The development of electric vehicles in China: Market facts and regulatory trends

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How does the development of electric vehicles in China affect global automakers' strategies? Alongside an exiguous, regulated market, China has an informal market for low-cost electric vehicles. The gap between these two markets is analyzed in the light of Chinese policies with regard to automobile transportation standards; and the problems raised for global automakers are discussed. Whereas the literature on the strategies of multinational firms in emerging countries generally concentrates on the question of the use value for customers, our research shows the importance of taking account of the forms of regulation that strongly determine market dynamics.

For several years now, the market for electric vehicles in China looks like a potential El Dorado for global automakers. For reasons related to urban pollution, public environmental policies, industrial strategies and the security of its energy supply, China has, since the 1990s, worked out an impressive, deliberate policy that continually boosts electric mobility. Nonetheless, the market for "real" electric cars has not yet taken off. Despite successive, ameliorated policies with incentives, the expected wave of consumption has not unfurled in this cramped market where Chinese automakers are competing with Western firms, which are trying to sell their own electric vehicles, including the most sophisticated ones.[1]

Alongside this market for "official" electric vehicles (EVs) has sprung up, in provincial cities, a market for "illegal" vehicles, namely: mini (or micro) electric vehicles (MEVs) in between electric scooters and ordinary cars. These MEVs do not meet the standards set for "real" EVs. Owing to their performance and cost, MEVs represent a fringe market; but unlike conventional EVs, they have found customers who are demanding local mobility since, after all, a driver's license is not needed to drive a MEV. The MEV market is serving older customers who now have problems riding two-wheeled vehicles and do not have access to conventional cars. At present, Chinese companies are the only players on this market. Global automakers have not been able to cross the gap from the official market to the type of offers made on the MEV market.

Is this dual market for electric automobiles — a cramped, official EV market as compared with a broad, locally authorized MEV market that does not produce vehicles on par with official standards — going to last? Might a Chinese regulatory trend upend this situation by making the suppliers of MEVs improve their offers while creating, below the official market's current standards, a new niche for less expensive EVs that are better adapted to a potentially vast customer base? How should global automakers take account of these trends in their strategies for targeting highly attractive growth markets? We shall try to answer these three questions.

[1] This article, including quotations from French sources, has been translated from French by Noal Mellott (Omaha Beach, France).

The first part of this article describes this dual market, the differences between these two types of products, their current state of deployment, and the radical differences in regulations and uses that set them apart. We then inquire into the trends on these two markets in relation to China's policies of setting standards for automobile transportation. The more probable hypothesis, we shall argue, is that these two markets, now totally separate, will converge for reasons related both to the consistency of China's industrial and environmental strategies and to a tradition of pragmatic interventionism that combines an *ex ante* laissez-faire for local initiatives with an *ex post* resumption of control over successful experiments. The third part of this article brings under discussion the problems that these trends raise for Western automakers' strategies. We shall insist on the importance for foreign firms to become involved in the current "gray zone" because the experiments conducted there will serve as the basis for drafting new regulations and standards for China's future EV market. In conclusion, general lessons will be drawn about the function of regulations in "reverse innovation" strategies (GOVINDARAJAN & TRIMBLE 2012).

We put in five stints of field work in China between April 2013 and January 2016. Information was collected through interviews with manufacturers and our work with academics, not to mention field surveys carried out in a region of the country with a well-developed MEV market (CHEN & MIDLER 2016a).[2]

The dual electric vehicle market in China

The EV market in China is divided in two: an official and an informal market (Figure 1).

Four segments account for most sales on the official market.[3] Sales of plug-in hybrid vehicles in the midrange segment are thriving, thanks to opportunities arising out of regulations. Not only do these cars benefit from subsidies granted to EVs but they can

[2] This article relies on research for a doctoral degree conducted at the Center of Research in Management at École Polytechnique and as part of a cooperative research program between Renault and ParisTech and the Institute of Sustainable Mobility. Our work benefitted from two years of collaboration with the Center for Automotive Industry (CAI) School of Automotive Studies, Tongji University in Shanghai.

[3] This research focused on private, all-electric vehicles: battery electric vehicles (BEVs) such as Tesla Model S and Nissan Leaf; and plug-in hybrid electric vehicles (PHEVs) that can be reloaded such as Chevrolet Volt. Our hypothesis is that they will be the driving force in this EV market.

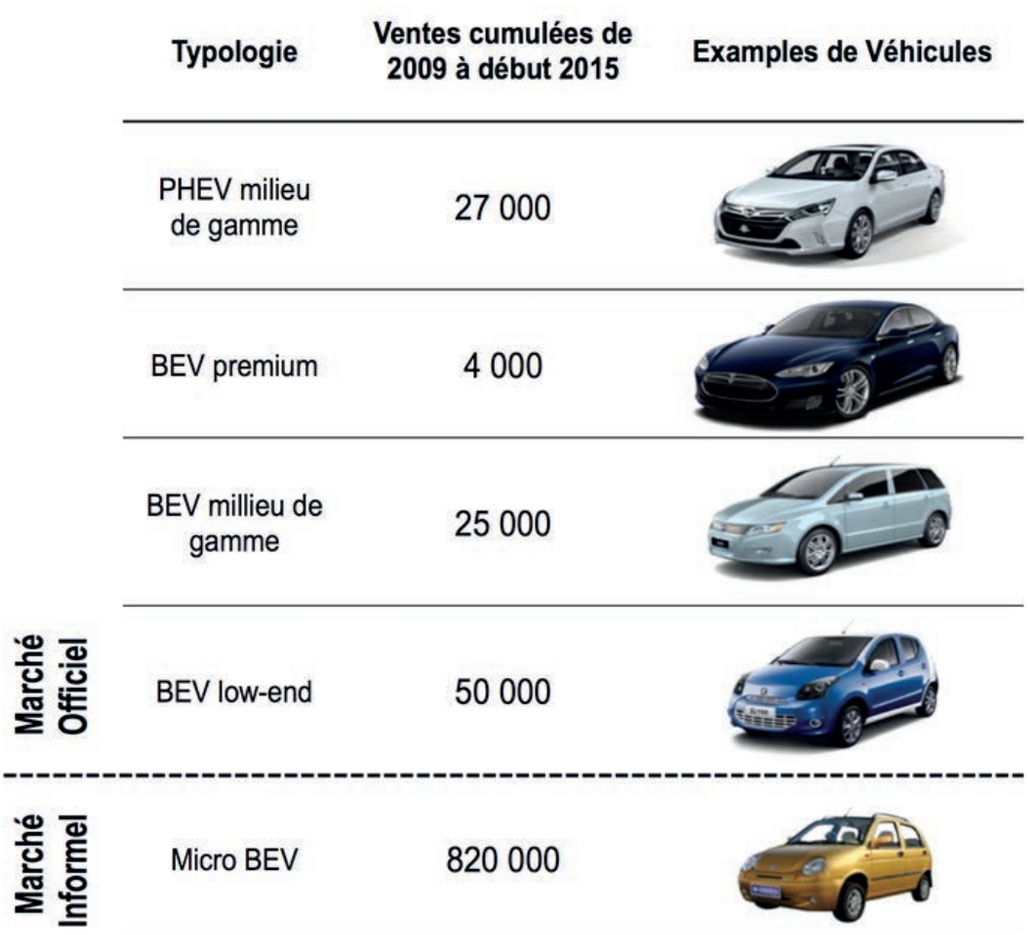

Figure 1: The electric vehicle market in China: Cumulated sales from 2009 to the first quarter 2015.

also be used in nearly the same way as vehicles with internal combustion engines. The three other segments are for all-electric vehicles. The first is a monopoly of imported cars made by Tesla, the midrange segment is mostly vehicles from Chinese and foreign automakers (BYD, BAIC and SAIC), and the bottom segment is mostly Chinese (Chery, Geely and Zotye).

On the informal MEV market — nearly ten times bigger than the official EV market — a large number of automakers (illegal in the eyes of the central government) provide products ranging from three-wheeled vehicles to genuine low-cost electric automobiles.

An official market shaped by government interventions

The official EV market in China comprises the domestic automakers who are recognized by the central government and have a manufacturing permit and foreign automakers who have set up joint ventures with local partners. Institutional and political forces have shaped this market through programs for developing technology, industry and EVs. Official EVs are eligible for the buyer assistance programs and tax incentives sponsored by the central and several local governments. In big metropolitan areas, electric vehicle registration is for free and nearly instantaneous, whereas the buyers of cars with internal combustion engines have to wait several years and pay for registration, up to the equivalent of €10,000 in Shanghai and Beijing. But first and foremost: plug-in hybrid and all-electric vehicles may circulate freely in these two cities whereas, in Beijing, the circulation of internal combustion engines is subject to road space rationing.

Besides the imported Premium Tesla, current midrange EVs are still strapped with disadvantages: their insufficient range compared with internal combustion engines, the lack of public charging stations, and the difficulty of installing private charging stations (WU et al. 2015). Local governments supported the top-down programs that targeted captive fleets, such as the 4000 BYD e6 taxi fleet in Shenzhen[4] or the fleets of long-term rental firms. EV sales to private persons are substantial only in highly regulated environments, such as Beijing.

The strongest growth of the official EV market is now at the low end.[5] In 2015, low-end EVs made up 60% of sales of all-electric vehicles in China. Most of them (the Zotye Z100, Chery eQ or Geely-Kandi K10/K11) benefit from the same financial and regulatory incentives as midrange EVs. This is not so of Chery QQ, a vehicle with a lead battery, which came out in 2009 and ranked at the top of sales of official EVs in 2012 and 2013.[6] The Chery QQ has been a source of inspiration for the makers of MEVs, who have been plying an illegal market since 2009.

An informal market thriving in an institutional void

The majority of users of mini (or micro) electric vehicles are private persons. These subcompact vehicles use lead batteries with a technology that, though far from the state of the art, has proven its mettle and is inexpensive.[7] A MEV's range is from 50 to 150 km; and its maximum speed, from 40 to 80 km/h (KIMBLE & WANG 2013, WANG & KIMBLE 2012). MEV are recharged using 220V-plugs. For these reasons, these mini vehicles are practical for local uses in rural or urban areas. These all-electric vehicles run the gamut from modified golf carts to genuine automobiles. However MEVs are not subject to automobile standards (in particular for safety); and in most cities, a driving license is not required for them. Despite their limitations in services and technology, especially compared with Western standards, more than a million MEVs have been sold since 2009 (CHEN & MIDLER 2016a).

MEVs have arisen out of the know-how of the makers of two-wheeled electric vehicles and, too, of the vehicles with internal combustion engines used in rural areas or by farmers. These companies have "spontaneously" sprung up outside the policies that sponsor technological development (WELLS & LIN 2015). They rely on a low-tech product strategy that tends in a direction opposite to the guidelines issued by the central government in support of the official EV technology. In this sense, MEVs are a typical example of "good-enough" products (GADIESH et al. 2007).[8]Their makers, not officially recognized in China, do not invest in developing the technology, in particular the batteries. Instead, they concentrate on rolling out products to an existing customer base, persons who own farm implements, commercial tricycles or e-bicycles (SHEN et al. 2015). A final point: this market is thriving in small and medium-sized cities, which the policies supporting traditional automakers have overlooked. Traffic is not yet very congested in these cities, which enjoy an "intra-electric mobility", since the urban area is relatively compact and thus suitable for vehicles with a low range (LANCKRIET & RUET 2011).

For users, the purchase price of a MEV is less than that of an equivalent internal combustion engine vehicle. Furthermore, a MEV costs, on the average, eight times less to run; and maintenance is easier (WANG & KIMBLE 2013). Most sorts of MEVs can be charged at home, overnight when electricity costs less. MEVs are being adopted in China (and in the West) because their cost-performance is better than internal combustion engines. Most drivers are more

[4] BYD (Build Your Dreams) is a Chinese firm that makes electric vehicles, the "e6" is, among Chinese electric taxis, the company's most widely sold model.

[5] This article has retained the term "low-end" with reference "*low-end disruption*" (CHRISTENSEN 1997).

[6] The Chery QQ's position on the EV market in Chin is similar to Maruti Alto's in the niche for small cars with internal combustion engines in India.

[7] By the way, the very slight breakthrough by MEVs on the Indian market has also been made by vehicles with lead batteries. "Cleaner" alternatives have, at least for the time being, proven disappointing.

[8] Once again, it is worthwhile drawing a parallel with India's more regulated market: Tata Nano, a "good-enough" vehicle with an internal combustion engine, has been a commercial flop compared with the sales of conventional vehicles.

than 45 years old; and MEVs are used for everyday trips in the urban area or between city and country-side. These minicars satisfy the demand for a vehicle devoted to a local use: shopping, driving children or grandchildren to school, or commuting to work. A driving licence is not required in this unregulated market; and most users do not have one.

In China, MEVs are quickly filling "institutional voids" in national regulations and standards for the automobile industry (PUFFER et al. 2010). In environments where national regulations do not exist, informal institutions (guanxi) fill the void; and local governments that want to strengthen their industrial base become directly involved. This "Chinese federalism" (QIAN & ROLAND 1999) runs counter to the wides-pread idea of a country steered solely through an institutional "trickle-down" policy (from the central government to certain local governments). Owing to their significance in a city's or region's economic growth, the makers of MEVs maintain strong ties with local governments, regional and, above all, municipal (SHEN et al. 2015).

Given, on the one hand, the preeminence of low-end vehicles on the official market and, on the other hand, the dynamic MEV market, a question arises: which upper layer in the informal market would it be worthwhile to link to the lowest segment in the official market? Which part of this illegal market is, owing to its products, closest to being a "frugal innova-tion" of the sort that Renault was able to roll out in India thanks to Kwid (MIDLER et al. 2017)? On the supply side, how could (some) MEV-makers integrate in their geographical niche low-end automakers from the official market that are increasingly plying the market in the provinces?

Two markets in nearly separate sociotechnical and institutional environments.

As our empirical analysis has shown (CHEN & MIDLER 2016a), China's EV market is split in two parts with more or less separate geographical basins, with different companies as players, with rather different regulations and with differences in the support provided by public authorities.

The official market, concentrated in big cities, enjoys the constant support provided by the central government and local institutions. This sort of "parallel policies of industrial development" (ARVANITIS & ZHAO 2008) or "economy in layers" (RUET 2016) is, in China, not at all restricted to the automobile market, since it can be observed in several other industries.

Structured in tightly controlled joint (Chinese-foreign) ventures, the automobile industry has been an exception for a long time (RICHET & RUET 2008, BHATTACHARYA & MICHAEL 2008, BALCET & RUET 2011). The manufacturing licenses delivered in several provinces eventually became obsolete and were not used. BYD bought one of these "forgotten licenses" from Xinjiang Province to develop its first vehicles (RUET 2016). The longstanding exception has recently been "normalized" owing to the twofold difficulty encountered by Chinese industry: catch up internationally from its technological lag in internal combustion engines and develop a top-down EV market.

In contrast, the second (informal) market emerged in small and medium-sized cities without backing from central authorities. While big metropolitan areas practice a local protectionism that bars MEVs (produced on the informal market), low-end EVs from the official market are being distributed in smaller cities, where they benefit from buyer assistance programs sponsored by local authorities. Urban areas of this size are the place where these two markets meet.

The coexistence of these two markets has arisen out of an equilibrium between formal and informal institutions (PUFFER et al. 2010) and, too, out of the geographical diversity of these sociotechnical systems (HANSEN & COENEN 2015). Far from Shanghai and Beijing, the sociotechnical profiles of smaller Chinese cities favor the development of MEVs: a less dense network of gas stations and of public transit, considerable urban and economic growth, a high demand for local mobility from people with low incomes, more places to park and recharge electric vehicles.

So, how to draft regulations for unifying these two markets? And why? Drawing from other studies (RUET 2016), we argue that, in the specific context of China, we should look for the answer outside the marketplace, namely: in medium-term industrial policies and the standardization processes related to them.

Chinese policies of normalization of the informal market

China is a country with supple planning. The plan is drafted in the framework set by the Communist system through a process in line with "Chinese federalism". However its ambit is supple: prior to reforms, the plan covered only 700 products (as compared with 20,000 in the USSR). China has opted for a systemic strategy that fosters e-mobility through: investments in research and industry, buyer assistance programs, the immediate for-free registration of e-vehicles, tax exemptions or even the development of appropriate infrastructures (in particular, charging stations). In the 1990s, Wan Gang, the current minister of Science and Technology, launched R&D programs on EVs. During the first decade of the 21st century, programs targeting captive fleets (*e.g.*, of busses and taxis) and special vehicles (used for street-cleaning, logistics, garbage removal) were successfully implemented thanks to heavy investments (mainly by municipalities). Authorities intended to manage strategic market niches (XUE *et al*. 2016), which were in Chinese cities. Meanwhile, these cities were competing, each with its own local regulations, products, business models and forms of technology (SHEN *et al*. 2015, HUCHET *et al*. 2015).

The year 2009 signaled the first phase (2009-2012) of a pilot city program for boosting EV purchases onto a massive scale. The program turned out to be a flop for the population — even though severe restrictions (*e.g.*, alternate-day driving in Beijing) were increasingly deterring the owners of internal combustion engine vehicles. This program's second phase (2013-2015) was not any more successful despite attractive incentives. Apart from the cities where internal combustion engines were saddled with restrictions, the consumer market for EVs was struggling to grow. At the end of 2014, the central government, pushed by Prime Minister Ma Kai and President Xi Jinping, tackled the problem of stations for recharging batteries, which was deemed to be the major obstacle to the massive deployment of e-vehicles.

In 2015, the government set up a committee to draft national regulations about MEVs. This committee brought together representatives of public authorities, state technological institutes, vehicle-makers and academic experts. The technical regulations for MEVs of 18 November 2016 kindled a discussion. The government wanted to impose drastic conditions for legalizing MEVs — conditions that would have killed the industry in Shandong Province. In 2017, discussions continued between central authorities, local governments and manufacturers. These discussions have fallen under the influence of this thriving market that is, nonetheless, laden with uncertainty for consumers.

The advantages of normalizing the informal MEV market

Several forces are pushing for legalizing the situation of MEVs. China's national goal is for sales by 2020 to amount to five million vehicles running on new forms of energy. For domestic and foreign automakers to meet the country's very tight pollution standards, which are based on the number of vehicles sold, it is necessary to counterbalance sales of internal combustion engines with sales of e-vehicles.

MEVs are at the "bottom of the pyramid". They are made using affordable, low-profit materials; and this is the very reason for the larger volume of sales. The lowering of subsidies for purchases of EVs (along with their announced abolition in 2020) has forced automakers to consider lowering prices. Meanwhile, improving the safety of MEVs has become a national issue, as ever more incidents are reported on Chinese social media.

Government regulations have pushed the automobile industry to invent "Chinese" brands. Chinese industry has adapted to cope with its inability to catch up with the foreign manufacturers of internal combustion engines (despite the sale of Volvo to Geely, a Chinese firm, and the installation of factories for making Volvo engines on Chinese soil). With regard to EVs however, China is convinced that it can catch up since an ecosystem of "green technology" has already sprung up (RUET 2016). Furthermore, BYD, which is going international, is apparently becoming a "global" brand. Given these developments, MEVs, owing to their technological simplicity, are an industry with a strong potential for exports.

Regulatory thresholds, the application of regulations and CAFC credits

Several processes will lead to setting the level of regulations to be applied to mini or micro electric vehicles. For one thing, setting high technical and regulatory thresholds would boost the technology and level of safety but while limiting the disruption that the MEV niche might wreak among current players on the official market (GEELS 2014). Yet another, the objectives set for 2020 and the pursuit of economic and industrial development are forces that push for massively legalizing MEVs and, thus, support more lenient regulatory thresholds. Another factor also carries weight: many MEV users do not have a driver's licence, and making a driver's license a national regulation would nip in the bud an industry that, though informal, is blossoming.

Whether or not the new national regulations about MEVs will be applied at the local — provincial and municipal — levels is not at all certain. MEV firms are a "pirate" industry similar to the shanzhai companies, which make low-cost copies of name brands in sectors ranging from mobile telephones to restaurants. Such businesses conduct operations in an institutional void (HENNESSEY 2012). Regional diversity and competition between local governments hinder the convergence toward a national policy, a situation reminding us of the incomplete single market for the automobile industry in the European Union (JULLIEN & SMITH 2014). Legalizing MEVs will not occur all at once everywhere in China. This process will be heterogeneous — taking place at different times in different cities and provinces (BRIDGE et al. 2013; HANSEN & COENEN 2015). Industry will continue coexisting with an informal market (PUFFER et al. 2010), especially in small cities.

The stated objective of legalizing MEVs is to include them in national statistics on sales, since the automakers who want to continue selling cars with internal combustion engines are interested in obtaining CAFC credits.[9] This context is important. China's new five-year plan has taken it into account by setting the goal to become the world's leading market for carbon credits. (figure 2)

Therefore, the most probable scenario for regulation is the following:

• On the one hand, the growth of low-end official EVs would be stimulated so as to "absorb" the offer of up-end MEVs close to this segment. This would come at the cost of safety improvements, in particular,

[9] CAFC (Corporate Average Fuel Consumption) is a regulation for controlling the average consumption of fuel by motor vehicles (electric as well as internal combustion engines). China has one of the most severe CAFC standards in the world. Its objective for consumption is 5 liters/100 km as measured using the NEDC (New European Driving Cycle). Since electric vehicles do not run on gasoline, they lower an automaker's CAFC by generating "CAFC credits".

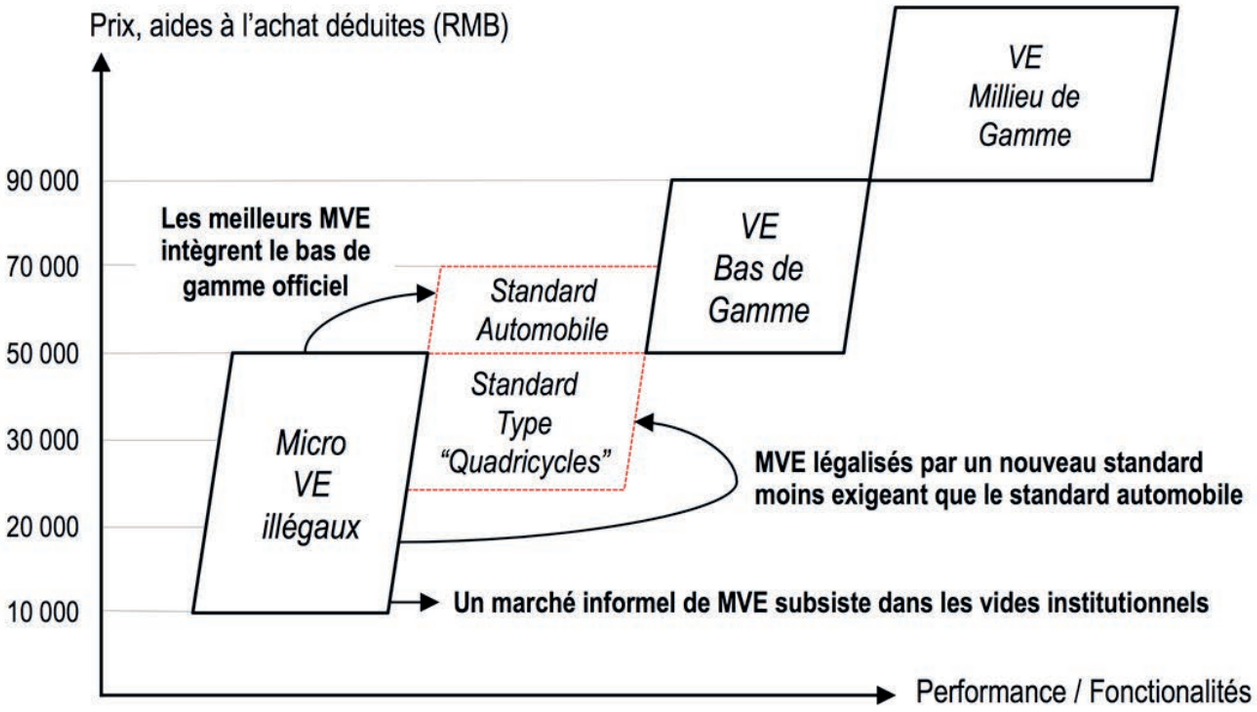

Figure 2: Scenario of a possible change in regulations: Legalizing MEVs and creating a new "quadricycle" standard

and significant changes in the technology used.

• On the other hand, a new standard would be drawn from the EU standard for "quadricycles" (four-wheeled microcars). This would guarantee buyers a minimum of quality and safety while retaining some of the current characteristics of the MEV market that cannot be transposed to "real" cars (*e.g.*, no requirement of a driver's license).

We hypothesize that this scenario's details will depend on the balance of power between categories of manufacturers, between provinces and the central government (and the context specific to each province), and between the objectives of catching up in technology and of creating jobs. To its advantage, such a scenario would be part of a clearly stated public policy for stimulating Chinese industry so that it could eventually export vehicles that meet international standards. Another advantage is that this regulatory framework would be acceptable in regions that, given their level of development (the purchasing power of local customers and the production capacity of local vehicle-makers) cannot abide by the regulations.

Under this scenario, what would be the place and role of Western automakers during this transition in Chinese regulations?

Western automakers' strategies in emerging countries: "Trickle-up" effects?

"Trickle-up" refers to a bottom-up adoption of an innovation. In contrast, Tesla, for example, has adopted a more classical "trickle-down" strategy: EVs are initially offered to premium customers (Tesla Roadster, Model S and Model X) before an offer (Tesla Model 3) is made to the lower end on the socioeconomic scale.

The conventional EV business model: Luxury and high tech

In the West, electric vehicles were invented under the sign of design, technology and even luxury. Tesla Model S, BMW i3 and even Renault Zoé and Nissan Leaf have made a bet on technology, on being the car of the future. Prime automakers like Tesla and BMW have clearly adopted a trickle-down strategy. The race is on for recharging batteries, and setting up ever more expensive charging stations that will soon be wireless. Vehicles are expensive, and buyer assistance programs weigh on the decision to purchase one. Meanwhile, Western regulations have augmented this inflation of technological requirements and standards.

In contrast, EV technology could be used to design very simple, affordable automobile products. After all, electric vehicles were invented more than a hundred years ago out of competition with internal combustion engines.

Chinese consumers still see Western cars as being of better quality, as symbols and high-end products — the epitome of the most recent technology. On the Chinese market, all foreign automakers offer EV models that, based on existing models, have to be made locally via joint-ventures with Chinese partners (cf. Figure 3).

A large share of the EVs in catalogs have not been placed on sale; they are simply listed to fulfill the requirement that joint ventures have to offer electric vehicles (CHEN & MIDLER 2016b). Other EVs in the catalogs serve for demonstrations or are (sometimes for free) part of public vehicle fleets. The very few models

Table 1: New car brands
from joint venures for producing electric vehicles in China

Chinese OEM	Foreign OEM	New brand	Launch date	Model	Cumulated sales (1st quarter 2015)	Reference model
DFM	Nissan	Venucia	2010.09	E30	1031	Nissan Leaf
BYD	Daimler	Denza	2010.05	Denza EV	399	Mercedes Classe B
Brilliance	BMW	Zinoro	2013.04	1E	307	BMW X1
SAIC	GM	Springo	2012.11	Springo EV	213	Chevrolet Sail
BAIC	Hyundai	Shouwang	2011.11	500e EV	Negligible	Hyundai Elantra
DFM+Yueda	Kia	Dianyue	2012.02	N30	Negligible	Kia Cerato
Changan	Ford	Jiayue	2012.10	Jiayue EV	Negligible	Ford Focus
FAW	VW	Kaili	2011.05	Carely E88EV	Negligible	VW Bora
FAW	Toyota	Ranz	2013.03	E50 EV	Negligible	Toyota Corolla EX
SAIC	VW	Tianyue	2011.03	Tantus EV	Negligible	VW Lavida
DFM	Renault	Fengnuo	2015.04	E300 EV	To be released	Renault Fluence
GAC	Toyota	Leahead	2014.10	i1 EV Concept	To be released	Toyota Yaris

BAIC: Beijing Automotive Industry Holding Co.
BYD: Build Your Dream
DFM: Dongfeng Motors
FAW: First Automobile Works
GAC: Guangzhou Automobile Group Co.
OEM: original equipment manufacturer
SAIC: Shanghai Automotive Industry Corporation
VW: Volkswagen.

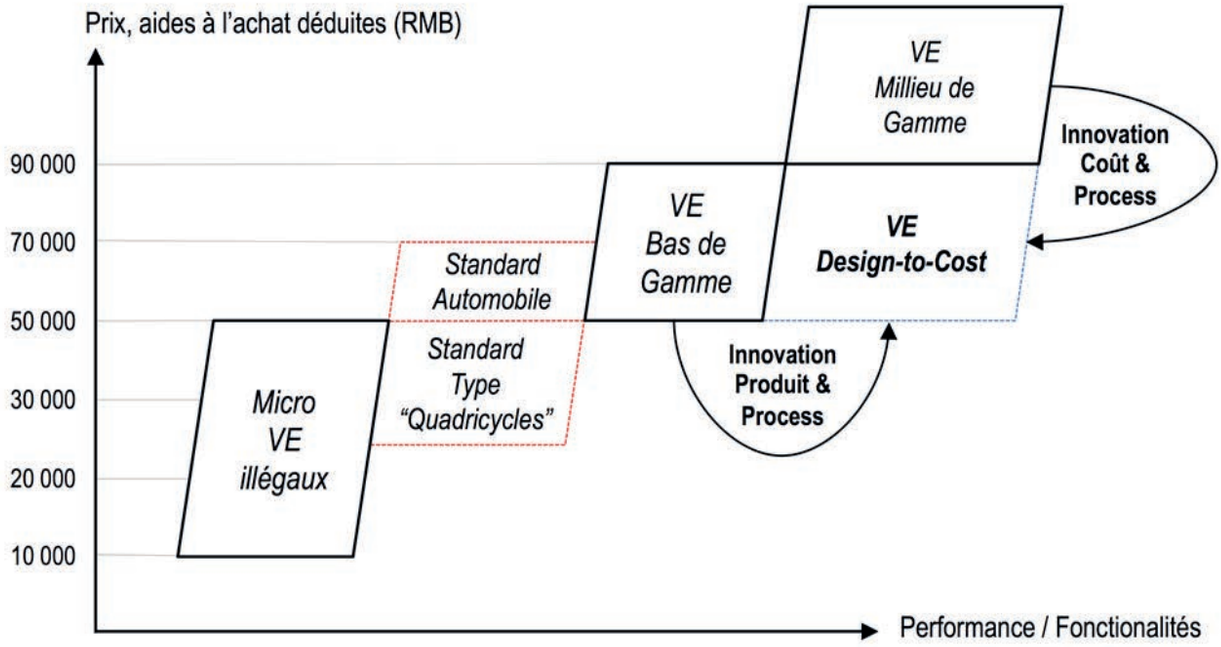

Figure 3: Disruptive strategy of low-cost electric vehicles (EVs) in China.

that can be purchased have not attracted customers: Venucia e30, Denza EV, Springo EV and Zinoro 1E. The sales price (outside subsidies) lies in the RMB 250-400 thousand range,[10] whence the scarce sales. In contrast, the prime automaker Tesla has sold 4000 Model S cars at a price of more than RMB 700,000 (including 25% importation duties, which buyer assistance programs do not cover).

Apart from Tesla, foreign automakers have not managed, despite heavily subsidized buyer assistance programs, to sell electric models on the middle and high-ends of their product lines. Several reasons account for this: a dissuasive (national and local) Chinese protectionism, a mismatch between the products offered and consumers' needs, steep prices, and a focus with blinders on big cities.

Low-cost strategies: The missing link

In China, "low cost" is a multifaceted, geographically variable notion. In the West and in big Chinese cities, it refers to the price equivalent of a Dacia (RMB 50,000) but in smaller cities to RMB 20,000. The customers who buy MEVs are purchasing a car for the first time; most of them had previously owned two-wheeled electric vehicles. For these customers, MEVs represent a high-end means of urban transportation compared with e-bikes and e-scooters, since they are safer, offer protection from the weather and have a higher state of charge.

As our analysis has shown, the regulatory framework could be used to establish a price/performance continuum over all segments of the informal MEV market along with the lower and middle segments of the official EV market. Theoretically, there is an opportunity for automakers, foreign and Chinese, to design an EV that costs less but has the same performance as EVs in the middle segment of the official market — and a better performance than EVs in the lowest segment (cf. Figure 4). This could be done by pursuing a low-end breakthrough strategy (CHRISTENSEN & RAYNOR 2003).

Western automakers would find it worthwhile to adopt a design-to-cost strategy for several reasons. First of all, the volume of sales would bring in CAFC credits, now a literal condition for joint ventures for making internal combustion engines. Besides, foreign automakers will apparently face stiff penalties (as requirements tighten on greenhouse gas emissions by internal combustion engines) if they do not manage to sell electric vehicles in China by 2018-2020. Since the number of EVs sold is the key criterion for assessing the performance of automakers in the race to become the leader on the EV market, there is an advantage to be had from focusing on marginal volumes and experimenting in China with a low-cost project that has the objective of turning a profit owing to the volume of sales — before eventually transposing this experiment worldwide (MANIAK *et al*. 2014).

Under a "*low-end disruption strategy*", a trickle-up product line would be designed (MIDLER 2013). Starting from the low end of the product line with the idea of triggering a trickle-up effect brings several advantages. Installing fewer technological innovations on simpler vehicles means reducing the uncertainty of sustaining a momentum for sales. A vehicle that charges its battery using a conventional 220V plug short-circuits the debate about the standards to be set for recharging batteries. Since MEVs are mainly used in or near urban areas and are recharged directly at home by their users, there is no need to wait for the government to install public charging stations. A final point: growth in China is no longer in Beijing or Shanghai but in smaller cities. Western firms normally think that the best strategy is to win new markets…

The challenge: Adapt products, adjust to regulatory trends and implement a low-end strategy

As suggested by the case of the Logan (JULLIEN et al. 2013), "reverse innovation" in the automobile industry is a creditworthy strategy under the following conditions: control over the design-to-cost procedure, "fractal innovation" (MIDLER et al. 2017) and a localized innovative industrialization. Success entails balancing the choice between paying close attention to regulations (about safety, for example) and meeting customers' expectations (about products and services). The choice is between a "compliant" approach that abides by a minimum set of regulations (as in a "bottom-of-the-pyramid strategy" (PRAHALAD 2012) and a "prescriptive" approach that intervenes before regulations are made and influences the choices to be made.

The requirements set in the new bill of law on MEVs will be decisive for the strategy of Western automakers. The room to be made for foreign firms is yet to be specified. The number of CAFC credits related to the new categories of vehicles is not known. Will the new law require partnerships with companies in the official market (the more probable solution)? Or should know-how from the informal market be adopted and formalized (the less probable solution). Since institutional changes of this sort overhaul value chains and alter the rules of the game (DIERKS et al. 2013), it is necessary to anticipate and decipher the convergence, now under way or possible, between these two markets (or sociotechnical systems) and, then, to negotiate with authorities and monitor the changing institutional context. From an organizational viewpoint, adjusting to a changing institutional context means being able to modify offers throughout via changes in the product line (MIDLER 2013).

The other task to tackle in pursuit of a low-cost strategy is its implementation (BEN MAHMOUD-JOUINI et al. 2015). Playing on geographical markets far from the big Chinese cities means having contacts with unfamiliar local institutions, both formal and informal. Distribution and maintenance networks will have to be set up. This could be the occasion to tap the resources of the network of relations already established with partners

[10] Renminbi (RMB), the official currency: €1≈ RMB 7.7 (June 2017).

in joint ventures (PENG 2003). Engineering the implementation of a low-cost strategy specific to China is yet to be done (VON PECHMANN et al. 2015).

Conclusion: Regulation, an omitted dimension in low-cost strategies?

For several years now, the literature on management has called for reviewing innovations and the cost-value compromise out of which they have come.[11] Other currents of thought have crossed this low-end approach with strategies for internationalizing innovation processes: "*bottom-of-the-pyramid strategies*" (PRAHALAD 2012), "*frugal innovation*" (RADJOU *et al*. 2012, MIDLER *et al*. 2017) and "*reverse innovation*" (GOVINDARAJAN & TRIMBLE 2012). Overall, these authors have drawn attention to the strategies that target the use value of products in order to satisfy the needs of segments of customers that have, till now, been overlooked. Apart from these questions of use value and of the direct relation between supply and demand, these authors have seldom focused on how market regulations affect "sustaining" strategies. In fact, regulations have a major impact on the products and services that will be authorized, in particular on the required level of product features.

This study of the development of electric vehicles in China has shown that it is important for a company's business strategy to reckon with the variable of regulations. China is definitely approaching the transition toward e-mobility in a systemic way by managing both strategic niches (competition between cities, between automakers and between their proposals) and the transition itself (policy commitments, experiments and the *ex post* legitimation of outliers, such as MEVs) (NILL & KEMP 2009).

This strategy leads to a regulatory force typical of emerging economies but opposite to Western policies, which set *ex ante* the standards and regulations that will shape scenarios of innovation. If the race to reach "zero emissions" in the EU were sped up by taking account of reality (namely: the upsurge of low-cost internal combustion engines in Europe), it would eventually be possible to ease regulations on condition that environmentally friendly recycling processes be developed. The path to progress thus runs through regulations.

In contrast, China's dynamic entrepreneurial spirit and the coexistence of formal and informal institutions have been the conditions for the emergence and then success of mini electric vehicles on what is an informal but quite real market. In fact, this niche market (MEVs) is ringing up more successes (sales) than the official market (EVs). Legalizing MEVs means a shift, both institutional and geographic, of this niche toward the official market. Emerging countries like China can serve as testing grounds for experiments involving not only products and uses but also regulations. At stake for Western automakers is to draw inspiration from these more agile contexts.

For multinational corporations, "reverse innovation" is an occasion to shift focus from mature markets and rigid institutional contexts. Regulatory systems in emerging economies are less developed and impose fewer delays for bringing innovations to market (GOVINDARAJAN & TRIMBLE 2012), In France, Renault Twizy abides by the law on four-wheeled motor vehicles whereas, in China, MEVS shape regulations by tailoring them for low-cost electric vehicles. By adopting a "design-to-cost" strategy balanced between "prescriptive" and "compliant" approaches, Western automakers could take part in this debate.

Can we imagine that developed nations bridle the inflationary trend in regulations fueled by the convergence of consumerist forces with high-tech business offers — a trend for "always more" features and, too, costs? One of the seldom pointed out effects of this trend is a much narrower access to the high-tech product market (since so many potential customers are barred from it) and thus a retrenchment of the progress to be expected (in particular, for a fleet of ageing motor vehicles) (JULLIEN *et al*. 2013)? Could we not, instead, draw inspiration from this innovative approach to regulations based on full-scale experiments with assessments being made and regulations drafted thereafter? Under this hypothesis, multinational firms could adopt a position in the case of reverse innovation that, benefitting from the institutional context in emerging countries, would, when they return to mature markets, serve as a vector for making new regulatory proposals so as to create the conditions for sustaining a mobility based on clean, low-cost automobiles.

[11] This vast body of literature on "low-end" strategies follows up on Christensen's work (1997).

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