99.86	74.02	73.54	89.90	92.02	88.40	84.91
<i>production share [%]</i>	<i>89.18</i>	<i>87.37</i>	<i>70.32</i>	<i>71.27</i>	<i>59.14</i>	<i>61.17</i>	<i>61.76</i>	<i>62.77</i>	<i>55.24</i>	<i>54.48</i>
Craiova output [units]	38849	45367	141507	140884	179008	163350	194787	190964	250670	248328
capacity utilization [%]	15.54	18.14	56.60	56.35	71.60	65.34	71.61	70.20	92.15	84.75
<i>production</i>	<i>10.81</i>	<i>12.62</i>	<i>29.68</i>	<i>28.72</i>	<i>40.85</i>	<i>38.82</i>	<i>38.23</i>	<i>37.22</i>	<i>44.75</i>	<i>45.52</i>

<i>share [%]</i>										
total output [units]	359306	359250	476769	490412	438107	420755	509465	513050	560102	545510
aggregate capacity utilization [%]	59.88	59.88	79.46	81.74	73.02	70.13	81.91	82.48	90.05	84.84

Source: Automobile Dacia and Ford Romania/Ford Otosan – Annual Reports, authors’ own research.

Despite approaching the 500,000-unit threshold in the late 2010s, the Romanian car industry experienced a 15% production downturn during the pandemic (2020-2021), primarily due to Dacia’s 25% output contraction. The sector rebounded in 2022 as Dacia’s figures (314,678 units) returned to more standard levels, while the facility in Craiova maintained its upward trajectory and achieved record production output (194,787 units). Together, these factors led to a 21% year-on-year increase, finally pushing the country’s total production beyond the half-million milestone for the first time with an aggregate level of 509,465 vehicles. This growth trajectory persisted as output climbed above 510,000 units (2023) before eventually peaking at an unprecedented 560,102 vehicles (2024) following a growth of nearly 10% year-on-year. Despite a marginal contraction of 2.6% in 2025, the Romanian car industry maintains its robust performance compared to historical averages and easily upholds its 4th consecutive year of output beyond the 500,000-vehicle threshold. Summary statistics for both carmakers’ production metrics, as well as their combined total output in Romania is provided in Table 6.

Table 6. Dacia and Ford Production Metrics in Romania (2015-2025), Summary Statistics

		Dacia, Mioveni (Arges)			Ford, Craiova (Dolj)			Romania, total		
		mean	st dev	CV	mean	st dev	CV	mean	st dev	CV
5-year avg (2016-2020)	output [units]	315,646	30,843	0.09	109,123	56,471	0.51	424,769	56,159	0.13
	capacity utilization [%]	90.19	8.81	0.09	32.09	22.58	0.70	70.79	9.35	0.13
	production share [%]	75.46	11.32	0.15	24.54	11.32	0.46	-	-	-
5-year avg (2021-2025)	output [units]	300,157	22,866	0.07	209,620	34,329	0.16	509,776	48,467	0.09
	capacity utilization [%]	85.76	6.53	0.07	77.12	10.01	0.12	81.98	6.54	0.07
	production share [%]	59.09	3.49	0.05	40.91	3.49	0.08	-	-	-
10-year avg (2016-2025)	output [units]	307,901	28,232	0.09	159,371	68,619	0.43	467,272	67,513	0.14
	capacity utilization [%]	87.97	8.06	0.09	61.08	24.08	0.39	76.48	9.79	0.12
	production share [%]	67.27	11.71	0.17	32.73	11.71	0.35	-	-	-

Source: Automobile Dacia and Ford Romania/Ford Otosan – Annual Reports, authors’ own research.

Manufacturing at Dacia’s Mioveni facility has remained remarkably stable, averaging over 300,000 units annually with a ten-year capacity utilization rate of nearly 90%. This steady output is corroborated by low coefficient of variation (CV) values across all three study periods, consistently staying under 0.1, though utilization slightly moderated from 90-95% (2016–2020) to 80-85% more recently. In contrast, Ford’s growth in Craiova progressed through three distinct tiers: approximately 15-20% capacity (2016–2017), 55% (2018–2019), and 70% (2020–2023), eventually hitting a record high of over 90% in 2024. While Ford’s early years (2012–2015) were

characterized by higher volatility, its operational stability during the 2021–2025 window (CV = 0.12) has converged with Dacia’s metrics. Consequently, the national production mix has shifted: Dacia’s share fell from 90% in 2016 to 60% during 2020–2023. Ford’s 2024 record output of 250,670 units was almost matched in 2025 (45% of total car production volume), boosting Romania’s total capacity utilization by over 10 percentage points (to 81.98%) in the last 5 years and coming close to a fourth straight year of record national production. Both Dacia (-3.95%) and Ford’s (-0.93%) lower outputs meant 2025 car production volumes would not match the record 560,102 units from 2024. Aggregate CV values for the country (0.07–0.13) confirm low overall output variability, underpinned by Dacia’s consistency and Ford’s recent 30% upswing. An overview of production operations at Automobile Dacia (FVL and CKD/SKD kits) and Ford Otosan’s main sites (only FVL) before and after Covid-19 is provided in Table 7.

Table 7. Recent Production Volumes at Dacia and Ford Otosan’s Main and Other Production Sites

	2019	2022	2023	2024	2025
Dacia, Mioveni (RO)	349,528	314,678	322,086	309,432	297,182
Dacia, Tanger (MA)	303,559	255,494	287,860	312,381	299,395
other sites (CKD-SKD)	357,165	341,472	338,793	329,143	342,568
Dacia production (agg)	1,010,252	911,644	948,739	950,956	939,145
Ford, Craiova (RO)	140,884	194,787	190,964	250,670	248,328
Ford, Kocaeli (TR)	265,095	251,755	242,425	159,338	392,450
other sites (FVL)	108,542	119,086	156,369	222,675	137,480
Ford production (agg)	514,521	565,628	589,758	632,683	778,258

Source: Renault-Nissan Alliance and Ford Romania/Otosan – Annual Reports (2019–2025), authors’ own research.

Dacia’s production operations are split between Mioveni (Romania), Tangier (Morocco) and other Renault-Nissan Alliance plants around the world which use CKD/SKD kits shipped through the AILN to assemble the brands models, as Renault-branded entry models usually, with only minor local variations to meet local market specifics (Renault Taliant, Nissan Terrano). Dacia-related production data is consistently balanced at around 950,000 vehicles/year, roughly one third being made in Mioveni, Tanger and other Renault-Alliance overseas sites (Africa, South America, Asia). Ford Otosan, on the other hand, has operations concentrated only in Turkey and Romania, but its investments in plant modernization and increasing production capacity have brought about a positive production dynamic. Compared to 2019, production output in Craiova has increased by more than 100,000 units (+76%), whereas in Turkey, where it holds two thirds of production capacity (Golcuk and Yenikoy in Kocali, Inonu in Eskisehir), most recent figures for 2025 show a significant 23% overall increase (778,258 vehicles) with Golcuk generating half of Ford Otosan’s total output (392,450 units).

After phasing out the Logan (Bursa, Turkey) and Sandero Stepway models (Tangier and Casablanca, Morocco), the plant in Mioveni will only produce Dacia’s higher end SUV models (Duster, Bigster) starting 2026. Ford’s assembly lines are designed for multi-powertrain flexibility, enabling the facility to shift or scale the volume of ICE, hybrid, or EV models according to current demand. Almost two thirds of cars produced in Craiova were Puma (155,073 units), the rest being Courier (93,225 units) with 99% of vehicles being exported (2025). Dacia and Ford use a mix of road transport, rail freight and sea shipping from their production sites in southern Romania (as highlighted in Figure 2) to distribute and export cars across Europe (FVL) and overseas (FVL and CKD/SKD). Both brands predominantly employ an intermodal logistics framework, with most of their vehicle output dispatched via unit trains that integrate road and rail transport (50–70%). The

remaining production volume (20-30%) is either routed to the Port of Constanta, where rail freight serves as the primary mode of transit or uses multiple car hauling FVL via truck/trailer units (10-30%).

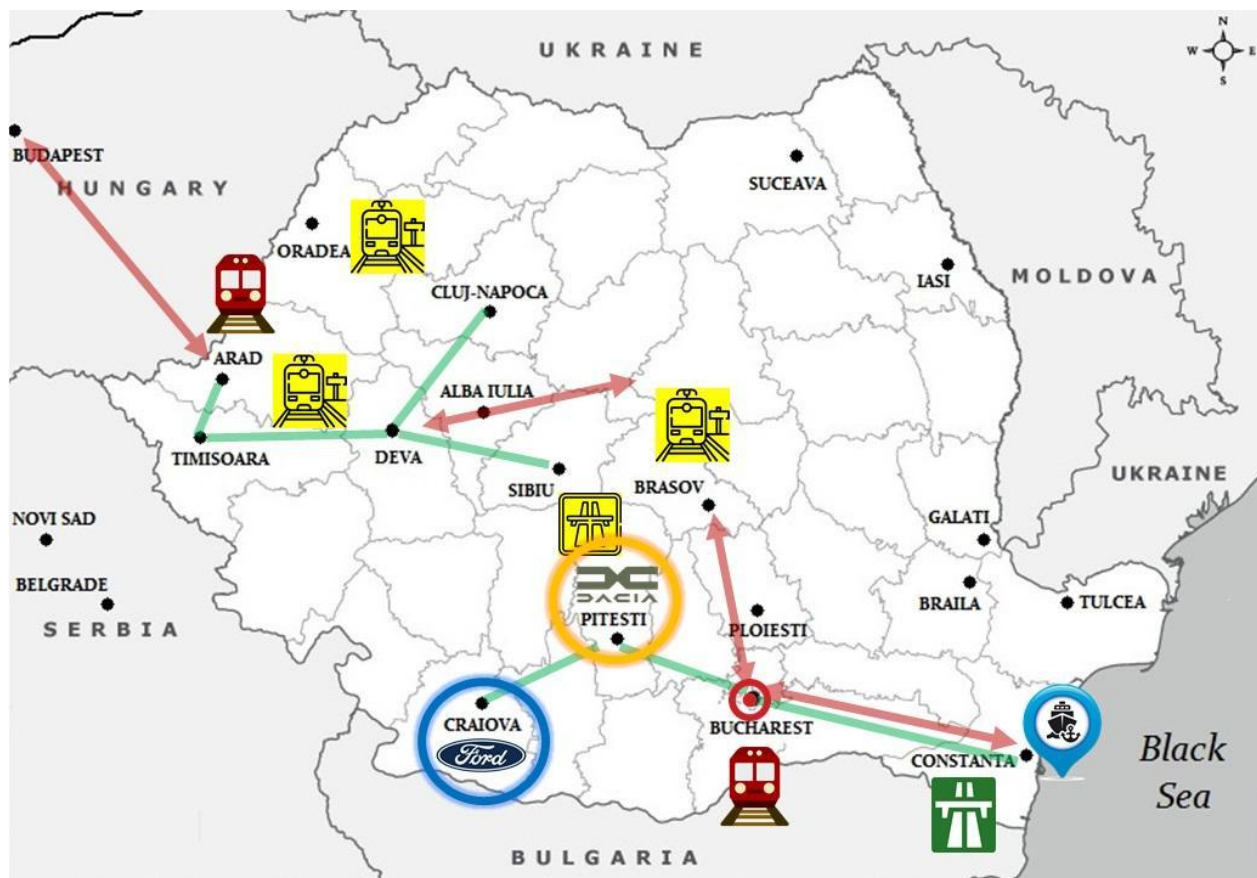


Figure 2. Mapping Dacia and Ford's Sites and Major Road (green) and Rail (red) Interconnections

Source: Authors' own research.

The factory in Mioveni is 530 km away from the border with Hungary by road: over 75% is on the A1 motorway (Sibiu-Nadlac) with 2 incomplete sections along the way: Curtea de Arges-Boita (108 km, E81) and Holdea-Margina (15 km, DN 68A). Craiova's Ford Otosan factory is 100 km closer (427 km to Nadlac), but only 35% is on the A1 motorway (145 km, Lugoj-Nadlac) with the main stretch being on the slower E70/DN6 road (Craiova-Lugoj). Reaching the Romanian-Hungarian (Curtici-Lokoshaza) border crossing near Arad by rail involves using the M100 (Bucharest-Timisoara) via 901 (Bucharest-Craiova) and a total of 540 km from Automobile Dacia's factory. Ford's journey is 142 km shorter since Craiova is part of the M100, but less than 5% of the entire stretch is on main rehabilitated railway lines (including M310 Timisoara-Arad and M200 Arad-Curtici). Reaching Constanta Port from Mioveni is done via 901 (Pitesti-Bucharest, 108 km) before taking the M800 (Bucharest-Constanta) for a total of 333 km on rail. From Craiova, Ford reaches the 225 km of rehabilitated M800 after 209 km on M100 (Craiova-Bucharest) for a total of 434 km on rail. Road transport takes 365 km from Dacia's plant in Mioveni using only motorway connections (A1 Pitesti-Bucharest, new A0 Bucharest bypass, A2 Bucharest-Constanta, A4 port area), whilst Ford Otosan's journey is 104 km longer, but the extra stretch is on a newly built expressway (DEx12 Craiova-Pitesti). The rail border crossing (Curtici-Lokoshaza) to

Hungary from Curtici Cargo Center (Arad county) gives access to more reliable rail/intermodal schedules, whereas the Port of Constanta is the main overseas distribution hub for both Dacia (FVL and CKD/SKD) and Ford Otosan (FVL) exports. An overview of Dacia and Ford's outbound logistics (FVL) distribution operations locations is presented in Figure 3.



Figure 3. Dacia and Ford's Main Road, Rail and Sea FVL DC Locations

Source: Renault Group/Renault-Nissan Alliance and Ford Otosan – Annual Reports, authors' own research.

More than 90% of all vehicles made in Mioveni (93%) and Craiova (99%) are exported by use of intermodal transportation: road-rail (to Curtici Cargo Center) for EU outbound distribution and rail (to Constanta Port) for overseas shipping. 149,212 vehicles with 698 unit trains were distributed from Mioveni to Valenton, France in 2024. Ford Otosan's FVL shipping volume was 15% higher (175,469 vehicles) to Neuss, Germany, albeit with a similar number of unit trains (702). Dacia's DC in Valenton is further than Neuss, but registered data shows a lower CV (0.05) for this route due to its more regular schedule, the contracted LSPs handling this section (GEFCO/CEVA Logistics) and the increased use of reliable rail connectivity. Ford Otosan's unit train has its main rail DC at Neuss, Germany (CV = 0.09), but it has an alternative to continue its rail connection all the way to Vlissingen, The Netherlands (via Antwerp, Belgium) for shipments further north. Mars Logistics and DB Cargo Romania are LSP involved in handling loading operations in Craiova (4-6 hours) with shunting, securing and technical inspection (1-2 hours each) bringing the total process time up to 11 hours. While Romania's entry into the Schengen Area (January 1, 2025) lifted formal

border checks for freight trains, which historically accounted for average delays of up to 10–12 hours per train, infrastructure projects have complicated the transition. Specifically, works on the Biharkeresztes-Episcopia Bihor crossing (April–July 2025) and the M300 line between Oradea and Cluj (scheduled for 2026 completion) forced traffic diversion through the Curtici corridor. Internal monitoring suggests this concentration of traffic resulted in localized congestion, partially offsetting the time gains provided by the border opening. Based on preliminary estimates for the first half of 2025, derived from stakeholder interviews and early-stage transit logs, automotive FVL lead times via intermodal transport appear to have improved following Schengen accession. Indicative data suggests a 10–15% reduction in total lead times, primarily associated with the drastic reduction in border waiting times, dropping from an average of 6–12 hours (2024) to an estimated range of 15–30 minutes (2025). However, these figures remain fairly sensitive to infrastructure-related bottlenecks and should be treated as early-stage observations rather than definitive absolute data, at least at this stage of the research. Sea shipments from Constanta (0.15 and 0.16) and road haulage towards DCs in Hungary (0.07) and Austria (0.09) have almost matching CV values for both Dacia and Ford, an alignment likely due to similar and/or shared routing, as shown by lead time ranges from Table 8.

Table 8. Breakdown of Dacia and Ford’s Outbound Shipments by Transportation Mode

Automobile Dacia – Groupe Renault, Mioveni (Arges) – Region: South (Muntenia), Romania									
main mode of transportation	road transportation			rail freight			sea shipping		
FVL volumes	550-600 trucks/week 23,842 trucks (2024)			11-15 trains/week 698 trains (2024)			1-2 ships/week 70 ships (2024)		
average loading capacity (vehicles)	6-10 cars/truck 160,220 vehicles (2024)			224-294 cars/freight train 149,212 vehicles (2024)			2,000-6,000 cars/ship 117,225 vehicles (2024)		
distribution center (main destination)	<u>Budapest</u> (Hungary)			<u>Valenton</u> (France)			<u>Tangier</u> (Morocco)		
distance	725 km (road)			2287 km (rail)			3741 km (sea)		
average lead time	12 hours			62 hours			13 days		
lead time range (min, max, CV)	11h	15h	0.0712	56h	72h	0.0574	8 days	18 days	0.1570
Ford Otosan – Ford Motor Company, Craiova (Dolj) – Region: South-West (Oltenia), Romania									
main mode of transportation	road transportation			rail freight			sea shipping		
FVL volumes	200-250 trucks/week 10,739 trucks (2024)			10-18 trains/week 702 trains (2024)			1-3 ships/month 21 ships (2024)		
average loading capacity (vehicles)	6-8 cars/truck 75,170 vehicles (2024)			224-294 cars/freight train 175,469 vehicles (2024)			2,000-6,000 cars/ship 50,134 vehicles (2024)		
distribution center (main destination)	<u>Straßwalchen</u> (Austria)			<u>Neuss</u> (Germany)			<u>Dagenham</u> (United Kingdom)		
distance	1150 km (road)			1800 km (rail)			6020 km (sea)		
average lead time	19 hours			68 hours			15 days		
lead time range (min, max, CV)	17h	24h	0.0936	56h	86h	0.0953	12 days	22 days	0.1655

Source: Automobile Dacia/Renault-Nissan Alliance and Ford Otosan personal communications (2024-2025).

The reliability of rail transport for Romanian automotive exports (FVL) has deteriorated significantly over the last decade. Between 50-70% of all Dacia’s FVL involves rail or intermodal transportation to either Curtici Cargo Center (CEE and Northern Europe) or Constanta Port (Mediterranean, UK and overseas). While 90% of Craiova’s output was rail-bound prior to 2019, current industry projections suggest this share may fall to roughly 60% as average freight speeds

are at only 15.2 km/h (CFR Marfa, 2025). The inefficiencies are most evident in transit times: the 398 km journey from Craiova to Railport Arad often requires 26–35 hours, a significant variance compared to the technical requirement of 11 hours or the desired baseline of 18–24 hours, with an additional 4–6 hours to factor in for deliveries from Mioveni (540 km). These delays are amplified by the prioritization of passenger traffic (also often late), bottlenecks on single-track sections and countless speed limitations, adding further uncertainty in LSP's efforts to accurately predict rail transit time. Between 2015 and 2024, chronic underinvestment caused technical speeds to drop from 45 km/h to 30 km/h, while observed average speeds worsened at a slower pace (from 17.8 km/h, 2015 to 15.15 km/h, 2024). In contrast, the 426 km route to the Port of Constanta remains more efficient thanks to the modernized Bucharest-Constanta M800 line (225 km), enabling 20% of Ford's (FVL) and almost 40% of Dacia's (FVL and CKD/SKD) deliveries to reach the port in an average of 12 hours. Dacia's Constanta-dispatched Ro-Ro throughput (117,225 vehicles, 2024) is usually bound for Tangier Med, Morocco or Alexandria, Egypt (African deliveries), Sete, France (Mediterranean Europe) or Newcastle upon Tyne (UK) for all imported Renault-Nissan Alliance branded models. Of the 50,134 Ford vehicles exported via Constanta in 2024, the majority were destined for the UK (Dagenham) and European hubs (Zeebrugge, Bremerhaven, and Koper), with less than 25% allocated to non-European markets.

Trucking is strategically employed to aggregate Dacia and Ford production at the Curtici Cargo Center, bypassing rail reliability issues and facilitating more flexible and functional distribution across Eastern and Central Europe. Based on observed operational cycles, these trucks require a driving time of 7–9 hours to reach the border with Hungary (carrying an average load of 6–8 vehicles). However, accounting for variable factors such as loading/unloading (1–2 hours) and external variables (such as weight controls, route restrictions, and traffic congestions), the total turnaround time is estimated to range between 10–12 hours. Dacia's main rail DC is in Valenton (France) with Flins and Creil as alternatives in case of higher volumes at Renault Groupe's main railhead. Following Schengen accession (2025), preliminary transit data indicates that reaching rail DCs in France (Valenton) now requires 4–5 days, compared to the 7–8 days recorded prior to the lifting of border checks. While these early results are promising, they represent indicative trends based on the first months of 2025 and may be subject to fluctuation as regional rail works progress. Bruhl (20 km from Koln) can handle both rail and road distribution, with Budapest and Prague mainly employed as a DC for road haulage (only 10–30% of all Dacia FVL deliveries) in Central Europe. More than half of all Dacia deliveries (160,220 vehicles with 23,842 trucks, as of 2024) use road haulage at least partially for their FVL distribution. Ford's DC in Neuss allows for further rail haulage towards the North Sea (Vlissingen, Dagenham and/or Southampton), with trucking also being an option. Ford's main road DC is operated by Lagermax in Straßwalchen (Austria), with Mosolf handling operations in Kippenheim as an alternative to Saarlouis, after the plant here was closed (November 2025). In 2024, road-based logistics at the Craiova plant accounted for 75,170 vehicles transported via 10,739 truck shipments. Early estimates show Ford expanded its intermodal route through Constanta Port, adding roughly 12,000 vehicles destined for Istanbul with 4 weekly departures (2025). Ford Otosan thus bypassed typical trucking issues (Bulgarian border crossing congestions prior to Schengen entry), increasing efficiency of delivered FVL volumes outbound and importing parts and components from Kocaeli to Craiova inbound (round-trip logistics). By substituting over 1,500 truck flows with this intermodal rail-to-sea route associated CO₂ emissions were estimated to be reduced by more than 63%, contingent on full-year verification. For Western European distribution, Ford utilizes the Bettembourg rail hub in Luxembourg (rolling highways) to consolidate shipments for Benelux, Northern France and the

UK. For southern Europe a rail connection to Perpignan (1,050 km) is used, near the Spanish border, completing the journey requires a target lead time of approximately 21-23 hours.

Dacia's Alliance International Logistics Network (AILN) coordinates all Renault-Nissan entry range model logistics (plant supply chain – inbound and outbound parts, FVL and CKD/SKD) with some important external partners: DB Cargo and Rail Cargo Group (rail), GEFCO/CEVA Logistics, Lagermax and Hodlmayr (road), Neptune Lines and DP World (sea shipping). Ford's main logistics service providers (LSP) in Romania are DB Cargo, Mars Logistics and Lagermax (as of 2025).

Discussion

While results detailed Automobile Dacia and Ford Otosan's evolution of automotive production and regional growth, this analysis integrates these findings to synthesize the relationship between logistical constraints and economic outcomes. The data indicates that infrastructure acts as a filter for economic impact. Essentially, the quality of the logistics network determines how effectively a company's turnover translates into regional GDP growth.

The quantitative results in Table 4 reveal that Romania's logistical constraints limit the immediate economic pass-through, attenuating the annual correlation between turnover and GDP. For Ford Otosan, the transition to a trend-dependent economic impact (losing year-on-year significance when detrended) can be attributed to the low average freight speed of 15.2 km/h. Because rail exports face such significant speed restrictions and several journey bottlenecks, the immediate economic contribution of production spikes is dispersed over time. This prevents the industry from acting as an immediate short-term driver of GDP in a single year, instead manifesting a more long-term, rather gradual correlation. A clearer link can be noticed between the lead time coefficient of variation (CV) and the robustness of the regression models, with Automobile Dacia's rail routes maintaining a lower lead time CV (0.05) compared to Ford's (0.09). This higher logistical reliability is associated with Dacia's more stable and robust economic contribution over the years.

As transit times gradually become more predictable, both carmakers can transition towards just-in-sequence supply chains easier, increasing their production schedule reliability and overall cost-effectiveness. The heavy reliance on a modal split dominated by intermodal road-rail transport (50–70%) makes the sector hypersensitive to border efficiency. The 10–15% reduction in lead times following Schengen accession in 2025 represents a significant easing of border-related bottlenecks. By eliminating the previously average 6–12 hours border waiting times, the Romanian automotive industry is better positioned to sustain its current 500,000 units threshold. This suggests that the high R^2 values observed in the national GDP models are not merely a result of production volumes, more likely being linked with an enhanced efficiency of Automobile Dacia and Ford Otosan's export-driven value chains.

Conclusion

Romania's automotive industry has fundamentally shifted in recent years into a dual-pillar sector that has grown and adapted. Since 2022, annual production has comfortably cleared the 500,000-unit mark, signaling a new level of maturity and resilience within the more complicated overall automotive context. However, by synthesizing production, economic, and logistical data from 2015 to 2025, evidence suggests that this success is associated with 2 different approaches: Automobile Dacia has traditionally provided a stable, high-volume baseline with deep regional integration in Arges, Ford Otosan more recent high-growth surge that has fundamentally rebalanced the

economic landscape of the South-West Oltenia region, especially since 2022. Robustness checks using time-trend and first-difference models confirm that while the automotive industry is a central pillar of these regions, the statistical relationship for Ford is primarily driven by long-term shared growth trends. Conversely, Dacia's impact remains statistically significant even when year-on-year growth rates are isolated, confirming its role as a stable regional economic anchor. By synthesizing logistical constraints and economic outcomes, this research confirms that infrastructure performance is not merely a secondary operational concern but a primary regulator of regional economic stability.

The core value of this research is its granular analysis in exposing the logistics infrastructure paradox facing the Romanian automotive sector. Despite the transformative impact of Schengen accession in 2025, which reduced lead times by 10–15% through the clearing of border queues and bottlenecks, especially on roads, the industry is still held back by its aged and deteriorated rail network. The contrast between few modernized corridors (such as the M800 to Constanta) and the volatile, low-speed transit toward the Western border (averaging 15.2 km/h) underscores a critical vulnerability in Romania's export-driven model. Balancing high-volumes of intermodal FVL shipments to Curtici and Constanta remains challenging, despite Ford's new rail-to-sea round-trip logistics route to Turkey proving efficient and also achieving a 63% reduction in CO₂ emissions.

These findings offer a clear, data-backed confirmation that the current infrastructure is still the primary bottleneck for Romania's automotive future. Targeted investment in the missing A1 motorway links and the M100/M200 rail lines are vital necessities, as well as synchronizing these networks for intermodal transportation and mitigating its underperforming infrastructure for long-term competitiveness. Future research could extend this analysis to the electrification transition challenges, specifically investigating how the shift to EV production in Craiova and the high-end SUV focus in Mioveni will influence more energy-intensive logistics and demand within these regional clusters.

Finally, several methodological limitations must be acknowledged. The quantitative analysis relies on a relatively small sample size ($N \approx 10$ years), which limits the ability to establish definitive causal links and therefore, observed trends should be interpreted as strong associations. Furthermore, the models may be subject to endogeneity, where infrastructure improvements and GDP growth mutually reinforce one another, and omitted variable bias, as broader EU macroeconomic shifts and multinational corporate strategies also significantly influence these regional economic outcomes. Certain methodological boundaries should also be noted. The use of turnover as a metric for economic contribution, while useful for scale, lacks the precision of GVA and may overemphasize the manufacturers' direct GDP share. Additionally, the regression models for Dacia did not reach the standard threshold for statistical significance ($p > 0.05$), unlike the Ford models. This likely reflects Dacia's deep-rooted, complex integration within South Muntenia region, such as its extensive local supplier network and service providers, which were not fully captured by the localized regression parameters used in this study.

Acknowledgments: During the preparation of this manuscript, the author used Gemini 3 Flash to a limited extent for the purposes of improving language and readability in the Introduction,

Literature review and Methodology sections. The original content, conceptual framework, all preliminary versions and drafts were authored exclusively by the researcher, and the AI tool previously mentioned was used strictly for grammar and stylistic polishing. The author has critically reviewed and edited the output and takes full responsibility for the accuracy, integrity and overall content of this publication.

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