

Second-level educational offers to face disruptive technological changes in the motor vehicle industry: the case of MUNER

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Framing of the research. *The motor vehicle industry is actually facing some of the most challenging technological changes since the settling of the dominant design for vehicles in the 1920s with the Ford T model (Perkins and Murmann, 2018). These changes are usually identified by the acronym ACES, which stands for Automation, Connectivity, Electrification, Sharing. The big players of the motor vehicle industry, up to date mainly western Original Equipment Manufacturers (OEMs) with their first- and second-tier suppliers (Jacobides et al., 2016), must therefore face challenging tasks to maintain their competitive position. The new technologies are indeed requiring high investments, and it seems to be no immediate payoff and returns due to the unpredictable diffusion and adoption of such new technologies (Mahdavian et al., 2021). These technological changes have the potential to both bring opportunities and pose challenges to the firms operating into the motor vehicle industry, especially in terms of competencies shortcomings (Perkins and Murmann, 2018). Indeed, each technological change requires specific resources and competences to be scouted, adopted and integrated into the value proposition of the firms. ‘Automation’ is related to the introduction of technologies enabling self-driving vehicles, and it is related to the ‘Connectivity’ issue, that comprises all technologies allowing connectivity service within the vehicle, amongst vehicles, and with the surrounding environment, thanks to the implementation of advanced communication protocols. Autonomous vehicles are based on the detection of real-time data on road conditions and traffic - including vehicles, motorbikes, bikes, and pedestrians - through enabling connectivity technologies (cameras, sensors, radars and lidars, etc.) that calculate the best possible route for the vehicle, and on the possibility to control acceleration and braking of the vehicle (Bagloee et al., 2016). Even if sophisticated manufacturing capabilities and supply chain management capabilities are still important, other technological competences, traditionally proper of firms operating in IT industry, such as software development and machine learning, are becoming increasingly important to compete (MacDuffie, 2018) and to face technological changes along the automation and connectivity issues. ‘Electrification’ stands for the replacement of petroleum-based propulsion systems with electrical systems, aiming at reducing the ecological footprint of the movement of goods and people. More specifically, three low-emission technologies are considered as alternatives: hybrid vehicles (HVs), electric vehicles (EVs) and fuel-cell vehicles (FCVs) (Bohnsack et al., 2015). From a technological point of view, each of them requires specific investments and competencies aimed at improving the efficiency and performance of the powertrain (Mahdavian et al., 2021), and hence to enter and compete into the EVs’ related segment of the motor vehicle industry. Following Tesla’s entry, which strongly influenced the competitive logic (Perkins and Murmann, 2018), traditional OEMs started to invest heavily in developing electric and hybrid models by leveraging mainly on own capabilities and partnerships (Hoeft, 2021). Finally, ‘Sharing’ includes all services that have contributed to change the way people move: passengers’ vehicles are increasingly offered with per-use opportunities and transactions, opposed to the permanent ownership of a vehicle. From a technological point of view, these alternative models of mobility are based on apps and IT technologies, which connect those who offer the car-sharing or ride-hailing service to the user (Machado et al., 2018).*

In this context, companies must equip themselves with the necessary competencies (Teece, 2018) to maintain their position and competitive advantage (Barney, 1991). As a consequence, the knowledge context in which the firm operates does matter (Skute et al., 2017), so as the ability to collaborate with universities or research centres to the education of high-talented graduate students (Wright et al., 2008) that could convey the missing competencies and knowledge. In addition, degree programmes created or adapted to meet the needs of the local firms (Caniëls and van den Bosch, 2011) facilitate the transfer of knowledge and competencies through students who move to firms (Bramwell and Wolfe, 2008). More specifically, it has been observed that the highest-level skills are those more impacting at the local level in OECD countries (Arbo and Benneworth, 2007), such as then graduates, post-graduates and doctoral graduates. Greater emphasis is therefore placed on the education and training of the individuals (Nafukho et al., 2007) by the main knowledge-producer that is the local university (Bramwell and Wolfe, 2008; Wright et al., 2008). Indeed, universities nowadays are called to operate “for the sake of solving specific and compelling problems and challenges confronting society” (Audretsch, 2014, p 317), implying for local universities to take on different roles and to

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collaborate at local and national levels with firms and policy makers (Tagliazucchi et al., 2021). Universities are then called “to produce new knowledge but also to alter its activities and values in such a way as to facilitate the transfer of technology and knowledge spillovers” (Audretsch, 2014, p. 314), addressing the needs of the local firms in terms of human capital by aligning their educational offer to them. As such, the universities could play an important role in helping local firms in targeting and managing the technologically innovative processes occurring in a specific industry. In doing it, universities actions could include both the transfer of newly invented technologies or the creation of research-intensive programs, but also innovations in educational programs (Etzkowitz et al., 2000) in collaboration with non-academic organizations (Culkin and Mallick, 2011) to meet the evolving needs of local firms. “In addition to translating research into economic development through various forms of technology transfer, the traditional teaching role is [then] reinterpreted as the university assists the modernization of low- and mid-tech firms” (Etzkowitz et al., 2000, p. 314) and aligns its teaching and education activities with industry technological changes. Thus, through new educational offers students and interns may actively play a new role in knowledge and technology competencies transfer to local firms. Therefore, the possibility of converting the newly graduates’ educational background, rethought by universities in collaboration with local firm to target the technological changes in place, into firms’ resources and competencies becomes ultimately an element of competitiveness for the local industry. We believe that the integration of the RBV perspective with HCT could help to understand how educated students acquire the embodied productivity within an organizational domain, thus overcoming some limitations and criticisms traditionally associated to HCT (Marginson, 2019).

Purpose of the paper. The present contribution, still in a preliminary phase, aims at investigating how the offer of master-level secondary education meets the needs in terms of technological competence shortcomings of the firms in the motor vehicle industry, that is currently experiencing significant and impacting technological changes. We then try to answer the following research questions: do graduate students’ competencies and knowledge that arise from new master degree courses matter in helping firms to face important technological changes? How does unfold the collaboration between local firms and higher education institutions to face technological changes?

Among the possible investigation perspectives with which to address this issue, for example Open Innovation initiatives (Chesbrough, 2003), or approaches based on leveraging existing technological competencies (Danneels, 2007), we opt for a theoretical framework able to offer a deeper analysis of how competencies to face technological changes could be integrated with the entry of new figures in training. We then adopt the perspective of the Resource-Based View (RBV) of the firm (Barney, 1991; Penrose, 1959) and of the Human Capital Theory (HCT) (Becker, 1993, Schultz, 1961) to assess if and how the competencies, and more specifically the technological competencies, of young graduates do matter in supporting motor vehicle firms in facing technological transition. The foundation of HCT lies in the assumption that individual learning capacity, mainly based on his/her previous education, is one of the company’s most valuable resources, as well as its ability to exploit the competencies acquired over time by the individual (Becker, 1993, Schultz, 1961). The main theoretical contribution we expected is to shed light on forms of collaboration between local firms and higher education institutions in supporting the local innovative system of a sector, such as the automotive one which is subjected to major technological changes, through the co-creation of educational courses.

Methodology. A single-case study approach is adopted (Eisenhardt, 1989), and information are collected from both primary and secondary sources (Yin, 1994).

The context of the study is geographically limited to the Motor Valley of Emilia Romagna, which stands worldwide as a leading area for the motor vehicle industry thanks to the presence of important brands known worldwide. The vast majority of manufacturing companies at the regional level are indeed concentrated on some clusters, mainly related to mechanical engineering and automotive, in particular sportscars, motorcycles, and agricultural machines. The case study of MUNER, Motorvehicle University of Emilia Romagna, is then selected. MUNER is configured as an association of the four regional universities, namely University of Modena and Reggio Emilia (Unimore), University of Bologna (Unibo), University of Ferrara (Unife), and University of Parma (Unipr), with the most important firms of the Emilian Motor Valley, namely Automobili Lamborghini, Dallara, Ducati, Ferrari, Haas F1 Team, HPE Coxa, Marelli, Maserati, Pagani, Scuderia Alpha Tauri. The peculiarity of MUNER lies in the co-design of the educational offer, aligning it with the needs expressed at the local level in terms of competencies and new profiles of graduates, within a framework of close collaboration between local universities and the firms operating in the industry (Tagliazucchi et al., 2021). MUNER educational offer is also characterized by a strong learning-by-doing approach, with lessons held by university professors and professionals of the partner companies, and internships aimed at implementing the knowledge acquired within the partner companies. Within MUNER there are 6 curricula - Electric Vehicle Engineering, Advanced Automotive Electronic Engineering, Electronic and Communication System, Autonomous Driving Engineering, Advanced Motorcycle Engineering, Advanced Powertrain, Advanced Sportscar Manufacturing, High Performance Car Design, Racing Car Design - which aim to train professionals of the future based on the changes taking place in the sector. The curricula are managed administratively on the campus of Unibo and Unimore, although the activities involve students on all the campuses of the four partner universities depending on the specialization. The educational offer is also complemented with summer and winter schools, dedicated to high school students willing to approach training courses in the motor vehicle industry, bachelor students and PhD candidates willing to deepen specific compelling issues for the motor vehicle industry and to develop specific technological competencies.

Data collection is developed in two steps. First, data on graduates and employment are collected through Almalaurea - the Italian interuniversity consortium to which 75 universities and the Ministry of Education, University and Research adhere - that annually carries out a survey on the employment of graduates. Due to data constraints, the

analysis is limited to the first cohort of MUNER graduates (a.y. 2017-2018) and focus on employment status one year after graduation, as data extracted from Almalaurea are updated to the 2020 survey at the time of writing. The collection of data from secondary sources is complemented by press reviews, and archive data from universities internal sources. Secondly, we will proceed with the collection of data from primary sources, through interviews to key informants from the local universities and the partners companies, preparatory to the construction of a semi-structured questionnaires to be administered to MUNER students and companies. The purpose is to collect the point of views of both students newly graduates and the firms in which they work about the alignment between individual competencies and firm's needs, and the role such of individual competencies - resulting from an innovative educational offer - in helping to target the technological changes in the industry. Multiple sources and two-steps collection strategies would allow for triangulation of data, assuring validity and reliability (Yin, 1994).

Results. The preliminary results are limited to the first phase of data collection, and present the employment status of the first cohort of MUNER graduates. The following tables present data from Almalaurea 2020 survey, relating to the students graduated in 2019. The survey then comprises only the first cohort of MUNER graduates (as the first academic year is 2017-2018) and their employment status one year after graduation.

Tab. 1: Employment features of graduates of the second-level degree programmes of MUNER

	Unimore	Unibo
Number of Graduates	25	11
EMPLOYMENT STATUS		
Working	72%	100%
Not working but looking for a job	8%	-
Involved in educational activities	20%	-
EMPLOYED GRADUATES		
Continuing the job prior to graduation	30%	-
Not continuing the job prior to graduation	-	16.7%
Started working after graduation	70%	83.3%
Time from graduation to the first job (average in months)	1,1	1,7
EMPLOYMENT CHARACTERISTICS		
Sector: engineering and precision mechanics	70%	50%
Sector: other industries	10%	16.7%
Service: consultancy and research services	20%	16.7%
Service: other	-	16.7%
EMPLOYMENT: GEOGRAPHIC AREA		
North-West	10%	16.7%
North-East	80%	66.7%
Centre and South	10%	-
Abroad	-	16.7%
SATISFACTION		
Satisfaction with the current job (on average in a range 1=low to 10=high)	8.2	8.0

Source: Almalaurea, 2021 integrated with Unimore Archival data, and Authors' elaboration

Table 1 presents the employment status one year after graduation of the first 25 MUNER graduates under Modena and of the 11 MUNER graduates under Bologna, who together manage all six curricula of the MUNER educational offer. What emerges, firstly, is the high employment rate for MUNER students, almost all of whom work or are continuing with further educational activities courses following graduation - mainly Ph.D. course in collaboration with the local automotive companies. Secondly, it should be noted the reduced time - less than two months on average - from the moment of graduation to the first job offer. Most of MUNER graduates starts a new job after graduation, and only 30% of the graduates at the Modena campus continue with their pre-graduation job, presumably the internship carried out in partner companies. MUNER graduates are mainly employed in the engineering and precision mechanics industries, in line with the course of study followed, and to a lesser extent in consulting services. It should also be noted that almost all of them are employed in the north-east regions of Italy, where the Emilia Romagna region is located according to the ISTAT classification. These data allow us to infer how MUNER's educational offer benefits the territory and local motor vehicle industry, by strengthening the technological competencies of the Italian Motor Valley, which welcomes almost all MUNER graduates. Indeed, only 15% of graduates from Bologna declares to work abroad one year after graduation. The satisfaction rate of interviewed students with regard to their employment status job is also high.

Tab. 2: Perceptions on the educational offer compared to the current job

	Unimore	Unibo
Number of Graduates	25	11
EFFECTIVENESS OF THE EDUCATIONAL OFFER		
Very effective / Effective	77.8%	83.3%
Moderately Effective	11.1%	16.7%
Not Effective	11.1%	-
USEFULNESS OF COMPETENCIES		
Use of the competences acquired: high	70%	66.7%
Use of the competences acquired: moderate	20%	33.3%
Use of the competences acquired: low	10%	-
ADEQUACY OF THE EDUCATIONAL OFFER FOR THE JOB		
Adequacy of the educational offer: high	90%	100%
Adequacy of the educational offer: moderate	10%	-
Adequacy of the educational offer: low	-	-

Source: Almalaurea, 2021 integrated with Unimore Archival data, and Authors' elaboration

Table 2 presents a first outlook on students' perception of the impact of their master-level courses in MUNER in terms of effectiveness, usefulness and adequacy in carrying out their first job one year after graduation. These data, partial and indicative only of the student's perception, will be integrated with a specific semi-structured questionnaire administered to both students and firms that employ them. However, the data turns out to be interesting, indicating high scores for all dimensions. The effectiveness and adequacy of the educational path co-designed in MUNER settles on very high scores values by almost all of the interviewees, just as the adequacy of competencies acquired are considered useful or very useful by the majority of MUNER graduates. As previously specified, albeit positive, these data require further integration of information, related, for example, to the evaluation of the type of activities and tasks performed by MUNER graduates who have just entered the firms, the technological and innovative content of the tasks, the role of supplementary activities and of the learning-by-doing approach in facilitating the execution of the tasks. Furthermore, there is currently no in-depth study of competencies shortcoming from the point of view of the firms, and their needs in terms of further training of newly-graded students.

As a first approximation, from the partial data now available, we find that the highly specific technological competencies conveyed within the six curricula of the second-level courses (master degrees) of MUNER seem to have the potential to meet the specific needs of the local firms of the Motor Valley to face the changes taking place in the motor vehicle industry. Future results are expected to offer new insights on the role the University - Industry collaboration in designing and performing teaching activities could have in improving the firms' capability to face successfully the ACES technological challenges. In particular, we aim to offer some contributions to integrate the traditional HCT explanation of how new highly-educated workers increase the recruiting firms' effectiveness in facing technological challenges with complementary explanations based on resources and competencies-related theories.

Research limitations. This contribution has some limitations, mainly related to its early development. The data collection in progress currently offers only a partial perspective on the issue under investigation, that is also characterized by a great complexity, dealing with technological changes currently occurring in the industry. At present, it does not allow assumptions to be drawn. Secondly, the study requires the setting up of a longitudinal survey. Longer-term aim of the research project is twofold. On the one hand, monitoring the consolidation of technologies at the industry level, and the responses of local firms in term of the adoption of new technologies, that will determine the needs for technological competencies in support their competitive position. On the other hand, in addition, the MUNER program is recently established, while it is necessary to have several cohorts of graduates to evaluate the effectiveness, adequacy and usefulness of the training offer. Then, the ability of the MUNER offer to enter this landscape of change and to adapt quickly to the demands of local businesses will be also investigated. Thirdly, as for any case study, the generalizability of results is low.

Managerial implications. The managerial implications that we expect to be able to convey concern the construction of educational offers in collaboration between firms and universities, aiming at targeting the local challenges in terms of adoption of technological innovations. In particular, by assessing how the individual education background of newly-graduates can be transformed into competencies in support of innovative processes in firms, specific actions can be designed to rethink the second-level educational offer by universities in collaboration and in favor of the local industry. Ultimately, these actions in support of second-level educational offer will have a positive effect on the local industry in addressing technologically innovative challenges.

Originality of the paper. The present contribution is intended to add a brick to the debate initiated by some scholars (Jacobides et al., 2016; Perkins and Murmann, 2018; MacDuffie, 2018) about the future of the automotive and motor vehicle industry, whose initial point was the entry of Tesla as new player. In line with Teece (2018), the focus is on the competences that current players must activate to maintain their competitive position, but looking specifically at the technological competences necessary for the adoption of technological innovations that are currently impacting the dynamics of the industry. Among the ways of integrating technological competencies within the firms, we analyse the

role of human capital, and in particular the education background of newly-graduates employed into the firms as proxy for new competencies at disposal of the firms themselves. It also analyses how specific educational background, co-designed by universities and firms together, can effectively configure as resources and competencies in support of innovative processes. In addition, the role of the university is explored in being able of targeting the local industry changes and the needs of the local firms, within an entrepreneurial university paradigm. The contribution also stands at the intersection of important perspectives for the discipline of strategic management: the RBV and the HRT complement each other in evaluating the role of the technological competencies of newly-graduates in maintaining the competitive position of the firms facing challenging and disruptive technological changes.

Keywords: education; automotive industry; technological competence, case study.

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