The development scenarios of the Russian automotive industry on the verge of the next technological revolution

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Automotive industry is one of the chief sectors of manufacturing in the industrially developed economies because of the broad range of effects it has on the economy. It is responsible for the majority of cargo traffic, the development of modern transportation infrastructure and road communications. Car production also requires the availability of a broad range of raw materials and resources; it provides stable demand for the steel industry and associated of car components production and meets a significant share of the consumer demand for personal means of transportation [9].

So far Russia has failed to keep up even with smaller car-producing countries due to weak competitiveness of the domestic automobiles. The apparent technological gap between domestic and foreign production of cars is substantial and Russian car factories fail to track the rapid succession of new generations of technology. Apart from the technological lag there is virtually no basis for production of modern car components, industrial research and development activity is weak and underfunded and the industry itself has low personnel potential.

In addition to internal problems, competition is expected to become stronger already in the medium term, thus leaving little to no time for own R&D efforts. Therefore in order to catch up the Russian automotive industry should rapidly advance by skipping a few stages of technological development. However in its current state the domestic industry is incapable of closing the gap so rapidly if at all using its only own resources.

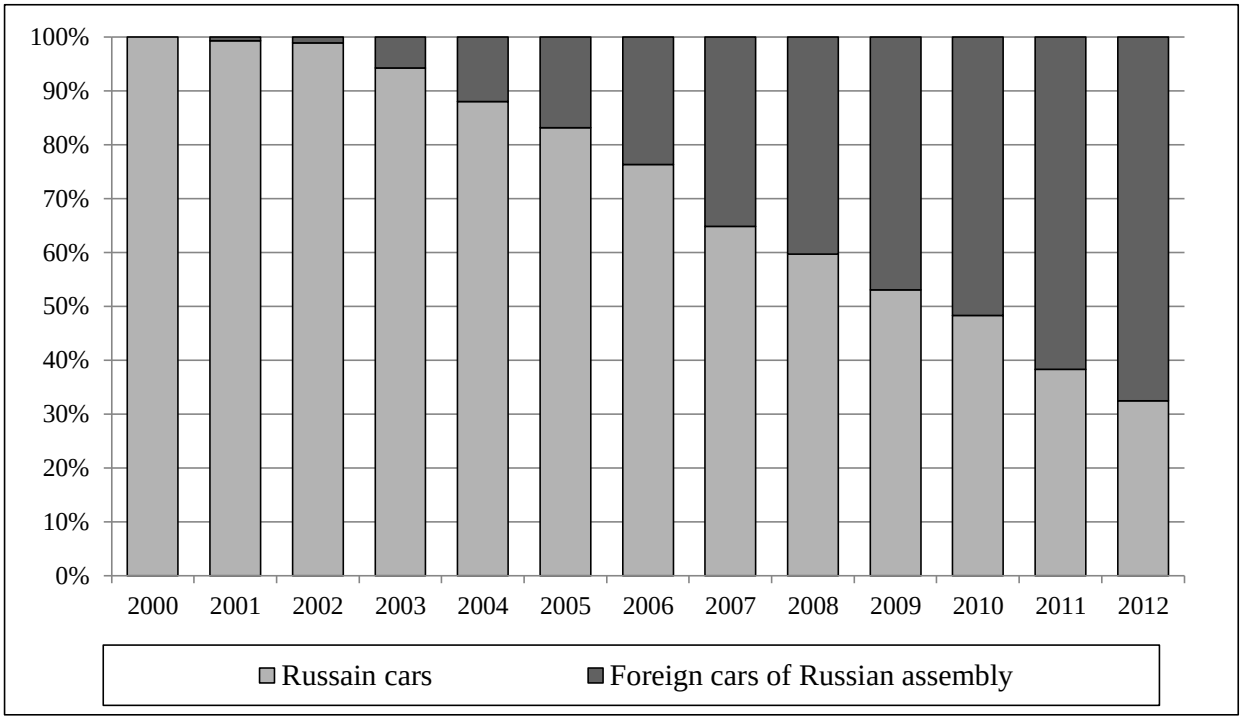
The feasibility of such accelerated development depends on the set of both the new and the already established technologies that the industry can acquire through direct foreign investments (FDI) without engaging in costly and measured design, testing and implementation process. Inflow of FDI could update and stimulate the development of the domestic automobile industry.

New technologies can be acquired even with the help of the industrial car assembly regime, by involving new producers in the construction of factories in Russia and motivating the existing ones to increase localisation levels through legislation. However, the downside is the risk of attracting dated technology and equipment needed for production of moderately outdated models, importing spare parts and car components from abroad, and halting of domestic R&D activity in the Russian automobile industry.

These observations give rise to a question of how the industrial car assembly regime is going to affect the domestic automotive industry and whether this regime is conductive to the revival of the sector.

The passenger motorcar market is one of the most dynamically developing markets in Russia: its structure has changed significantly in the last decade. With the establishment of the first foreign car assembly line in Kaliningrad in 1996, the categories of Russian cars and imported foreign cars were complimented by the third one – the foreign cars of domestic assembly. And the share of foreign cars in production has been rapidly growing ever since the introduction of industrial car assembly regime in 2002, (pic. 1). The volume of domestically produced foreign cars surpassed the production of Russian cars for the first time in 2010, and its share approached the milestone of 70% in 2012. The dynamics of passenger motorcar sales confirms stably high demand for foreign cars assembled in Russia, because the sales of Russian cars have been less than 30% since 2008.

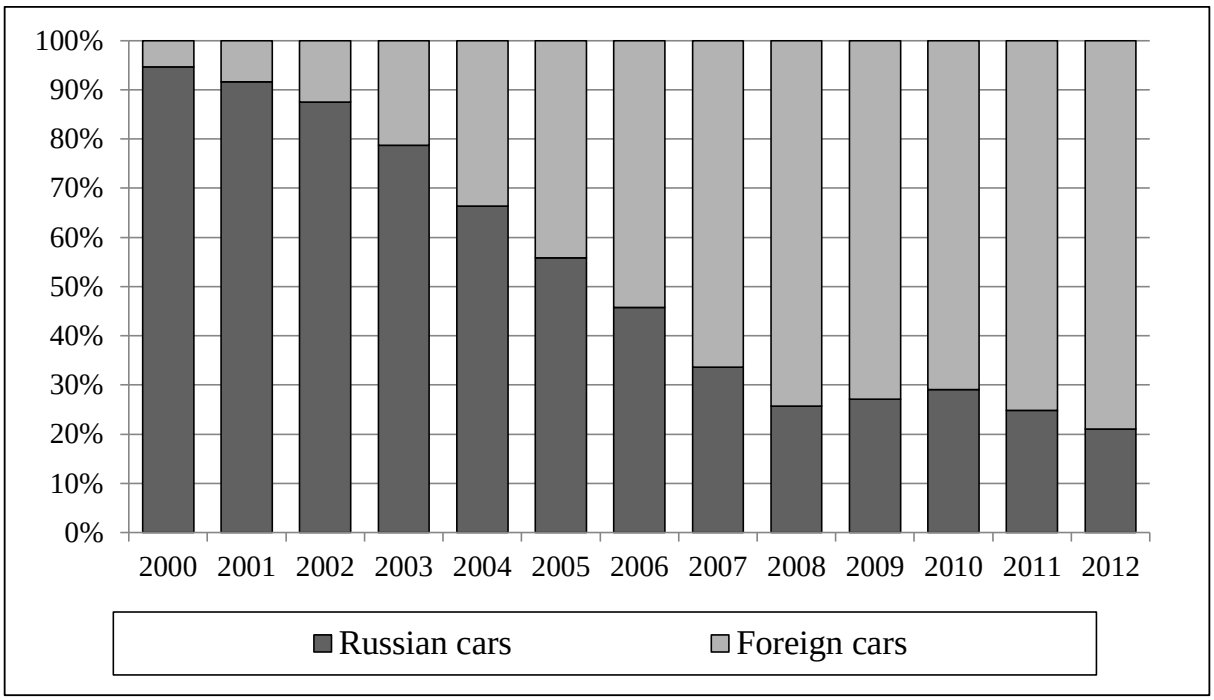
Picture 1. The production structure of passenger vehicle industry in Russia.



Source: ASM-holding OJSC, the ministry of industry and trade of the Russian Federation

Picture 2. The structure of sales of passenger vehicles in Russia

Hence it might seem that the industrial car assembly regime and the operation of foreign car factories in Russia have driven out Russian cars from the domestic market. Despite that the benefits to the country's economy include transfer of technology and spillover effects through localisation and the domestic assembly of foreign cars, job creation and training of workforce [4]. However it is impossible to definitely conclude whether the industrial car assembly regime would adversely affect the industry, since the effects depends on the present and future economic and technological environment in which the industry operates. It is possible to assess the effects by comparing development scenarios.



* Foreign cars include both the imported vehicles and foreign cars assembled in Russia. Russian cars category includes only the family of car models designed, developed and produced in Russia.

Source: PWC, AEB

The authors of the strategy of development of the Russian automobile industry until 2020 sketched four scenarios based on two key factors – the share of car imports and the share of vehicle exports on the domestic market, (tbl. 1).

The set of plausible trajectories of development of the automotive industry includes three scenarios, since the excessively protectionist "passively innovative" scenario seems improbable given Russia's admission into WTO. The first scenario assumes the development of industrial assembly lines only, the second – collaboration with the leading automobile producers and the third – the transformation of Russia into a potent car producer able to compete globally [10].

Table 1. Scenarios of development of the Russian automotive industry

Scenario	Key points
"Current Vector"	The continuation of the present trends in the automotive industry with no structural breakthroughs The Russian car producers just assemble the finished product The domestic production covers only 50% of the domestic demand, the rest are imported cars Automobile components are manufactured for outdated Russian cars, with marginal supplies to foreign car producers Research and Development financing and activity is insignificant
"Moderately innovative"	Restructuring of the automotive industry to increase its ability to meet the domestic demand; volumes of export and import are small Emphasis on the cooperation between the domestic and foreign automakers; creation of joint enterprises for production of automobiles and car components Satisfactory funding of industrial R&D Provision of incentives to reach 50% localisation level Renting of automobile platforms and other intellectual property
"Actively Innovative"	Introduction of Russian cars into the global competition as the result of major re-configuration of the domestic industry, modernisation and expanding investments into industrial R&D Greater specialization on vehicle exports with a third of the produced cars is sold internationally Large-scale research and development, design of new motorcar models and automobile platforms, more suitable for the international market
"Passively Innovative"	Introduction of protectionist measures against vehicle imports Exclusive specialisation of industry on the domestic sales

According to the developers of the mentioned strategy the most likely scenario for the development of the automobile industry was "moderately innovative" scenario based on active involvement of foreign companies and creation of many joint businesses. It assumed that 80% of domestic demand for motorcar would be met by the domestic production divided equally between Russian vehicles and domestically assembled foreign cars.

Despite the intensive implementation of the crucial steps of this scenario, the structure of the automotive industry has not changed so far towards the desired goal, and is still closer to the "current vector" scenario than to any other. The share of domestically assembled foreign cars in production attained 70% and the level of car-component localisation crept up only slightly.

This has happened because the stimulating measures were mainly targeted at the finished car producers and not at the associated industries of automobile components. Since the production base of these associated industries has not been modernized, the level of localisation has been growing very slowly. The policies setting the minimal level of localisation seem to have goals of more formal or bureaucratic, rather than economic and productive nature. Closer attention to and higher funding of the R&D activity in the industry of motorcar components is imperative to the realisation of the "moderately innovative" scenario.

Besides, all scenarios of the outlined strategy of development neglect the level of production technologies which directly influence the development of the automotive manufacturing and relations with the foreign partners.

In view of the beginning of active transition to the VIth technological mode in the developed economies in 2015, scenarios which take into account the technological level were composed.

Country's technology is determined by the prevailing technological mode[1]. There are six known technological modes at the moment, of which the first three had been mastered prior to the 1950s. The first mode (or wave) was based on new textile technologies and the utilisation of energy of falling water (1600 – 1780), the second was characterised by the adoption of mechanical steam-powered means of production in all industries (1780 – 1880). The third mode constituted the advancements brought about by the usage of electricity in economic production and the development of heavy and electrical engineering industries on the basis of rolled steel, new discoveries in chemistry and physics (1880 – 1940) [7].

[1] Usually the notion of **the technological mode** implies a set of technologies, typical for a particular stage of industrial development. In this article it also means a combination of technologically conjoined industries, which keeps its integrity during its development. It encompasses the complete cycle of economical reproduction structure – from the extraction of natural resources, through the professional education, to the final consumption. Such view of the technological structure of an economy enables to describe its dynamics as a gradual process of development through successive technological modes [8].

The industrial technology currently prevailing in the Russian economy is associated with the fourth technological mode which began to emerge in 1930s. This set of technologies grew on the basis of progress in power generation from hydrocarbons, supplemented by advancements in telecommunications and new synthetic materials. The distinctive feature of this mode was mass production made possible by the invention of the industrial assembly line and the key factors were the internal combustion engine and petrochemistry. This technological mode provided sufficient technological base for the creation of transnational corporations capable of direct investments.

The successive, the fifth, mode had scientific basis in the progress of microelectronics, cybernetics, computer science, biotechnology and genetic engineering. Economically this mode was made feasible by adoption of new sources of energy and new materials, exploration of near-earth space, advancements in satellite communication and others. The key technological factor was microelectronic components.

The foundation of the sixth technological mode, technologies of which are yet to become dominant, are the achievements in molecular biology, nanotechnology, genetic engineering and artificial intelligence. Prior rapid development of such infrastructure as worldwide information networks and integrated high-speed transport grids provide the necessary conditions for the next technological "revolution".

Originally the technologies used in the automotive industry were the core of the fourth mode, but ceaseless progress in material sciences, electronics and cybernetics superseded. The use of electronics and software and their share in the cost of an average motorcar, not necessarily of Russian assembly, has been increasing from at most 16% in 1990, through 21% in 2001 up to 40% in 2005 [1, 2]. Given this trend, it is important that the Russian industry advance to the fifth technological mode, since otherwise this economy would lose the

opportunity to develop sophisticated components that add value and remain just the producer of hardware.

Presently the technological structure of the Russian manufacturing notably differs from the developed countries. The technologies of the IVth mode account for at least 50% of the production while almost 30% are from the third generation. The share of technologies of the Vth mode is no more than 10% even in the most technologically advanced industries such as military and aerospace. In the USA for example the fifth technological mode accounts for 60% and the IVth mode for 20%, older technologies have negligibly small shares and yet 5% of technologies are associated with the VIth mode [3].

The framework of the sixth mode implies the widespread application of nanotechnology in automotive industry (new advanced surface coatings, nanomaterials and nanoelectronics). German automakers were the first to adopt nanotechnological advancements: Mercedes-Benz has been using nano-coatings in premium-class cars since 2003. Nanotechnology is already being used in the motorcar production of BMW, Nissan and Toyota. And soon this technology is going to be at the forefront of the development of the motorcar industry [5,6].

Given the generational gap between the predominant technology in the Russian industry and the leading developed economies it is reasonable to formulate three scenarios of development of the domestic automotive industry based on the technological modes: the "current vector", the "development of automobile electronics" and the "implementation of nanotechnology" (see tbl. 2).

Table 2. Scenarios of development of the Russian automotive industry base on technological modes.

Scenario / Variable	"Current Vector"	"Car electronics"	"Implementation of nanotechnology"
Level of technology	The IVth technological mode dominates the industrial production	Transition to the Vth mode; progress of electronics industry; increase of share of sophisticated electronic components in the genuinely Russian cars	Simultaneous adoption of the technology necessary for the Vth and VIth modes; implementation of nanotechnology in car production
Level of localisation	The localisation level plateaus at the prescribed level of 60% entirely by production of simple hardware modules and components	The production of advanced components and complex hardware (internal combustion engines and pressure differential valves) increases the localisation past the prescribed level (60%)	Localisation attains 90-100% level
Factories and car components	New factories are not built; weak basis for competitiveness of the car-component industry	Construction of new foreign-car factories; enhancing the model range of produced cars; Creation of modern car-component industry	Construction of new Russian factories around the adopted and mastered technologies; Stronger basis for a competitive industry of car components.
Personnel	Low level of job creation; training of staff to service the assembly lines	Intensive creation of new jobs; training of the assembly line staff together with engineers, management and administration personnel	Skilled labour at the domestic car factories with spillover effects to associated industries; Russian training centres based on the new developed technology;

The "current vector" scenario assumes that the technological structure of the automotive industry and trends on the market remain unchanged. Under this scenario the domestic producers hold on to the fourth mode technologies while the government monitors and maintains the terms of the industrial car assembly regime. The localisation level of 60% would be eventually attained, but the spectrum of the localised car components would range only from hardware to

near-hardware: simple modules and equipment, basic electronics, windows, seats and the like. Such technological narrowness could not create a competitive motorcar-component industry and genuinely Russian motorcars would continue to occupy the niche of economy-class vehicles with at most 20% of the market. Under this scenario the human resources necessary for technological spillover effects would not be developed, because the foreign car producers would only train service personnel for the assembly line.

The second plausible development scenario is based on the progress of electronic car appliances fuelled by investments in R&D and maintenance of conditions for the industrial car assembly regime on part of the state. This scenario would culminate in the transition to the Vth technological mode. The technologies of the fifth mode would help to achieve the desired localisation level and master the technologies necessary for a competitive industry of motorcar components. These advancements should make the components of domestic origin meet the quality standards of foreign car producers, who already operate in Russia, thereby favourably affecting the localisation level. Subsequently the foreign producers might become more interested in expanding production within Russia, broadening the range of cars and training new engineers and management as well as assembly line staff. The improvement of industrial production conditions would attract new car producers, which in turn could spur job creation and development of new technologies and improvement of the competitiveness of the automotive industry.

The foundation of the "nanotechnological" scenario is the application of technologies of the V^{th} and VI^{th} modes. In view of the nascent transition to the sixth generation of industrial technology in the developed economies it is important to adapt the domestic motorcar industry to new conditions. Thus the switching to the fifth generation must be accompanied by research and development of the technologies needed for further rapid transition to the

successive mode. For this scenario to actually be implemented the Russian government must finance and actively encourage R&D activity in the motorcar industry. Consequently the efforts to modernise and improve competitiveness of the Russian industry, if undertaken, should boost the initial level of localisation and provide basis for its further accelerated growth. This would directly affect the dynamics and the volume of import of the modern technologies and improve efficiency. Subsequently would bring about the shrinkage of the technological gap between the domestic industry and the world leaders. The successful realisation of this scenario would lead to higher employment of more skilled personnel in the motorcar industry and the establishment of training centres for professional education. Adopted technologies and business practices would enable the launching of new domestic production capacity for both the car components and the finished vehicles. Thus the automotive industry would manufacture competitive products, capable of competing on the global market.

Under the current technological and economical trends and conditions in the domestic motorcar industry the most likely scenario is the "current vector", rather than any other. The likelihood of the transition to the V^{th} technological mode increases with sufficient monitoring of the terms of the industrial car assembly regime and co-financing of the industrial R&D by the government. However in the current reality of the international trends and competition the most optimal yet the most unlikely development scenario is the last one.

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