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FROM ASSEMBLY TO TECHNOLOGICAL CAPABILITY: LESSONS FROM CHINA'S AUTOMOTIVE INDUSTRY FOR UZBEKISTAN'S INDUSTRIAL UPGRADING

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Abstract
This article examines how production scale, technological learning, supplier integration and industrial policy interact in the transformation of China's automotive industry, and assesses which elements of this experience may be relevant to Uzbekistan. The study uses a comparative industry-level approach based on secondary statistics and selected corporate cases, including BYD and the BYD–Toyota cooperation initiative. The analysis distinguishes vehicle production from domestic sales, brand ownership and the location of manufacturing, and treats observed associations as evidence of plausible mechanisms rather than conclusive proof of causality. China's position in global vehicle production and electric-vehicle supply chains reflects the combined effects of a large domestic market, accumulated engineering capabilities, dense supplier networks, competitive pressure and sustained policy support. Uzbekistan has also developed significant production capabilities, including engine manufacturing, precision casting, machining and passenger-vehicle assembly. However, the depth of localisation cannot be assessed adequately through assembly volumes alone. The article proposes an evaluation framework based on domestic value added, supplier capability, productivity, research and development, export diversification and quality performance.

Keywords: Automotive industry; China; Uzbekistan; industrial upgrading; electric vehicles; global value chains; localisation; domestic value added; industrial policy.

Introduction

The geography of the global automotive industry has changed substantially over recent decades. China has become the largest vehicle-producing economy while accelerating the electrification of transport and expanding the international presence of its manufacturers. This shift is important not only because of the number of vehicles produced, but also because production capabilities have increasingly extended into batteries, power electronics, software and other strategically important components.

The central research problem is to explain how a large domestic market can be converted into durable technological and export competitiveness. Market size may enable firms to spread fixed costs over higher output, but scale alone does not guarantee innovation, productivity or

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international success. These outcomes also depend on engineering capabilities, supplier relationships, competitive conditions and the design of public policy. For economies with smaller domestic markets, such as Uzbekistan, the relevant question is therefore not whether China's model can be copied in full, but which mechanisms can be adapted to local industrial conditions.

The article advances the proposition that competitive capability emerges from the interaction of four mechanisms: production scale, technological learning, supplier integration and institutionally supported competition. Implementing isolated incentives without building links among these mechanisms may generate assembly capacity without comparable growth in local value added or engineering competence.

The article contributes an analytical framework—scale, technology, cooperation and domestic value added—for comparing China's automotive transformation with Uzbekistan's industrial development. It identifies potential policy applications and proposes indicators through which progress can be assessed. The analysis is exploratory and does not claim to isolate the causal effect of each factor.

2. Literature Review and Analytical Framework

Three strands of research inform the analysis. First, the literature on competitive advantage and industrial clusters emphasises the interaction between factor conditions, demanding markets, related industries and rivalry among firms. Second, global value-chain research examines how production tasks, value added and decision-making are distributed across firms and countries. Third, the literature on technological learning stresses that acquiring advanced equipment is not equivalent to acquiring the capability to design, adapt, maintain and improve technology.

These perspectives suggest that automotive performance should be evaluated through several distinct measures: total vehicle production, domestic sales, exports, the share of electrified vehicles, component capabilities and the ownership or location of technological functions. A vehicle assembled in China may belong to a foreign brand, while a Chinese brand may manufacture abroad. Treating manufacturing location and brand nationality as interchangeable can therefore distort comparisons.

The framework used here links four dimensions. Scale can reduce average fixed costs when facilities are efficiently utilised; technological learning converts repeated production into engineering capability; supplier integration reduces coordination costs and may support faster product adaptation; and competition creates incentives to improve cost, quality and product design. Each mechanism has limitations. Excess capacity can weaken financial performance, localisation can raise costs if domestic suppliers lack scale or quality, and intense price competition can compress margins. Public support can facilitate capability formation, but poorly targeted support may preserve inefficient production.

3. Materials and Methods

The study is a comparative, qualitative and descriptive analysis based on secondary data. It draws on international automotive statistics, publications of the China Association of Automobile Manufacturers (CAAM), the International Energy Agency (IEA), Uzbekistan's

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official statistical publications, corporate information and policy documents. The period of comparison is primarily 2015–2025, while later developments are treated as contextual information rather than complete annual observations.

Four methods are applied: (1) calculation and interpretation of relative production indicators; (2) comparative analysis of industrial institutions and supply-chain structures; (3) case analysis of BYD's vertical integration and the BYD–Toyota cooperation initiative; and (4) development of policy-performance indicators for Uzbekistan. China's share of global vehicle production is calculated as national production divided by global production, multiplied by 100. Production categories are not assumed to be directly comparable where the statistical definitions differ. In particular, China's total motor-vehicle production is not compared as an equivalent measure of industrial efficiency with Uzbekistan's passenger-car output.

The evidence has important limitations. Secondary statistics use different definitions and reporting periods, and descriptive co-movement does not establish causation. The article consequently identifies plausible mechanisms and policy hypotheses that should be tested in future firm-level or panel-data research.

4. Findings and Discussion

4.1. Production scale and electrification

The source data used in this study report that China produced approximately 34.5 million motor vehicles in 2025, compared with global production of about 96.4 million. On this basis, China's calculated share was approximately 35.8%. Chinese production of new-energy vehicles was reported at around 16.6 million units. This category includes battery-electric vehicles and plug-in hybrids and should not be treated as synonymous with battery-electric vehicles alone.

The scale of production creates opportunities to spread research, platform development, tooling and testing costs across larger volumes. Nevertheless, scale is beneficial only where demand, production planning and platform architecture support efficient utilisation. Expanding capacity ahead of verified demand may increase unit costs and financial exposure. For Uzbekistan, capacity expansion should therefore be assessed alongside expected demand, export access, productivity and the utilisation of existing facilities.

4.2. Technological learning and supplier integration

Automotive competitiveness increasingly depends on capabilities beyond final assembly. Battery cells and materials, electric motors, power electronics, control systems, software and precision components influence product cost and performance. Concentration of complementary suppliers can reduce coordination costs and shorten the time needed to introduce engineering changes. At the same time, reliance on a narrow set of suppliers or a single geographical source may increase vulnerability to supply disruptions.

The relevant policy objective is not maximum localisation at any cost. Local production is economically meaningful when it builds competitive capabilities and increases domestic value added without imposing disproportionate cost or reducing quality. Evaluation should therefore consider the value of domestically generated inputs, local suppliers' technical certification,

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defect rates, productivity and the extent to which suppliers can serve more than one customer or market.

4.3. Cooperation and vertical integration: the BYD cases

The cooperation between BYD and Toyota illustrates how firms with overlapping market interests may collaborate in technology development. The companies agreed in 2019 to work jointly on battery-electric vehicles and announced the establishment of BYD TOYOTA EV TECHNOLOGY CO., LTD. in 2020. The case demonstrates an institutional form of cooperation in which complementary engineering resources can be brought together. It does not, by itself, prove that cooperation will always outperform independent development; outcomes depend on governance, intellectual-property arrangements and the distribution of responsibilities.

BYD also illustrates a vertically integrated model that combines vehicle manufacturing with in-house capabilities in batteries, electric motors and power electronics. Integration may help align component performance and accelerate engineering changes, but it can require substantial capital and concentrate technological risk within the firm. For Uzbekistan, the lesson is not necessarily to reproduce vertical integration, which may be unrealistic for a smaller market, but to identify strategic components where supplier development, joint ventures or engineering partnerships could create a credible local specialisation.

4.4. Industrial policy and international competition

China's automotive transformation has taken place in a policy environment that combines measures affecting both supply and demand. These have included support for research and development, investment incentives, infrastructure, public procurement and consumer-side measures for new-energy vehicles. Regulatory mechanisms have also encouraged manufacturers to improve fleet efficiency and expand new-energy vehicle production. Such policies can reduce early-stage uncertainty and accelerate learning, but their effectiveness depends on implementation, market discipline and the ability to withdraw support when objectives are not met.

The international response shows that industrial competitiveness is also shaped by trade policy. Measures such as the European Union's countervailing duties on battery-electric vehicles originating in China demonstrate that rapid export growth can trigger trade remedies and political resistance. An export strategy for Uzbekistan should consequently avoid reliance on a single destination and account for rules of origin, technical standards, certification requirements and the possibility of changing trade conditions.

4.5. Uzbekistan's production base and opportunities for upgrading

Uzbekistan's passenger-car production increased from approximately 190,500 units in 2015 to 457,900 in 2025, according to the figures cited in the source material. This represents an increase of roughly 2.4 times. The country's industrial base includes more than vehicle assembly: it encompasses engine production, precision aluminium casting, iron casting,

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machining and component manufacturing. These capabilities provide a platform for further industrial upgrading, although their contribution to domestic value added and export competitiveness requires systematic measurement.

The development of BYD Uzbekistan Factory, launched in Jizzakh region in 2024 with a stated first-stage capacity of 50,000 vehicles per year, creates an opportunity to expand into electrified-vehicle production. However, assembly volumes should not be interpreted as evidence of deep technological localisation. The next stage depends on supplier qualification, workforce skills, testing and certification capacity, and the ability of local firms to meet cost and quality requirements.

A selective specialisation strategy is likely to be more feasible than attempting to localise every component. Uzbekistan could prioritise component groups aligned with existing competencies and regional demand, while using international partnerships to develop capabilities in electrified powertrains, electronic systems and digital engineering. Support measures should be tied to observable outcomes rather than announced capacity alone.

5. Policy Implications and Evaluation Indicators

The findings suggest five priorities for Uzbekistan's industrial policy. First, assess market and export demand before subsidising additional capacity. Second, develop supplier-upgrading programmes that address quality management, productivity, certification and technical skills. Third, strengthen joint training between manufacturers, universities and technical institutions. Fourth, expand testing, validation and certification infrastructure so that locally produced components can meet international requirements. Fifth, encourage joint engineering and research projects where responsibilities, intellectual-property arrangements and measurable outputs are clearly defined.

Progress should be monitored through a consistent set of indicators: (a) domestic value added as a share of product value; (b) local procurement measured by value rather than supplier count; (c) labour productivity and capacity utilisation; (d) research and development expenditure relative to revenue and the number of engineering improvements introduced; (e) export share and destination-market diversification; and (f) defect rates, certification and delivery reliability. Baseline values and a defined time horizon are necessary before these indicators can be used to assess policy effectiveness.

A central risk is that localisation requirements may increase production costs without a corresponding improvement in productivity or technical capability. Support should therefore be conditional, transparent and periodically reviewed. Where domestic suppliers cannot yet meet international cost or quality benchmarks, time-bound technical assistance and partnership-based learning may be more effective than rigid local-content targets.

6. Conclusion

China's position in the global automotive industry is consistent with the combined influence of production scale, technological learning, supplier integration, competition and sustained industrial-policy support. The available descriptive evidence does not allow the independent

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causal contribution of each factor to be isolated. The cases of BYD and BYD–Toyota nevertheless illustrate two relevant organisational approaches: vertical integration of key technologies and cooperation between firms to develop new products.

For Uzbekistan, the most transferable lesson is to build interconnections between production, engineering capabilities, local suppliers and export markets rather than to reproduce China's scale or policy instruments. Existing competencies in engine production, casting, machining and vehicle assembly offer a starting point for selective specialisation. The strategic objective should be to increase domestic value added and technical capability while maintaining cost competitiveness and quality.

Future research should use firm-level panel data to examine the relationship between localisation, productivity, exports, research expenditure and employment skills. Such evidence would allow the proposed indicators to be tested and would provide a stronger basis for evaluating the effectiveness of industrial-policy interventions.

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