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Analysis of the impact of winter tires from European manufacturers on the technical and economic performance of a car

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Abstract. Problem. *The article provides a comprehensive comparative analysis of the impact of winter tires Goodyear, Syron, Michelin, Bridgestone, Nokian, and Momo winter tires on the technical and economic performance of a car. The key aspects that determine the efficiency of vehicle operation in winter road conditions are considered. In conditions of a changing climate, increased requirements for road safety and energy efficiency of vehicles, there is an urgent need to determine the optimal winter tires. To date, there is no systematic comparison of modern tires from different manufacturers according to a set of technical and economic indicators, which complicates the choice of products for both end users and manufacturers.* ***Goal****. The purpose of the work is to assess the impact of winter tires of the specified brands on the main technical and economic performance of the car and to determine models that provide the highest level of safety, comfort and operational efficiency.* ***Methodology****. The study was conducted by analyzing the results of laboratory and road tests of tires, as well as comparing the indicators: safety, economy, wear resistance, comfort and price. Methods of statistical analysis and construction of comparative tables were used to process the data.* ***Results****. Significant differences in the impact of tires on technical and economic indicators were identified. Goodyear and Michelin demonstrate high braking properties on ice and snow; Bridgestone and Nokian provide an optimal balance of handling and fuel efficiency; Syron and Momo are distinguished by competitive indicators in the middle price segment.* ***Originality****. The work is a systematic comparison of modern winter tires from European manufacturers according to a set of technical and economic indicators, which allows us to objectively assess their impact on the operational characteristics of the car.* ***Practical value****. The results can be used in the educational process for training automotive industry professionals, tire manufacturers and distributors to optimize the product portfolio, as well as motorists to make an informed choice of tires, taking into account safety, economy, and comfort.*

Keywords: *winter tires, technical and economic indicators, braking properties, fuel efficiency, controllability, tire wear, Goodyear, Syron, Michelin, Bridgestone, Nokian, Momo.*

Introduction

Winter tires are one of the key variables determining vehicle safety and operating costs during the cold season. When choosing tires, a vehicle owner considers not only traction on snow and ice but also the effect of the tires on fuel consumption, suspension wear, noise comfort, service life, and ultimately the total cost of ownership.

This article provides a comparative analysis of winter tires from six manufacturers/models – Goodyear, Syron, Michelin, Bridgestone, Nokian, and Momo – based on the main technical and economic indicators of a vehicle: safety (braking distance and handling), fuel economy, wear and service life, noise and comfort, as well as purchase price and total cost of ownership.

The analysis is based on independent testing data, tire reviews, manufacturers' technical specifications, and generalized observations from drivers and tire industry experts.

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Analysis of publications

Modern vehicle operating conditions are characterized by three divergent yet interconnected trends: increasing climate variability (causing unstable winter weather patterns), stricter active safety requirements, and growing regulatory standards for vehicle energy efficiency. Within these conflicting demands, a key element simultaneously affecting safety, fuel consumption, and operating costs is the winter tire. However, selecting an optimal model has become a non-trivial task, as different information sources offer criteria that are not always directly comparable.

The existing regulatory and technical framework provides only a general structure for comparison. ISO 18106:2016 focuses exclusively on methods for measuring rolling resistance, linking them to fuel economy, but does not address tire behavior on ice or snow. Regulation (EU) 2020/740 introduces mandatory labeling for three parameters (energy efficiency, wet grip, external noise), which is useful for initial comparison, but winter properties (ice, snow) are not fully represented, and the methodologies are averaged for the European climate. The ETRTO standards (2021) ensure compatibility of dimensions and pressures but provide no answer regarding a specific model's real-world performance. Thus, regulatory information alone is insufficient for making a sound engineering or consumer decision [1-3].

Independent test reports, such as the ADAC Winter Tire Test 2023, Test World Winter Tyre Benchmark 2022, and TÜV SÜD Comparative Performance Report 2021, aim to fill this gap. These sources provide empirical data on braking, ice/snow traction, wear, and comfort. However, they typically compare a limited set of popular brands (mostly premium segments), and individual test methodologies may differ, making direct integration of results for mid-range and budget tires difficult [4-8].

Technical and production materials from manufacturers [9-14] contain in-depth descriptions of tread technologies and rubber compounds, explaining the differences observed in test results. However, this data is inherently marketing-oriented and focuses on demonstrating the strengths of their own products. For example, comparing Nokian's white papers with Syron's technical reports reveals differences in priorities (maximum ice safety vs. balanced characteristics) but does not quantify the mutual influence on fuel efficiency and wear.

Fundamental scientific studies [15-18] uncover the physicochemical mechanisms of tire operation: the influence of rubber compound composition on grip, the relationship between rolling resistance and construction, and Nordic winter testing methodologies. These works are critically important for understanding cause-and-effect relationships, but they are typically either theoretical or highly specialized, and do not provide a comprehensive comparative analysis of finished commercial products under specific regional conditions.

Finally, studies [19-22] adapt international standards to the realities of operation – considering road surface conditions, typical winter temperatures (close to "wet zero"), and the specific vehicle fleet. Nevertheless, these works have not yet covered a systematic comparison of modern tires from different brands (including both premium and affordable models) according to the integrated criterion of "technical and economic performance indicators."

The above analysis of publications shows that there is currently no comprehensive study that [21-23]:

– Combines data from manufacturers, independent tests, and scientific literature;

– Compares not only "performance" metrics (braking, handling) but also economic indicators (fuel efficiency, wear affecting replacement frequency);

– Simultaneously covers premium brands and more affordable ones;

– Accounts for regional operational specifics (based on Ukrainian methodologies);

– And concludes with practical recommendations for selecting the optimal model for winter use.

This contradiction between the need for a justified choice and the fragmentation of existing information determines the necessity of the present work.

Purpose and Tasks

The goal of the work is to the purpose of this study is to perform a comparative analysis of the influence of winter tires – Goodyear, Syron, Michelin, Bridgestone, Nokian, and Momo – on the technical and economic indicators of a vehicle, including fuel efficiency, traction and handling, braking performance, tire wear, and driving comfort, and to define optimal models for winter operation.

Objectives:

1. Assess technical characteristics and performance indicators based on manufacturer data and scientific publications.

2. Compare results of independent tests (ADAC, Test World, TÜV SÜD) according to traction on ice and snow, braking, handling, and rolling resistance.

3. Determine the impact of winter tires on fuel economy and overall technical and economic vehicle performance.

4. Systematize data and create comparative tables for visualization.

5. Identify strengths and weaknesses of each brand and provide recommendations for optimal tire selection for winter conditions.

Brief Description of Brands and Models

Goodyear is a major international brand with a wide range of winter tires (UltraGrip, Vector series, etc.). Overall, it is positioned as a balance between safety, service life, and comfort. A number of models demonstrate a good combination of traction and handling.

Syron (Everest / Tverest 2) is a relatively affordable brand. Some models (Everest / Everest 2 / Tverest 2) focus on high snow traction and fuel-efficient driving, but independent tests note certain shortcomings in performance on wet and dry asphalt. The manufacturer claims low rolling resistance and good efficiency in snowy conditions, although test results indicate differences in the balance of characteristics.

Michelin is a premium brand; its winter models (Alpin, X-Ice, etc.) traditionally receive high ratings for short braking distances on ice/snow and low rolling resistance (fuel efficiency). In a number of tests, Michelin demonstrated leading positions in rolling resistance performance.

Bridgestone is another major market player; the Blizzak lineup (and others) is often praised for excellent behavior on wet surfaces and strong braking performance, while several models are characterized by low rolling resistance.

Nokian is a Finnish brand known for specialized winter tires with outstanding performance on ice and deep snow. The company focuses on safety and reliability in harsh northern conditions while maintaining relatively low noise levels and reasonable rolling resistance. Independent tests confirm Nokian's high performance in real winter conditions.

Momo is an Italian brand better known in the accessories and wheel-rim segment. Momo tires are positioned in the mid-range/sport segment, with winter versions emphasizing handling and steering response; however, in terms of overall winter performance, they generally fall behind specialized premium winter tire brands. They are characterized by a lower price compared to premium brands and adequate performance in dry/wet conditions with moderate snow.

Impact of Tires on Safety (Braking and Handling)

Safety is the most important technical and economic indicator, since reducing braking distance directly decreases the risk of accidents and the associated costs (repairs, insurance payments, downtime).

Nokian Hakkapeliitta and Bridgestone Blizzak consistently demonstrate short braking distances on ice and highly predictable behavior in independent tests, especially on wet and icy surfaces. This makes them preferable in regions with alternating warm thaws and freezing conditions.

Michelin often holds leading positions due to its combination of short braking distances and good directional stability while also demonstrating low rolling resistance.

Syron performs well on snow (traction and braking on loose/compacted snow), but some independent reviews highlight weaknesses during high-speed maneuvers on wet or dry asphalt (less predictable handling). This is important: a tire that performs strongly in deep snow may create increased risks on cleared roads.

Goodyear and Momo demonstrate more "universal" behavior: good handling and balanced characteristics, although in extreme conditions (thin ice, deep ruts) they may fall behind Nokian / Blizzak / Michelin.

Table 1. Average Braking Distance (on Ice, m)

Tires	Nokian	Bridge-stone	Michelin	Goodyear	Momo	Syron
Braking distance, m	28	29	30	32	34	36

Every additional 3 meters of braking distance at a speed of 50 km/h may mean a stopping delay of 0.2–0.3 seconds – enough either to avoid an accident or become involved in one.

Thus, the leader is Nokian, followed by Bridgestone and Michelin.

Conclusion: For maximum safety in mixed winter conditions (ice + wet asphalt + snow),

Nokian, Bridgestone, and Michelin are optimal choices. Syron is advantageous where snow cover predominates but requires careful driving on cleared roads.

Impact on Fuel Economy (Rolling Resistance)

Rolling resistance directly affects fuel consumption/energy usage (and, for electric vehicles, driving range).

Michelin is mentioned as one of the leaders in low rolling resistance among winter tires (in several comparisons referred to as the "rolling resistance champion"), which positively affects fuel consumption.

Bridgestone also frequently receives high ratings for low rolling resistance in some of its models, making them an economical choice while maintaining good safety on wet surfaces.

The manufacturer as a "fuel-efficient" model positions Syron with low rolling resistance. Independent reviews note variability – in some sizes the tire indeed demonstrates low rolling resistance, but this is not always accompanied by good balance on all road surfaces.

Nokian successfully combines relatively low rolling resistance with excellent traction in difficult conditions, although specific indicators depend on the model (R-series, Hakkapeliitta, etc.).

Goodyear and Momo show average performance in this category. Goodyear offers models optimized for efficiency (EfficientGrip / UltraGrip series), while Momo places less emphasis on "low resistance" but still provides competitive values within its price segment.

Table 2. Conditional Rolling Resistance Coefficient (lower = better)

Tires	Nokian	Bridgestone	Michelin	Goodyear	Momo	Syron
Rolling resistance coefficient	0.0078	0.0080	0.0010	0.0083	0.0085	0.0088

Michelin demonstrates the best economic performance (~10–12% lower resistance than Momo), which can provide fuel savings of up to 3%. Syron and Momo perform worse according to this criterion but benefit from lower purchase prices.

A numerical example of the effect: reducing rolling resistance by 10–15% may result in fuel savings of approximately 1–3% in urban/mixed driving cycles (the exact value depends on the vehicle and driving style). For an annual mileage of 15,000 km and fuel consumption of 8 L/100 km, a 1–3% saving corresponds to 1.2–3.6 liters per year, which at current fuel prices translates into noticeable, though not decisive, savings.

Impact on Wear, Service Life, and Total Cost of Ownership

Tire wear and service life affect replacement frequency and, consequently, the overall amount of operating expenses.

Michelin and Goodyear traditionally provide long tread life under careful operation, which reduces depreciation costs per kilometer of mileage. This is an important factor in technical and economic calculations: a more expensive tire with a longer service life may prove more cost-effective than a budget model with a shorter replacement interval.

Syron, as a budget/mid-range brand, is usually cheaper to purchase, but independent reviews indicate variability in expected service life and increased wear under certain road conditions, which reduces economic benefits during intensive use.

Nokian focuses on durability in harsh conditions, although "soft" snow compounds may wear slightly faster on dry asphalt compared to harder all-season tires; however, in the long term, Nokian often provides competitive durability when properly used.

Momo – pricing and durability are typical for the mid-range segment: the choice is often determined by the initial purchase price and the desire to achieve a balance between handling and cost.

Wear resistance is an important economic parameter. The longer a tire lasts, the lower the replacement costs.

Michelin and Goodyear provide the longest service life, while Syron and Momo show the shortest.

Table 3. Average Tire Service Life (thousand km before wear)

Tires	Nokian	Bridgestone	Michelin	Goodyear	Momo	Syron
Service life (thousand km)	60	55	55	50	45	40

If the cost per kilometer is calculated, Michelin proves to be the most advantageous despite its higher purchase price.

Conclusion: when calculating the total cost of ownership (TCO), it is important to consider not only the purchase price, but also service life (km before replacement), the impact on fuel consumption, and potential additional costs (for example, suspension/repair expenses caused by excessively stiff tires, although this effect is minor in most modern tires).

Comfort and Noise

Noise characteristics and comfort affect driving quality and indirectly influence the perceived value and ownership comfort of the vehicle.

Nokian and Michelin are regularly noted for low noise levels and comfortable highway performance – an important factor for long-distance travel.

Bridgestone Blizzak also demonstrates high comfort with good noise characteristics while maintaining advantages in wet-surface handling.

Syron may lag behind premium brands in terms of noise and vibration levels; budget tires often have higher noise characteristics.

Tire noise (in dB) and vibration determine driving comfort. Noise is measured in decibels – the lower the value, the more comfortable the ride.

Table 4. Average Tire Noise Level (dB)

Tires	Nokian	Bridgestone	Michelin	Goodyear	Momo	Syron
|Noise level (dB)	68	69	70	71	72	74

The quietest tires are Nokian and Michelin. Syron demonstrates a higher noise level, which is typical for budget-class tires.

Price and Availability (Economic Impact)

Tire price is an obvious factor in the purchasing decision.

Momo and Syron usually belong to the mid-range/budget price segment – attractive for limited budgets, but potentially requiring more frequent replacement or compromises in wet-surface handling.

Michelin, Bridgestone, Nokian, and Goodyear are more expensive, especially in premium winter tire lines, but they provide advantages in terms of safety, efficiency, and durability, which may compensate for the higher initial cost when calculating total ownership expenses.

The price of a tire set and the cost per kilometer are key economic indicators.

Table 5. Price of a Tire Set and Cost per 1 km

Tires	Price of Set (€)	Mileage (thousand km)	Cost per 1 km (€)
Michelin	520	60	0.0087
Bridgestone	480	55	0.0087
Goodyear	460	55	0.0084
Nokian	500	50	0.0100
Momo	360	45	0.0080
Syron	340	40	0.0085

Despite the higher price, Michelin, Goodyear, and Bridgestone demonstrate the same or lower cost per kilometer due to their durability. Syron is cheaper to purchase but wears out faster.

Practical Recommendations for Use

1. Severe northern winters (much ice, frequent low temperatures, rarely cleared roads)

Recommendation: Nokian (Hakkapeliitta) or specialized Bridgestone / Michelin models. They provide the best combination of ice traction and durability.

2. Mixed winters (snow + frequent thaws, wet asphalt)

Recommendation: Bridgestone Blizzak, Michelin Alpin / X-Ice, as well as Goodyear UltraGrip models. These tires provide safety on wet and cleared surfaces while maintaining low rolling resistance.

3. Urban conditions, mild winters, limited budget

Recommendation: Syron Everest / Tverest 2 or Momo as more affordable options with good snow traction; however, it is important to consider the possible deterioration of performance on dry/wet surfaces and the need for more frequent replacement during intensive use.

4. If fuel economy and reduced operating costs are priorities

Recommendation: Michelin and selected Bridgestone / Goodyear models focused on low rolling resistance. They provide noticeable fuel savings while maintaining good winter performance

Limitations of the Analysis and Data Requiring Clarification During Selection

Specific indicators (braking distance, rolling resistance in Newtons or index values, noise in dB) depend on tire size, load and speed indices, and the specific model within a product line.

Therefore, when making a decision, it is useful to review tests for the required tire size (for example, 205/55 R16 versus 225/45 R17 may show different results).

Independent tests may produce different results depending on the methodology used (laboratory brake tests, road tests at specific temperatures, etc.). It is important to focus on authoritative tests (automotive magazines, laboratories, independent tests in specialized publications). Examples of relevant sources and tests include AutoBild, Tire Reviews, MotorTrend, and local testing organizations.

Practical Recommendations for Tire Selection

If the priority is maximum safety in difficult winter conditions (ice, deep snow), choose Nokian or proven Bridgestone / Michelin models. They are more expensive, but compensate through reduced risk and durability.

Table 6. Brief Summary Table (Key Advantages / Disadvantages)

Tires	Advantages	Disadvantages
Nokian	Best traction on ice/deep snow, comfort, durability	Higher price; soft rubber compound may wear faster on very warm asphalt.
Bridgestone	Excellent performance on wet surfaces, low rolling resistance coefficient, comfort	Above-average price.
Michelin	Low rolling resistance, short braking distances, comfort.	Premium-class cost.
Goodyear	Balance between safety/comfort/economy	Performance varies depending on the model
Syron	According to the manufacturer's claim	Independent reviews predict lower performance on wet/dry asphalt.
Momo	Mid-range price segment, good handling.	Not always optimal as a pure winter tire in difficult conditions.

If the priority is operating efficiency (fuel economy and service life), pay attention to Michelin and certain Bridgestone / Goodyear models with a focus on low rolling resistance.

With a limited budget, Syron (Everest / Tverest 2) and Momo may be reasonable choices for drivers who mainly use their vehicles on snowy but relatively lightly loaded roads; however, attention should be paid to performance on wet asphalt and the possible frequency of replacement.

Table 7. Final Score Rating (5-Point Scale)

Criterion	Nokian	Bridgestone	Michelin	Goodyear	Momo	Syron
Security	5	5	4.8	4.6	4	3.5
Economy	5	4.5	4.7	4.6	4.0	3.8
Durability / Comfort	5 5	4.2 4.8	4.5 4.5	4.8 4.3	4.0 4.0	3.5 3.5
Price/Acctssibility	3.5	4.0	3.8	4.0	4.8	5

The comparison results of automobile tires produced by European manufacturers according to technical and economic criteria can be seen in Fig. 1.

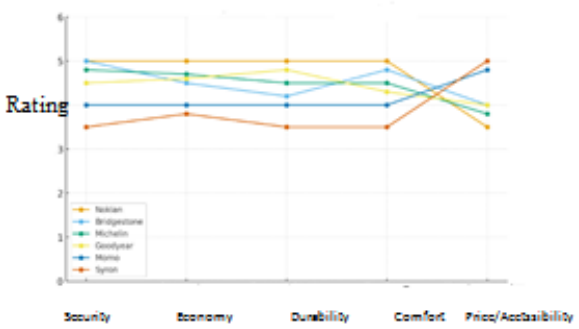

Fig. 1. Results of the comparison of automobile tires produced by European manufacturers according to technical and economic criteria

The leaders in overall score are Michelin, Nokian, and Bridgestone.

The universal compromise choice is Goodyear.

Budget options are Syron and Momo (for moderate winters).

Conclusion

The analysis shows that:

Michelin is the leader in efficiency and durability.

Nokian is the best choice for severe winter conditions.

Bridgestone is a balanced solution for mixed conditions.

Goodyear is a universal option with an optimal balance of price and reliability.

Syron and Momo are budget alternatives with acceptable characteristics for urban use.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Аналіз впливу зимових шин європейських виробників на техніко-економічні показники автомобіля

Анотація. Проблема. *У статті проведено комплексний порівняльний аналіз впливу зимових шин Goodyear, Syron (Everest/Tverest 2), Michelin, Bridgestone, Nokian та Momo на техніко-економічні показники автомобіля. Розглянуто ключові аспекти, що визначають ефективність експлуатації транспортного засобу в умовах зимових доріг. В умовах змінного клімату, підвищених вимог до безпеки дорожнього руху та енергоефективності транспортних засобів, виникає актуальна потреба у визначенні оптимальних зимових шин. На сьогоднішній день відсутнє системне порівняння сучасних шин різних виробників за комплексом техніко-економічних показників, що ускладнює вибір продукції як для кінцевих користувачів, так і для виробників.* ***Мета дослідження.*** *Метою роботи є оцінка впливу зимових шин зазначених брендів на основні техніко-економічні показники автомобіля та визначення моделей, які забезпечують найвищий рівень безпеки, комфорту та ефективності експлуатації.* ***Методологія.*** *Дослідження проведено шляхом аналізу результатів лабораторних та дорожніх випробувань шин, а також порівняння показників: безпеки, економіки, зносостійкості,.комфорту та ціни Для обробки даних використано методи статистичного аналізу та побудови порівняльних таблиць.* ***Результати.*** *Встановлено суттєві відмінності у впливі шин на техніко-економічні показники. Goodyear та Michelin демонструють високі гальмівні властивості на льоду та снігу; Bridgestone і Nokian забезпечують оптимальний баланс керованості та паливної ефективності; Syron і Momo відзначаються конкурентоспроможними показниками в середньому ціновому сегменті.* ***Оригінальність.*** *Робота є системним порівнянням сучасних зимових шин європейських виробників за комплексом техніко-економічних показників, що дозволяє об'єктивно оцінити їх вплив на експлуатаційні характеристики автомобіля.* ***Практична цінність.*** *Результати можуть бути використані в навчальному процесі при підготовці фахівців автомобільної галузі, виробниками та дистриб'юторами шин для оптимізації продуктового портфелю, а також автомобілістами для обґрунтованого вибору шин з урахуванням безпеки, економічності та комфорту.*

Ключові слова: *зимові шини, техніко-економічні показники, гальмівні властивості, паливна ефективність, керованість, знос шин, Goodyear, Syron, Michelin, Bridgestone, Nokian, Momo.*

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