Editorial

Tommaso Pardi

IDHE Cachan,
Ecole Normale Supérieure de Paris-Saclay,
Bât Lapalace, 61, Avenue du President Wilson,
94235 Cachan Cedex, France
Email: tpardi@gerpisa.ens-paris-saclay.fr
Email: tpardi@gerpisa.ens-cachan.fr

Giuseppe Giulio Calabrese*

IRCrES-CNR,
Via Real Collegio, 30, 10024 Moncalieri, Italy
Email: giuseppe.giulio.calabrese@ircres.cnr.it
*Corresponding author

Biographical notes: Tommaso Pardi is a senior researcher at the CNRS (IDHES), France, and the Director of the Gerpisa Network of Research on the car industry. He is teaching economic sociology at the ENS Paris-Saclay. His main areas of research are economic sociology, sociology of markets, organisational studies and sociology of work with a particular focus on the automotive industry. His current projects concern Industry 4.0, the EV revolution and the reorganisation and internationalisation of automotive R&D.

Giuseppe Giulio Calabrese is a senior researcher at the CNR-Ircres (Research Institute on Sustainable Economic Growth of the National Research Council, former CNR-Ceris) of Moncalieri, Italy which he joined in 1988. He taught as a Visiting Professor in Managerial Economics at University of Turin and Polytechnic of Turin. He is the Editor-in-Chief of the *International Journal of Automotive Technology and Management* and member of the International Steering Committee of Gerpisa. His main areas of research are focused on industrial organisation, SMEs, technological innovation, industrial policy, balance sheets analysis and automotive industry.

The 2019 International Colloquium of Gerpisa in Paris concluded the program of research on the 'New frontiers of the automotive industry' started four years earlier in Puebla. During this period, the number of articles presented at the Gerpisa Colloquium focusing on 'new frontiers' topics – electric vehicles, autonomous driving, shared mobility and digital manufacturing – has increased steadily: from 12 in Puebla 2016 to 41 in Paris 2019. This is why this year, we have not one but two special numbers based on works presented at the colloquium: the present one, which focuses on electric vehicles and global value chains; and a second one edited by Daniele Attias and Sylvie Mira-Bonnardel on the 'Promises, pitfalls and social needs of the autonomous vehicle technology'. We should also mention the collective book edited by Alex Covarrubias and Sigfrido Ramirez, which has been published in 2019 and provides

a comparative overview of the works carried out by the Gerpisa during these last four years with a special focus on the role of public policies in 16 different countries.

So what have we learned from this international program and how does this special number contribute in this respect?

On the one hand, it has become clearer that the automotive industry is undergoing a paradigm shift. The need to decarbonise cars and light trucks in order to contain global warming, the regulatory pressure to push the automotive industry towards this end, the growing demand for new mobility services and less congested cities (in particular amongst younger generations), the possibility opened by new digital technologies in autonomous driving and connected vehicles, and the entry of new digital players ready to seize all these opportunities and create new mobility and new energy markets around the cars… all these factors converge towards a structural transformation of the automotive sector and several scenarios have been built and discussed these last four years to explore how these factors will scale up and interact one with each other (Covarrubias, 2018). On the other hand, the concept of disruption, which has been initially used to frame these transformations and build these scenarios, has started to be increasingly questioned inside our network (Smitka and Warrian, 2016). Disruption implies that sooner rather than later we will reach a tipping point after which the transformation of the automotive sector will be rapid and sweeping, carried out by new digital and electric players and leaving the carmakers in the same position as Kodak after the digitalisation of photography, as Nokia after the spreading of the smartphones, or as IBM after the triumph of Microsoft. Now, many in the Gerpisa network argue that this is not going to happen to the automotive sector, for at least three reasons.

First, contrary to the electronic sector, the automotive sector is a large, extremely competitive oligopoly characterised by very high fixed cost and very small margins. For this reason, it is almost impossible to disrupt it from below, by offering cheaper products or cheaper services than those already available to consumers. Second, even if the 'new frontiers' technologies are mature enough to industrialise a large variety of electric vehicles, to run experimental autonomous vehicles through cities and even countries, and to make shared vehicles easily available to consumers through their smartphones in urban areas, the business models to scale up most of these technologies are still missing. Third, contrary to cameras, mobile phones and personal computers cars are much more expensive, durable, regulated and political products, which mean that the inertia of the old paradigm will be much more important than initially expected.

As a result, rather than seeing the old and the new paradigm as being opposed, i.e., the emergence of the latter leading to the inevitable disappearance of the former, we have started to consider them as complementary, the transition between the two being probably a matter of decades rather than years. In terms of scenarios, this implies to think about the long-term coexistence of the two paradigms, and about the complex technological, economic, political and social conditions that will push forward, slow down or even push backward the transition between the two.

In this special number, it is in particular the diffusion of electric powertrain that is discussed. The tumbling sales of EVs in China after the cut of government incentives in 2019, reminded us of the uncertainties that still surround the scale up of EVs, despite pressing environmental regulations in Europe, California and China and constantly growing offer from the side of OEMs.

Takefumi Mokudai analyses in his article how OEMs deal with these uncertainties. He develops an original theoretical framework based on 'real options' reasoning to

compare the strategies of Toyota and Nissan towards electrifications and to weight the virtues of flexibility (keeping several options open) versus commitment (putting all the eggs in one basket to surge ahead in a particular type of electrical powertrain). 'Real options' are investments made by OEMs to keep certain technological avenues open without committing to them. Keeping several options open increase the flexibility of OEMs, but it is costly and forces them to built flexibility in their current platform in order to keep the cost of shifting from a technology to another low. By contrast, committing to one technological avenue has several advantages – it reduces both R&D costs, as resources are now concentrated on just one avenue, and manufacturing costs, as platforms are optimised for that specific technology – but if the technological avenue chosen is the wrong one, then OEMs can go bankrupt. This is precisely the dilemma OEMs are facing when dealing with alternative EVs powertrains. The comparison between Toyota and Nissan is interesting because it shows that not only the two main Japanese OEMs have taken very different strategic options (Toyota early commitment to hybrid electric vehicle versus Nissan early commitment to battery electric vehicles) but also how these past choices influence the capacity of the two OMEs of holding, striking or abandoning new technological options: Toyota for instance is still holding the BEV option, but has already struck the fuel cell EV option with the launch of the Mirai, while Nissan has struck the hybrid electric vehicle and plug-in HEV options but is still relying on the BEV powertrain of the leaf to develop these new models.

These different choices and paths towards electrification are visible in all OEMs (Muniz and Belzowski, 2017). They reflect the current volatility of markets for EVs but also nurture this volatility as they made it hard to converge towards a new dominant design (Fujimoto, 2017). However, this strategic uncertainty does not only concern whether these different types of new electric powertrains will scale up, but also what will happen when they will finally do so. Bruno Jetin provides one of the first in-depth analyses of the uncertainties that surround the future supply of raw materials for batteries, in particular of graphite, lithium and cobalt which are indispensable, rare and expensive to recycle. Jetin combines different sources to highlight the probable shortage of raw materials if EVs scale-up in the 2020s. This will have important implications for both the cost of batteries and the control of the value in automotive value chains. First, the cost of raw materials, which according to Jetin's sources represent on average 66% of the cost of a cell, is bound to increase if EVs scale up impacting the cost of batteries and, more generally, of EVs. Second, the countries and companies that will have assured the access to these raw materials will significantly increase their share of the value chain profitability at a time when EVs will have become mandatories in several markets. Hence, the crucial role of governments and public policies in anticipating these shortages, assuring access to raw materials, and developing their recycling despite its high cost. Jetin confirms in his analysis the huge advance taken by China and Chinese companies in all these domains. A conclusion that adds a further element of uncertainty to the EV equation: what will happen to EVs friendly policies in the USA and Europe when their geopolitical costs will become more evident?

While many countries, despite all these uncertainties, have announced that they will have only electric powered vehicles by 2040, Japan, which is the G20 country that has the most reduced CO_2 emissions from road transport since 2000 (–18% in 2016), seems to have taken a more conservative approach despite the fact of betting on the 'next' disruptive technology: the fuel cell electric vehicles powered by hydrogen.

Michaël Fernandez analyses in detail the Japanese political project of creating a 'hydrogen society'. The roadmap developed by New Energy and Industrial Technology Development Organization (NEDO) is expected to lead by 2030 to a fleet of 800,000 FCEVs, equivalent to about 3% of new vehicle sales. The focus however is not on the substitution of gasoline and diesel cars with FCEVs, but only on long-term and heavy applications (sedan cars, heavy trucks and buses). Fernandez highlights how Japanese policies develop FCEVs as a complementary contribution to the greening of transport, along with HEVs, PHEVs, EVs but also clean diesel and gasoline vehicles. While his analysis mainly applies to the specific deployment of hydrogen technology in Japan, it has implications for all types of EV technologies. It suggests in particular that the implementation of long-term transitory policies that organise the coexistence of different technological solutions and optimise their diffusion according to their specific characteristics, can play a decisive role in pushing forward the transition, while short-term strong support for short-term/disruptive diffusion might easily backfire.

Along electric vehicles, this special number also focuses on the transformation of automotive value chains. While there is no doubt that the diffusion of EVs will have significant consequences for the structure and the geography of automotive value chains, it is still too early to appreciate them, given the current low market share of EVs. Other factors however shape today these transformations: in this special number, we look in particular at the availability and cost of workers in low cost countries and at the impact of foreign direct investments in a context of rapid technological change.

Tomasz Olejniczak et al. explores how subsidiaries of Japanese suppliers in Central and Eastern Europe countries (CEEc) have been dealing with shortage of labour and growing wages due to the massive migration of skilled and unskilled workers towards Western European countries and to the clustered nature of automotive production. The article provides a vivid picture of the type of cost pressure that regional value chains exert on 'low cost' suppliers. Of the 19 automotive companies studied which were part of a previous sample of 29 Japanese manufacturing companies analysed in 2003 by Yuan (2006), five have been liquidated with some of them being relocated to even lower cost countries. All the others have developed different ad-hoc strategies to cope with these pressures: such using cheaper and more stable female employees; hiring migrants from lower cost countries as Ukraine, Mongolia and Vietnam through agencies; increasing the share of temporary workers to reduce the cost of flexibility; developing multiskilling and job rotation as a way to cope with absenteeism and turnover; hiring skilled workers (technicians) when they are still in their second and third year of university; and increasing the rate of automation, with few cases of advanced 'Industry 4.0' automation pushed by the exigencies of German clients. Olejniczak engages with the debate about low road/high road labour models. He shows that while these Japanese suppliers are striving to preserve a high road model based on "long-term employment of core employees, specialized and on-the-job training, and multifunctional skill development through job rotation", they have to rely more and more on low road strategies to cope with cost pressure from their clients. Clearly, the hopes expressed before the 2008 crisis of a high road development for the CEEc' automotive industry (Jürgens and Krzywdzinski, 2009) came up against the logic of putting low-cost production sites in competition with each other and the constant threat of closures and relocations. In such a context, the only way to escape this 'race to the bottom' is through combined economic, functional and social upgrading in order to climb the value chain and increase the share of value added.

Guendalina Anzolin et al., who has received the special mention of the 2019 Young Author Gerpisa Prize[1], develops in her article a global comparison of upgrading strategies by focusing on the relationship between inward FDIs and industrial robots' adoption, across different segments of the automotive value chain. She shows that upgrading does not happen automatically through FDIs, in particular in the component sector. Only countries such as China, Turkey, Czech Republic and Thailand that have built-up the local ecosystem, supported local suppliers with aids and incentives, developed education and infrastructure, and engaged with multinational companies to regulate their relationships with local suppliers, show a positive correlation. Also, building on the possibility offered by the fDi Markets database of comparing different types of suppliers in metal parts, in airbag, safety belts and seats manufacturing, and in electrical and electronic parts, the results show a significant heterogeneity within the component sector in terms of upgrading trajectories, highlighting the importance of different product features and technological interdependences for technological upgrading.

These results confirm all the interest of bringing together the insights and results produced by the global value chain literature with the sectoral approach developed by industrial economics (Durand et al., 2018), and in particular the productive models approach of Gerpisa (Pardi, 2019).

The next International Colloquium of Gerpisa that will take place in Detroit from the 8th to 12th of June 2020 will allow us to dive deeper into all these questions and debates by looking at how digitalisation is transforming products, value chains and automotive ecosystem. On a much sadder note, it will also be the opportunity for the members of the international network of Gerpisa to gather together and pay homage to our co-founder and former director, Michel Freyssenet, who passed away on the 22nd of January 2020. Michel was a great researcher, a true leader, and a good friend. He will be truly missed, but his legacy will live on through his works, theories and passion for collective, interdisciplinary, theoretically ambitious and empirically grounded research.

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Notes

1 The article of the winner of the Young Author Prize, Fabio Antonialli, untitled 'Autonomous shuttles for collective transport: a worldwide benchmark', will be published in the second Gerpisa *IJATM* special number edited by Daniele Attias and Sylvie Mira-Bonnardel.