UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "MARCO FANNO"

CORSO DI LAUREA MAGISTRALE IN ENTREPRENEURSHIP AND INNOVATION

TESI DI LAUREA

"Environmental upgrading in the automotive industry: the case of the Italian value chain"

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MATRICOLA N. 1207004

ANNO ACCADEMICO 2020 – 2021

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Firma dello studente

Alla mia famiglia che mi ha supportato in questo percorso

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Introduction

Global trade has grown exponentially in the recent years and the increasing fragmentation of production across countries increases the difficulties in managing the sustainability issue (Ponte, 2019b). Many environmental outcomes have transnational effects and require to be managed adopting an across-boundaries approach. A lot of studies have emphasized how pollution and CO_2 emissions affect climate change and, in the long run, lead to wide disasters on economies and on living beings.

Enterprises, organizations, policy makers and non-governmental organizations (NGOs) have redirected their efforts on sustainable development solution enacting laws and promoting initiatives at transnational and local level. "The reframing of international agenda from *Millennium Development Goals* (MDGs) to *Sustainable Development Goals* (SDGs) is one example" (Ponte, 2019b pg. 2). Moreover, the drafting of *Paris Agreement* in 2015 on climate change aims at limiting the greenhouse gas emission with important implication of economic activities.

Automotive industry is one of the biggest polluters as fashion and leather sectors (De Marchi & Di Maria, 2019). This industry has been experiencing a radical change due to stricter emissions regulations - or even quotas - on vehicles use and production.

Production and use of cars significantly cause greenhouse gas emissions and air pollution. A common internal combustion engine issues around 24 tonnes of emissions over its life cycle, about 23% of which occurs in production (ILO, 2020). The shift towards new powertrains (hybrid, electric) has further emphasised the greater environmental impact of production process.

Since most of cars' environmental impact occurs during the production of vehicles is important studying how sustainability is transmitted along the value chain.

The proposal of this work is studying the Italian value chain of automotive industry beneath the light of sustainability issue. It will be investigated how firms rethink their operations and their strategies.

An original survey that has been administered to Italian and Swedish suppliers will support this analysis. It is examined how regulations, internal and external factors influence the firms' strategy and the approach to sustainability; if their commitment is only linked to law

compliance or their approach is more inclusive, considering also further process improvements linked to the use of recycled materials and renewable resources.

In Sweden, the survey was supplied by *Tillväxtanalys*, the governmental agency for Swedish development and growth. As for the Italian survey, I administered it by addressing all firms that are associated with the Italian automaker industry association *ANFIA (Associazione Nazionale Filiera Industria Automobilistica)*, one of the main Italian trade associations members of *Confindustria,* who also collaborated in this effort.

The structure of this thesis consists of three chapters.

FIRST CHAPTER – ENVIRONMENTAL UPGRADING IN GLOBAL VALUE CHAIN. The first chapter analyses the theoretical and conceptual framework of Global Value Chain (GVC) with a focus on environmental upgrading. After a short exploration of the main factors that shape the participation of firms and countries in the global economy, the analysis will scrutinize the upgrading pathaway, particularly the environmental one. The study will focus on the drivers forcing firms to invest in products, processes and organizational changes with 'green' features and on how difficult is manage this aspect along the supply chain, especially in a context of fragmented production network. This perspective highlights the issue of how, when and at what conditions suppliers undertake successful upgrading.

SECOND CHAPTER – GLOBAL VALUE CHAIN OF THE AUTOMOTIVE SECTOR. The second chapter provides an analysis of automotive global value chain and its relative challenges. The first part explains the structure and the main characteristic of the sector using the four pillars of GVC. Then a focus of the current situation of GVC with the main actors and players are specified with an emphasis of Italian automotive industry. The radical changes inside the automotive industry are driven by 4 forces: (1) electrification, (2) new technologies, (3) new entrants and (4) shared mobility (Deloitte, 2019). These factors affect the OEMs which have been started to re-design their operations, activities, and strategies. Car makers, in turn, ask to their own suppliers to adopt a sustainable approach to create a sustainable supply chain. These premises lead to the specification of the research question.

THIRD CHAPTER - SUSTAINABLE SUPPLIERS IN ITALIAN AND SWEDISH AUTOMOTIVE GVC. The third chapter exhibits the results of the questionnaires with a specification of methodology undertaken. The analysis is carried out through a descriptive part and a statistical one offering a GVC approach: (1) embeddedness in global market

(export less or more), (2) reliance with a single customer and (3) country participation in value chain with a comparison between Sweden and Italy. The descriptive part will be supported by the interview submitted to ANFIA that gives a major grasp of the phenomenon.

Chapter 1 – Environmental upgrading in Global Value Chain

1.1 Globalization in XXI century

The world economy has had a deep change in the past decades, especially in the areas of international trade and industrial organization (Gereffi, Humphrey & Sturgeon, 2005).

In the last 30 years of XX century, a variation in global economy occurs mainly due to offshoring of some activities and to the slicing up of supply chains across countries (Gereffi, 2014). Technology and organizational changes transform the production across time and space which lead to the separation of production from consumption (Ponte, 2019b).

The major dynamics emerged are: (1) the trade of intermediate inputs especially parts and components; (2) the subdivision of production process into many geographically separated steps; (3) the creation of global production system that has changed governance structures and the distribution of gains in the global economy; (4) the shift of global lead firms to a pattern in which suppliers used to produce their own products; (5) consolidation of few large suppliers (Gereffi, 2005; Gereffi, 2014; Ivarsson & Alvstam, 2010; Ponte, 2019b).

Evidence of this transformation arose analysing the globalization and firms' trends from second half of XX century to the present. Gereffi (2014), from this point of view, has offered a broad view about globalization, capturing the most significant turning points below explained.

Since 60's, multinational firms - large and vertically integrated - have divided their supply chains to gain advantage by low-cost and efficient suppliers in offshore production. The effect was an exponential growth of the establishment of labour-intensive export platforms set up by these multinationals in low-wage areas especially in less developed countries in Asia, Latin America, and Eastern Europe. This way of establishing production sites abroad was also the pattern adopted by Western Countries to promote development. In fact, in this period, Japan, South Korea, Hong Kong, Taiwan and Singapore had been starting to emerge and they were called "The East Asian Miracle".

Only later, during 70's and 80's, the oil shocks and debt crisis created outflows of foreign capital investments stopping the economic growth of above-mentioned countries, especially in Asia and Latin America. All the standardized activities in these countries were moved to lower-cost production sites worldwide. During this decade, US retailers and brand marketers

joined manufacturers in the search for seaward suppliers and this happened for the majority of consumer goods category.

The fundamental shift was from 'producer-driven' chains to 'buyer-driven' chains. In this era, global firms 'buy' their products from suppliers instead of producing themselves. This trend has moved chains from regional production system to a creation of a global supply system, with a growing share on East Asia.

Between 90's and 00's, global supply chains kept growing and consolidating, spanning many manufacturing and service industries. ICTs in the latest part of the XX century further improve global outsourcing and offshoring of manufacturing activities (Ponte, 2019b).

Further changes took place following the global economic crisis of 2008, through a rapid growth of productive capabilities in China, India, Brazil and other large emerging economies. These economies were able to shift global demand, becoming the major exporters of intermediate goods as well as the major consumers of finished goods (Cattaneo et al., 2010).

The phenomen of global integration of firms and countries and the participation in the global economy is widely analyzed in literature under the issue of *Global Value Chain* (*GVC*).

Here below these concepts will be examined better, making references to the early stage of study in literature and to various specifications and insights born over years.

1.2 The Global Value Chain framework

The *Global Value Chain (GVC)* term describes "the full range of activities", from the design to customer service, "that firms, farmers and workers perform to bring a product from its conception to end use and beyond" (Fernandez-Stark & Gereffi, 2019 pg. 55).

The GVC paradigm – early named Global Commodity Chain (GCC) – focused on "how value is generated and appropriated along functionally integrated but internationally dispersed activities, accounting for power dynamics among various global economic actors" (De Marchi et Al., 2020 pg. 1). The birth of this literature strand dates to 1994 with the publication of Gereffi & Korzeniewicz *Commodity chains and global capitalism* (De Marchi et Al., 2020). The transition from GCC to GVC happened in the early 00's when more explanation about firms' coordination needed besides the industrial and labour organization of global industries (Gereffi, Humphrey, Sturgeon, 2005). The shift focuses on the value creation, externalization's decisions and on how lead firms exert power in GVC (De Marchi et Al.,

2020). Various publications enriched the literature over years (see Gereffi, Humphrey & Sturgeon, 2005; Gereffi, 2005; Gereffi, 2014), defining a setting that has provided tools to investigate the global structure of economic activities providing 'top-down' and 'bottom-up' outlooks of GVCs (De Marchi et Al., 2020 pg. 3).

According to Fernandez-Stark and Gereffi (2019), GVC consists of 4 pillars:

1) *Input-output structure* describing all the activities performed (from raw materials to final product) and their geographical scope (how industry is globally organized);

2) *Governance structure*, which explains how value chain is controlled by (lead) firms (top-down view of the industry);

3) *Upgrading*, the process of value acquisition through which suppliers 'move up the value chain' (bottom-up view of the industry);

4) *Institutional context* and *industry stakeholders* influence local developmental opportunities stimulating upgrading and/or connection with social and economic elements.

The first two dimensions (input-output structure and governance) describe the international elements that determine the dynamics of the industry at global level. The second set of dimensions (upgrading and institutional context and industry stakeholder) study how individual countries participate in GVCs (Fernandez-Stark and Gereffi, 2019).

1.2.1 Input-output structure

The first point is the analysis of how a product is made, from initial conception to end use and beyond (De Marchi et Al. 2020). The analysis starts from the structure production activities considering all the industries involved and the and the production of intermediate product (De Marchi et Al., 2020). When the analysis of a product production occurs, there is the simultaneous account of "(1) individual value chain activities, (2) the overall value chain organization and its evolution over time, and (3) the multiple actors and territories involved" expanding the investigation beyond the study of individual firm (De Marchi et Al., 2020 pg. 3). One of the most significant articles is Bair and Gereffi (2001) in which the authors report an analysis of the activities needed to perform jeans (e.g., trim and labels, laundry and finishing), describing how the geography of such activities evolved over time, between US and the Torreon cluster, and illustrating the actors performing each activity (Fernandez-Stark & Gereffi, 2019).

1.2.2 Governance and power

Governance is defined as "both the process by which particular players in the chain exert control over other participants and how these lead firms (or 'chain drivers') appropriate or distribute the value that is created along the chain" (De Marchi et Al., 2020 pg. 2); or "as the actions, institutions and norms that shape the conditions for inclusion, exclusion and mode of participation in a value chain, which in turn determine the terms and location of value addition, distribution and capture" (Dallas, Ponte & Sturgeon, 2019, pg. 668).

Initial contributions of governance 'as driving' were made emphasise the role of lead firm in shaping the development trajectories of the industry distinguish *buyer-driven chain* and *producer-driven chain* (Golini et Al., 2018).

In *Buyer-driven* chains, most powerful actors are located downstream, such as some global brands (as *Nike* and *Gap*) and some retailers (as *Walmart* and *Tesco*). They establish global sourcing networks to procure labour-intensive consumer goods from low-cost suppliers in Asia, Latin America and Africa. "They had no direct ownership of factories but increasing control over production through their ability to set prices, product specifications, process standards and delivery schedules in their supply chains" (Barrientos, Gereffi & Rossi, 2011 pg. 323). In *producer-driven* chains, "the power is held by final product manufacturers as happens in capital- and technology-intensive industries, like automobiles and advanced electronics" (Barrientos, Gereffi & Rossi, 2011 pg. 323).

This classification, at the beginning of new millennium, was overcome by a more detailed types of governance that look at alternative inter-firms linkages and upgrading opportunities: governance "as linking" (Ponte, 2019b). This governance pattern enhances the endowment of resources and knowledge for GVC participation (De Marchi et Al., 2020). The 3 parameters to analyse the governance structure are (1) complexity of information exchange, (2) codifiability of information (3) capability resident in the supply base relative to the specification of the transaction (Gereffi, Humphrey & Sturgeon, 2005; Ponte, 2019b). Gereffi, Humphrey & Sturgeon (2005) identified 5 types of network governance structure:

(1*) Market* - the relationship is based on arm's length due to the ease of product realization;

(2) *Modular* - there is a common architecture among products that can be easy identified and applied to a different range of goods;

(3) *Relational* - capabilities and knowledge to develop products are complex and both parties must exchange much information to create the best solution;

(4) *Captive* – product complexity induces suppliers to improve and create new knowledge and capabilities to satisfy the requirements of head-firm through a specific investment;

(5) *Hierarchy* - lead firms prefer in-house production.

Captive form, in some study is assimilated to *quasi-hierarchical* governance structure (Navas-Aleman, 2011) given the high interaction among firms. Relational and captive governances require high flow of information. The main difference is linked to coordination effort exercised by one part, mainly lead firms and by the type of investment undertaken by firms (Golini et Al., 2018).

Other contributions highlight that operations in an industry may be shaped by other actors that do not directly participate in VC as civil society, policymakers, consumers groups, third party certifiers and NGOs: governance "as normalizing" (Ponte, 2019b). These players exert *power* on the actions of enterprises in different way, often acting concurrently.

In GVC, p*ower* has multiple dimensions. Over years, power was studied according to different point of views and often linked to governance model. The early study showed that the 'buyer-power' created very powerful suppliers and how they try to retain their position; and other have analysed how lead firms exert power in Global South helped by State-support (Ponte, 2019b). However, much of studies focus on the power exercised by one actor, usually lead firm and how it shapes GVC participation (Ponte, 2019b). Other study shows that different actors in different position of the value chain may shape its dynamics (Ponte, 2019b). It appears that also actors outside the value chain may drive GVCs as NGOs, trade unions, governments and so on (Ponte, 2019b).

The more recent power approach includes a broader spectrum of actors often outside these dynamics. Combing the two components of *transmission mechanism* and *arena of actors* (see Dallas, Ponte & Sturgeon, 2019) emerges that power may be divided in four types of power (Dallas, Ponte & Sturgeon, 2019; Ponte, 2019b):

(1) *Bargaining* power is wielded by a single actor (often a lead firm that exercised power over suppliers located in the Global South);

(2) *Istitutional* power is exert by categories as associations or governmental authorities, often external to dynamics of GVC. In this category is included also third-party certifiers and standard-setting bodies;

(3) *Demonstrative* power emerges through a specific transaction that generates a standards and adaptation among competitors and suppliers as may happen with a specific form of environmental upgrading or sustainability requirements. It may be also the result of a reshaping of a strategy;

(4) *Constitutive* power refers to the emergence of good/best practises that over time, become widely accepted. It may arise also in an unintended way maybe catching a market opportunities. Typical example of this power is the extraction of all value of suppliers under the name of sustainability.

It is important to highlight that governance and power change as industry evolves leaving room for opportunities and challenging issues (Fernandez-Stark & Gereffi, 2019) as happened for automotive industry "that moved away from 'hierarchical' towards 'modular' when lead firms sought to reduce costs and risks through outsourcing" (Sako & Zylberberg, 2018 pg. 4). Since mappings of power and the description of governance can be quite challenging and are not always easily distinguishable in real settings it is useful to remember that different types of power and governance concur together especially when actors operate in multiple VC and when different actors intervene concurrently as NGOs, policy makers and customers as it has happened in the last years (De Marchi et Al., 2020).

1.2.3 Upgrading

The bottom-up perspective focuses on how actors 'move up the value chain' for economic gain, shifting up functional position or making products with more value added to enhance market position in the context of interconnected functions globally dispersed (Poulsen, Ponte, Lister, 2016; Riisgaard et Al., 2010; Goger, 2013; Fernandez-Stark & Gereffi, 2019).

Upgrading refers to the strategies adopted by regions, countries and firms to move toward higher value activities and capture more value and catch learning opportunities (De Marchi et Al., 2020).

Humphrey & Schmitz (2002) identified four types of upgrading:

(1) *process upgrading*, to achieve a more efficient transformation of inputs through reorganization of productive activities;

(2) *product upgrading* to create more sophisticated goods with an higher value;

(3) *functional upgrading* consists of integrating new functions or abandoning the existing ones to increase the value-added activities and so the overall skills;

(4) *intersectoral upgrading* which means apply competences acquired in one function and traslate them in a related industry.

This distinction of upgrading types was collected under the general term of *economic upgrading*.

Literature suggests that functional upgrading is the most important to reach to strengthen the position along VC. In fact, scholars initially underline the importance of following the trajectory from process upgrading to functional one - considered the more skilled and the one with high knowledge content - (Ponte, 2019b). One of the best formulations of dynamic trajectories were study in consumer goods industries as apparel, footwear and electronics considering increasing firm level capabilities (Gereffi, 2019). Starting from the assembly of imported inputs so called *Export-Processing Zone (EPZ)* a firm may shifted to a local production and sourcing of finished products, so called *Original Equipment manufacturers (OEM)*, to a further and more complex value-added stages like *Original Brand Manufacturers (OBM),* where actors sell their own-branded merchandise in domestic and external markets, to *Original Design Manufacturers (ODM),* in which players carry out the design of goods sold under the brand of other firms (Gereffi, 2019).

This literature strand related to economic upgrading agrees with the idea that suppliers (especially the ones located in developing countries) must undertake this pathway to obtain a higher share of value added in their product and services. But the reality offers conflicting evidence. Most of firms have tried to move up (after entering in contact with international companies) remained at the assembly stage of global industries, with low assistance in promoting social or industrial policies causing the lowest returns and the most intense competitive pressures (Gereffi, 2019; Bernhardt & Pollak, 2015). In some cases, a firm may adopt a downgrading strategy to accommodate buyer demands or to overcome the constraints (Ponte, 2019b).

Literature is trying to include a more complete vision of upgrading including environmental and social aspects. The recent literature is moving toward a global comprehension of economic, environmental and social aspects, collecting under the name of sustainable development. So, the latest trends refer to the idea that economic growth, and environmental and social protection may coexist without mutually excluding each other.

1.2.4 Institutional context

Upgrading success and GVC participation are determined by institutional framework which identifies policies and economic and social conditions that shape countries' and firms' participation in value chain (Fernandez-Stark & Gereffi, 2019). "Economic conditions include the availability of key inputs: labour costs, available infrastructure, and access to other resources such as finance. Social context governs the availability of labour and its skill level, such as female participation in the labour force and access to education. Finally, institutions include tax and labour regulation, subsidies, and education and innovation policies that can promote or hinder industry growth and development" (Fernandez-Stark & Gereffi, 2019, pg. 64). "Cross-country differences in terms of policies and supportive regulatory frameworks affect the opportunities of local firms (suppliers) or local individuals (workers) to benefit from being a part of GVCs (upgrading)" (De Marchi et Al., 2020 pg. 9).

1.3 Sustainability issue in GVC

Literature has paid attention to environmental and social upgrading since economic one may lead to exploitation of natural resources, workers and have questionable effects on the environment and quality of employment (Rossi, 2019). Economic upgrading often carries to environmental and social downgrading because it creates a long-term ecosystems damages and a framework for vulnerable labour (e.g.: informal and migrant workers and temporary contracts) (Rossi, 2019; Lister, Poulsen & Ponte, 2015; De Marchi et Al., 2020).

More recently, the reframing of international development agenda from the *Millennium Development Goals*[1] to *Sustainable Development Goals*[2] has highlighted the appearance and urgence of sustainable development for an inclusive growth (Ponte 2019b).

The signature of the *Paris Agreement*[3] in 2015 marks another the turning point. This treaty is first-ever universal binding global climate change agreement (174 signed-countries) setting

[1] *Millennium Development Goals* (MDGs) is an initiative promoted by United Nation sealed in 2000. This initiative commits the member states in 8 goals by 2015: eradicate extreme poverty and hunger in the world, make primary education universal, promote gender equality and empower women, reduce child mortality, reduce maternal mortality, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability, develop a global partnership for development. [https://www.un.org/millenniumgoals/ Access date: 01/21/2021]

[2] With the end of 2015 takes place the end of 15-year cycle of the anti-poverty MDGs, and on January 2016 – an even more ambitious set of goals were set up. The *Sustainable Development Goals* (SDGs) are built upon the 8 MDSs and include 17 objectives and 169 targets to reach by 2030 to wipe out poverty, fight inequality and tackle climate change [https://www.un.org/sustainabledevelopment/blog/2015/12/sustainable-development-goals-kick-off-with-start-of-new-year Access date: 01/21/2021].

the limit of increase of global average temperature below 1.5°C. European Union, for example, aims at reducing the greenhouse gas (GHG) emission by at least 40% by 2030 compared to 1990.

The first time that the notion of '*Sustainable development*' occurred was in 1987 during the United Nation General Assembly in the report of the world commission on environment and development entitled '*Our common future'*. "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (pg. 37).

The three basic elements of sustainable development are economic growth, environmental stewardship, and social inclusion (Muralikrishna, & Manickam, 2017) (Fig. 1).

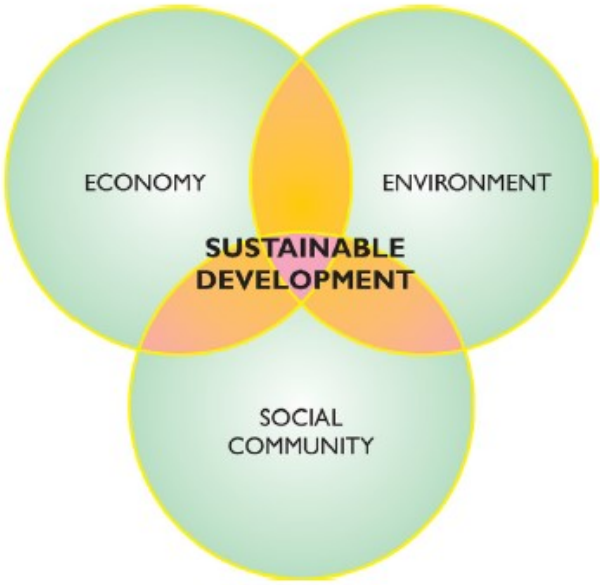

Figure 1. The three pillars of sustainable development. Source: Muralikrishna & Manickam, 2017

Economic development furnishes incentives for organizations and businesses to commit in sustainability beyond the only compliance with regulations. Especially for what concerns developing countries, economic development means satisfy the needs of people without reducing the quality of their lives (Muralikrishna, & Manickam, 2017). Sustainable economic development means that businesses and/or countries act responsibly in using resources to sustain activities in the long term.

[3] https://ec.europa.eu/clima/policies/international/negotiations/paris_en [Access date: 01/29/2021]

Social development considers the protection of human beings from pollution and other dangerous activities of businesses. The objective is to instil awareness about environmental protection and promote warning of danger (Muralikrishna, & Manickam, 2017).

Environmental protection focuses on reducing the impact of activity through 4Rs (reduce, recycle, recover and reuse) (Muralikrishna, & Manickam, 2017) given the scarcity of some resources. It refers to the discharge into the environment of substances that may be harmful for living beings as well as the damage caused by the extraction of materials.

The aim for the future is protecting ecosystems, air quality and integrity and sustainability of resources (Muralikrishna, & Manickam, 2017). It also concerns on how potential technology will drive green improvement in reduction of current and future potential damage (Muralikrishna, & Manickam, 2017).

Sustainability and sustainable development are two sides of the same coin: the concept of sustainable development is connected to a proactive approach which includes factors that may promote sustainability (Clune & Zehnder, 2018); sustainability offers a long-term goal in which environmental, societal, and economic aspects are balanced to reach a better quality of life (Muralikrishna, & Manickam, 2017).

In the long run, sustainability objective may be reach through (1) technology and innovation, (2) laws and governance and (3) economics and financial incentives (Clune & Zehnder, 2018). However, the transition toward a sustainable development faces the trade-off between actual needs and limitations imposed by the state of technology. Often, without an appropriate technology, sustainability solutions will fail, even in presence of regulation and financial incentive (Clune & Zehnder, 2018).

In this context, again, the major role is played by enterprises, which, activities generated the attention of public due to the clear effects of environment and society (Ponte, 2019a). Especially lead firms - operating on international scale - shifted from an initial scepticism and reactive actions to a self-regulatory approach and market-based initiatives aimed at improving the environmental and social impact of their activities (Ponte, 2019a). Now firms "are actively using sustainability to help mitigate reputational risk[4], increase profits, create new product

[4] *Reputational risk* refers to "the potential for negative publicity, public perception or uncontrollable events to have an adverse impact on a company's reputation, thereby affecting its revenue". [https://www.reputationmanagement.com/blog/reputational-risk/ Access date: 01/21/2021]

line enhance brand loyalty and increase their power" (Ponte, 2019b pg. 14). Sustainability of corporate activities is part of *Corporate Social Responsibility* (CSR) that covered this field from businesses' perspective.

Studying sustainability in GVCs means analyses how sustainability requirements travels along the value chain, what the incentive, rewards and punishment are, what consequences these processes have for the geography of production and distribution of the value added, the nature and organization of production activities and the actual impact on environment outcome (Ponte, 2019b). It is possible distinguish '*sustainability management*' that refers to the actions undertake by lead firms in GVC related to environmental issue; '*sustainability governance*' which refers to the whole effort made by different actors (as associations, corporations, and NGOs…) to address environmental challenges; and '*orchestration*' which refers to the attempt of different actors in shaping environmental process and outcome (Ponte, 2019b).

In GVC literature, these dynamics are better explained under the study of '*environmental upgrading*' process. This issue, in literature, tries to analyse also to what extend 'environmental improvement' is drive by lead firms and other actors and what the consequences for suppliers and environment are. This topic is important given the non-tangible and delayed effects on environment and society, and by the latest concrete effect on climate change.

1.4 Environmental Upgrading

Environmental upgrading is defined as "the process of improving the environmental impact of value chain operations" (Poulsen, Ponte Lister, 2016 pg. 60); or "the process by which economic actors move towards a production system that avoids or reduces environmental damage from their products, processes or managerial systems" (De Marchi, Di Maria & Micelli, 2013 pg. 65); or, in a broader meaning "a process by which actors modify or alter production systems and practices that result in positive (or reduce negative) environmental outcome" (De Marchi et Al., 2019 pg. 312).

In literature, the adoption of sustainable strategies focuses on how lead firms have been able to induce environmental upgrading in their suppliers and the effect on supply chain (see Goger, 2013; Khattak & Stringer, 2017; Ivarsson & Alvstam, 2010). Less papers investigate the suppliers' ability to promote environmental upgrading (De Marchi & Di Maria, 2019). Successful upgrading in suppliers is affected by knowledge and capabilities. The ways firms

could leverage skills vary according to embeddedness in regional and national network, to institutional context and to governmental policies and regulations that may support or frustrate capability-building through initiatives and incentives (Whitfield et Al., 2020).

Environmental upgrading involves the *production process* (often related to use of superior technology), the *product itself* (related to use of recycled materials and avoidance of toxics) and the *"way of doing business"* (related to the achievement of standards and certifications) (De Marchi et Al., 2019). Substantially, environmental upgrading refers to reduction of damage on the environment by firms though fall of GHG emission, declining pollution, decreasing long-run ecosystem damage, and saving of natural resources (De Marchi et Al., 2019). Instead, environmental downgrading occurs when there is a negative outcome on natural environment (De Marchi et Al., 2019). Downgrading may be also the result of failure in the product, process, and organizational improvements. An example could be when a partial improvement of the production process linked for example to water saving, caused an increase of GHG emission because of an overuse of another resource (De Marchi et Al., 2019).

Environmental upgrading is often linked to lower costs related to efficient energy use and materials and improved productivity. The adoption of green strategies often drifts organizational change and higher prices paid for products embedding environmental qualities. But in other instances, it can impose net costs in the short term that are not necessarily recouped. However, if firms can recover these costs, they can charge higher prices, improve margin and profitability, achieve lower costs in the long term, and achieve economies of scale (Ponte, 2019b). This issue is consistent when environmental upgrading is analysed considering all the value chain.

1.4.1 Drivers

Scholars figure out internal and external factors that accelerate and encourage the transformation to reach sustainability. Most masterpieces agree with the heavy importance of lead firms in shaping upgrading in suppliers. It is not possible to figure out a one-way pattern to drive environmental upgrading because each industry has its own dynamics, issues, and international and local rules (if available) to cope with (Khattak & Stringer, 2017). Some factors work better for some industries, others have questionable results about effectiveness and further coexist together.

However, improving sustainability performance, as measured in environmental and social impact will increase the companies' possibility to obtain higher return and reduce reputational and sustainability risk[5] (Bové & Swartz, 2016).

Extra-firm factors typically refer to consumers, policy makers and regulation, technology, and other stakeholders.

More and more final consumers have increased their power and are able to ask firms green products (*market pull*) and it opens possibility for companies to capture new value. *Marks&Spencer* has tried to meet the need of their costumers of "being ethical and cost competitive" through the development of eco-friendly apparel line (Goger, 2013).

Results about regulation is mixed, sometimes conflictual and not well defined. Even if scholars agree with the greater importance of law in pushing environmental upgrading, a scarce discipline both in international and local field, may leave room for opportunistic behaviour (De Marchi et Al, 2019; Poulsen, Ponte, Lister 2016). Fragmented and uncertain environmental regulation, in maritime shipping, caused a delay in new investments and initiatives (Lister, Poulsen, Ponte, 2015). Indirect effect had the environmental regulation of manufacturing industry in China which directives were captured by investor multinationals and not by local firms (Hu, Jin & Liu, 2019). These rules have "shaped" and guided foreign investments in tech-intensive manufacturing industries causing an upgrading in manufacturing industries thanks to spillovers effect (Hu, Jin & Liu, 2019).
Some empirical case suggest that regulation seems to have a 'double face': it catches inefficiencies, but it is mitigated by power wielded by GVC actors (Riisgaard et Al., 2010): British Organic Certifier, in 2007 wanted to exclude from certification all organic product air-freighted to the UK market. Since most world poorer countries are organic food exporter by air, this change should imply the conversion to conventional farming or exit the VC. This idea, however, was abandoned because the international organization lobbied against the proposed ban.
Other kind of regulation is identified in international certifiers and third-party auditors that verify the compliance with some standards. Some examples are *Green Building Council*[6] and

[5] *Sustainability Risk* refers to the ability of system (organization/corporation) to flourish, given the negative externalities that may erose value creation and affect other ecosystems. [https://envecologic.com/what-is-sustainabilityrisk/#:~:text=Sustainability%20risk%20refers%20to%20the,time%20or%20impact%20other%20related Access date: 01/21/2021]

ISO[7]. Usually, compliance is voluntary and the choice to adhere is often a cultural factor (Khattak & Stringer, 2017).

Technology represents the most important factor in improving environmental outcomes because the use of new technology often implies reduction of environmental outcome and an improvement of processes (De Marchi et Al., 2019). Especially for what concern products and processes, their success is linked to the presence of technology that satisfy the needs (Clune & Zehnder, 2018). An example is the reduction of phosphates in laundry soap in the US during the 60's. Even if there was the presence of bans in the use of it, there was no substitute till the end of 70's with discover of zeolites (as a new technology, whose discovery was in part driven by political pressure and economic opportunity) (Clune & Zehnder, 2018). "Continuous improvements imply that inside a company there is a continuous commitment in being awareness of new trends and dynamics inside the industry and responsive to customers' needs" (Clune & Zehnder, 2018 pg. 216).

Lead Firms are the most powerful companies inside GVCs and may be able to dictate standards and to stimulate the improvements and upgrading of suppliers - at least first tier (Villena & Gioia, 2020; Khattak & Stringer, 2017). Some research and case study demonstrate how difficult is driving environmental upgrading in second and lower tier suppliers mainly for lack of knowledge and distance from the public attention (De Marchi et Al., 2019; Villena & Gioia, 2020).

Multinationals may be able to force other firms to follow their code of conducts and to adhere to environmental specifications (Poulsen, Ponte, Lister, 2016; Khattak & Stringer, 2017) and sometimes, their directive may substitute a lack in regulation. Considering Pakistan's sporting

[6] The World Green Building Council (*World GBC*) is no-profit organization founded in 2002 based in Toronto. It promotes the sustainable development of construction industry and of buildings themselves. This organization is part of UN Global compact and its network counts 70 sites around the World. It works with businesses, organisations, and governments to drive the ambitions of the Paris Agreement and UN Global Goals for Sustainable Development. The main strategic areas regard climate action, health & wellbeing, and resources & circularity. This organization proposes different types of certifications "to assess and recognise buildings which meet certain green requirements or standards". [https://www.worldgbc.org/ Access date: 01/21/2021]

[7] ISO (*International Standards Organization*) is an independent, non-governmental international organization with a membership of 165 national standards bodies. It covers different fields and they are applied to different sectors and industries. Some examples are 'Quality management standards' to help work more efficiently and reduce product failures; 'Environmental management standards' to help reduce environmental impacts, reduce waste and be more sustainable and 'Health and safety standards' to help reduce accidents in the workplace. [https://www.iso.org/standards.html Access date: 01/21/2021]

goods industry in global value chains (Khattak & Stringer, 2017), some firms involved recognize the importance to comply with ISO 14001 to have the chance to enter in contact with the major brands and work with multinationals. Certification, in this case, may be seen also as internal driver and avoid, to some extent, the increasing control of lead firm. Another example are multinationals oil corporations that have adopted a clear auditing scheme on their tankers, more than *IMO* (International Maritime Organization) requirements (Poulsen, Ponte, Lister, 2016).

In fact, GVC literature suggests that the sustainability strategy chosen by lead firm impacts on governance adopted to manage suppliers. These processes of knowledge sharing through interaction between buyer and supplier is fundamental to catch new trends in the industry, in practises and regulations (Khattak & Stringer, 2017). An example is *Aquafil Group* specialized in the production of nylon for carpeted floors. They started to face environmental issue upon request of its main client – Interface – a multinational, leader in production of carpets (De Marchi, Di Maria, Micelli, 2012).

Main reason to 'manage' suppliers is determined by some scandals where the lack of control caused some image damage to lead firms as it happened for *Nike* and suppliers' children labour during Nineties. Opposite (and more recent) example is *Ikea*, with a strict policy about suppliers' selection and, at the same time, a great commitment in helping supplier to reach upgrading (economic, environmental and social) through free consultation and long-term agreement but not exclusive (Ivarsson & Alvstam, 2010).

Intra firm drivers are often related to the creation of a competitive advantage through the reduction of environmental impacts such as energy and water usage, carbon footprint[8] and waste. Typical drivers are cost reduction and efficiency. Literature about maritime shipping said, as major environmental driver, fuel saving and energy price (Poulsen, Ponte, Lister, 2016). A survey of McKinsey (2011) said that companies switch to more sustainable activities to increase operational efficiency, reduce the cost for "managing reputation" and to catch growth opportunities. *Valcucine*, an Italian firm specialized in high-end kitchen which, thanks to continuous investment in reduction of environmental impact of process and the product itself, has create a sustainable competitive advantage (De Marchi, Di Maria, Micelli, 2012). Arzignano tannery district in Italy is trying to address environmental issue by developing and

[8] The carbon footprint is a measure that expresses in CO_2 the gas emissions associated directly or indirectly with a product, organization or service [https://www.minambiente.it/pagina/cose-la-carbon-footprint Access date: 01/29/2021]

improving process using fewer toxic chemicals and less water to obtain a premium price and have new market opportunities (De Marchi & Di Maria, 2019). Another motivation is related to "first move advantage" as happened for *Marks&Spencer* about eco-factories in Ski Lanka for its apparel line. From an interviewed employee emerged that: "nothing existed at that time (2006) and *Marks&Spencer* was quite pioneering. We would try and create those factories that would stand as model learning experiences for the broader manufacturing community" (Goger, 2013 pg. 74)

1.4.2 Sustainability along the supply chain

The global dispersion of firms makes very difficult to determine straight road in managing supply chain sustainability. "While lead firms easily apply governing instruments to first-tier suppliers, the process of stimulating environmental upgrading by second-tier suppliers and beyond is more complex" (De Marchi et Al., 2019 pg. 317). Lead firms play an important role in shaping engagement in suppliers acting in two different manners (Ponte, 2019b). (1) Lead firms bring substantial technical support especially when standards are not readily available; (2) lead firms exert less control because suppliers already comply with standards. This is also consistent with De Marchi et Al. (2019) who have identified 3 instruments driving environmental upgrading in suppliers: (1) standards and certifications, (2) product design and (3) knowledge transfer and supports, providing examples of successful and failure of environmental upgrading.

This commitment of lead firm is often driven by pressures received by different stakeholders (or to avoid potential pressure) addressing systemic environmental issues, such as those attributed to their suppliers (Hall, 2001). It is possible to say that the dominance of lead firms in an industry has important implications for environmental supply-chain innovation (Hall, 2001). The *Ikea* case is one of the most successful. *Ikea* designs the IWAY code to promote sustainable practises procurement along all the supply chain (Ivarsson & Alvstam, 2010). The more the supplier is far from minimum standard, the stricter is the control. This fact is quite evident in suppliers located in developing countries as China and India which 50% of them improve their operations especially in sourcing certified wood, improve chemical storage and handling, emission reduction and water manage (Ponte, 2019b; Ivarsson & Alvstam, 2010). The result was positive both for *Ikea* and suppliers: *Ikea* obtained an effective cost savings through its paternalistic approach; suppliers assimilate new knowledge and avoid the lock-in of a single firm (Ponte, 2019b; Ivarsson & Alvstam, 2010). *Ikea*, however, keeps

collaborations with suppliers in advanced countries: despite their higher cost, it continues relations because of their knowledge in complex and skilled products (Ivarsson & Alvstam, 2010).

Lead firms leverage sustainability for profit maximization, while suppliers build new competences or sharpen existing one to meet these demands (Ponte, 2019b). "Suppliers, workers and farmers – often based in the Global South – create new value through sustainability to remain in the game but, may not be able to retain it" (Ponte, 2019b pg. 133). The example of Sri Lanka eco factories of *Marks&Spencer* shows that even if all the industry gains from the 'green image' and obtained new orders, most of suppliers did not received additional price premia and the financial risk of firms increases (Goger, 2013). Sustainability, in fact, is often used by lead firms to extract more value from suppliers exerting more power and control on their resources and reducing information asymmetries consolidating their own supply chain and leading to a sustainability-driven supplier squeeze. (Ponte, 2019b).

Suppliers are frequently not under the same types or levels of pressure as their larger customer firms and therefore have fewer incentives to engage in environmental and social innovation (Hall, 2001). The study of Lister, Poulsen & Ponte, (2015) has shown that high distance from public caused inaction in managing environmental issue in maritime shipping because of low interest, lack of awareness (from final consumers) and low return. Villena e Gioia (2020), in their article for *Harvard Business Review,* have shown that many lower-tier suppliers avoid addressing their environmental and social matter on voluntary basis because they perceive no advantage and no effect in doing so. This is consistent with downgrading strategies that some firms may adopt to satisfy request of important clients reducing the social (and environmental) protection of workers. Chinese Foxconn factory, the world largest exporter and producers of mobile phone, is an example. It gains the supply contracts of some global electronic brands. The satisfaction of these clients leads to a reduction in the quality of work that led to various suicide attempts (Barrientos, Gereffi & Rossi, 2011). This is consistent with the fact that economic upgrading does not automatically translates into social upgrading through better wages and working conditions (Rossi, 2019; Barrientos, Gereffi & Rossi, 2011). This discussion refers to social upgrading that studies the "improvements in the wellbeing of workers" (Bernhardt & Pollak, 2015 pg. 6) considering entitlements, rights and quality of employment (Rossi, 2019). This is significant as low skilled workers are often exposed to worst labour condition given the trade-off that suppliers face in GVC framework:

quality maximizing (to meet buyer's standards) and cost-prices minimization (to attract other clients) (Barrientos, Gereffi & Rossi, 2011).

It is necessary to clarify that not all firms are exposed to the same types of pressure or to the same extent (Hall, 2001). Each firm is primarily legally responsible for its own activities and not necessarily responsible for that of its suppliers (Hall, 2001). This issue opens the question of the gains of (environmental) upgrading and sustainability showing that the greater advantage belongs to lead firm and final consumers: "global buyers benefit from sustainability management through value appropriation; consumers feel good about their 'sustainable' purchase, which come at limited or no extra cost to them" (Ponte, 2019b pg. 133); suppliers are legally responsible for their activities, including investments and loans undertaken to satisfy their clients (Goger, 2013).

However, another perspective is that successful upgrading paths may be shaped by suppliers' strategies (also called bottom-up perspective) (Whitfield et Al., 2020). Firms' ability to leverage resources, capabilities and knowledge, influences the strategies to adopt, and these strategies determine their upgrading paths and their captured value added (Whitfield et Al., 2020). If the initial 'background' of a firm is quite good (considering access to finance, tacit knowledge, and social networks), it will increase the probability of success. Floricultural industry in Kenya and Ethiopian apparel industry are two opposite examples that demonstrate that upgrading paths jump with the presence of other factors not only strictly related to the presence of lead firms. Examples of suppliers' upgrading is often linked to the economic one. Sustainability approach is often used by enterprises in Global North to increase their product portfolio and avoid the saturation of the markets as the only economic upgrading is no longer sufficient to assure a sustainable return (Ponte, 2019b). However, literature shows that suppliers able to deliver environmental upgrading are the one with superior capabilities already in place (Ponte, 2019b). This is consistent with the study of De Marchi, Di Maria & Micelli (2012). They have drawn up a framework that include green issue in firms' strategy in a way that environmental and economic issues may coexist together without mutually exclude each other. They provide examples in Italian furniture industry showing how these firms were able to shape the external environment and gain benefits catching opportunities.

GVC shapes a framework in which firms may enter in the global economy. For years, the participation was linked to the exclusive economic gains that actors may obtain through the economic upgrading. Now, the idea is that GVC may include sustainability issue has lead

chain governors and other actors to integrate and promote environmental and social aspect in their strategy. The aim is ensuring economic growth through the adoption of practises that reduce the transnational and local consequences of pollution and activities and improve the employment quality. It relieves the dimension of exclusive economic growth considering other key elements as natural impact of the operations and the wellbeing of workers, and, in general of society. The drivers of environmental upgrading demonstrate how different players react to various incentives posed by other actors, focusing on the result of upgrading process or outcome.

However, the grasp of sustainability issue, in a fragmented production network, needs more efforts to be addressed as often the whole supply chain impact is not always fully counted. The strategies undertake by some actors (lead firms) may influence the strategies of the other ones with negative or positive effects.

Chapter 2 – Global Value Chain of the automotive sector

The automotive industry is one of the most studied in the GVC literature (De Marchi et al., 2020) because of the depth of globalization dynamics. It is also one interesting setting where to study environmental upgrading, given the significantly contribute to permanent environmental pollution. This industry, in fact, has a deep impact on nature and on society, and so it has always been scrutinized by regulatory agencies setting environmental standards and featuring of products.

The presence of an increasing stringent environmental legislations about emission and waste/disposal and new technology drive car manufacturers to integrate green attributes in their operations to reduce environmental pollutions of their activities and along their value chains.

The presence of new entrants as *Tesla* and the increasing demand for electric cars and new mobility solutions push incumbents (as *Toyota, PSA, BMW, Volkswagen* and so on) to undertake significant investments in new technology to develop more environmental-friendly products and services. Furthermore, the eco of *dieselgate* of German cars sold in Europe and America and the strict pressures exert by political policies has made final consumer more aware of sustainability matter.

2.1 Automotive global value chain

Different forces have shaped the automotive industry over years, from strong competitive pressures and local governmental authorities to the emergences of new markets and economies till new technologies and demand that are shaping a radical transformation of the vehicle.

The *input-output structure* of Automotive industry (Fig. 2) offers a broad view of all production stages that take part in the construction of a vehicle.

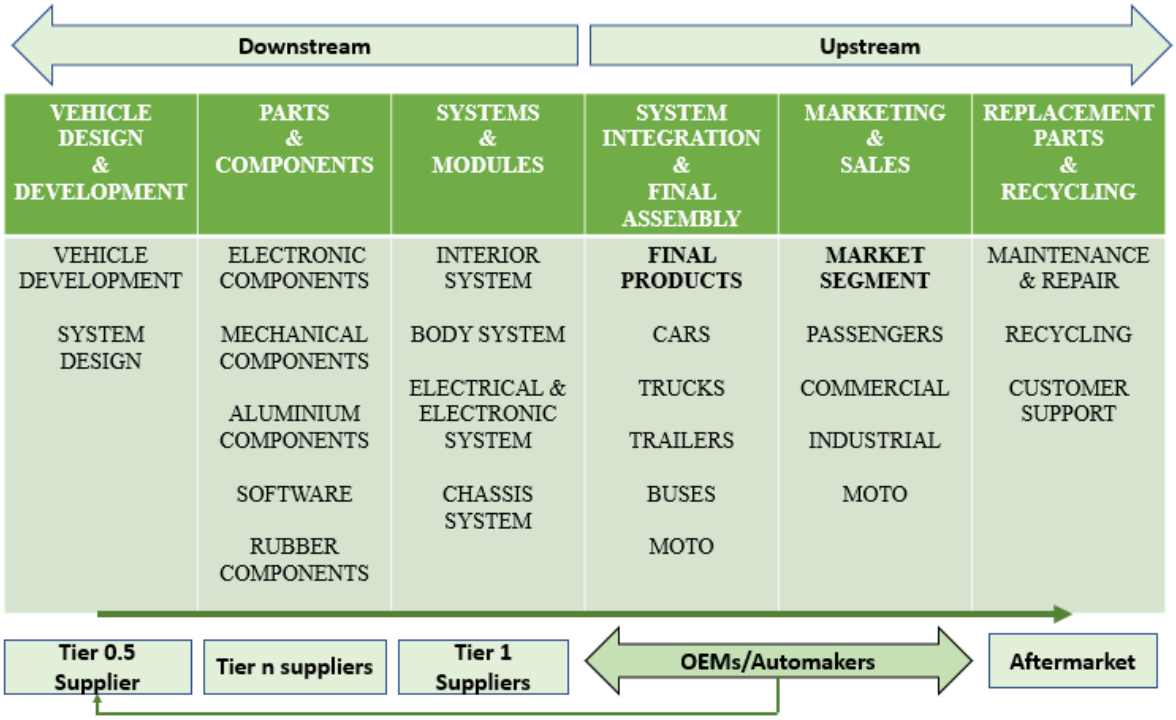

Figure 2. Input-output structure of automotive industry. Source: Own elaboration

The typical *governance structure of the industry* is the hierarchical one. Car manufacturers is on top (carrying out the assembly of vehicles), followed by top suppliers (which carry out design activity and provide sub-systems) and by a large network of lower tier suppliers and subcontractors (De Backer & Miroudot, 2013).

In this industry, there are a high degree of concentration, a capital-intensive production system in which few countries have 90% of total production and this is the result of the consolidation route that took place in the 90's and is currently going on (OECD, 2016; Castelli, Florio, Giunta, 2011).

In fact, strong competition, consumer preferences, political pressure and high level of motorization forced car manufacturers to establish final assembling plants near to final market in a fashion said 'build where you sell' (Sturgeon, Van Biesebroeck, Gereffi, 2008 pg. 204). These factors, together with high transportation costs in downstream activities drive the creation of regional cluster with high degree of specialization (De Backer & Miroudot, 2013). However, inside a cluster, there are activities carried out at the global level as vehicle design, engineering, and sub-systems development; and other activities that are carried out at the regional and/or national level as production of parts and components. Activities carried out on global scale are made by top-tier suppliers 'Tier 0.5' (Humphrey & Memedovic, 2003 pg. 22) and by Tier 1 which had created a strong relation with OEMs suppliers through a worldwide presence (Castelli, Florio, Giunta, 2011; Humphrey & Memedovic, 2003). Regional/local

production is linked to the heavy, bulky and model-specific parts, which are usually close to final assembly plants to avoid delay. Lighter parts, instead, are traded among different regions, exploiting economies of scales and cost advantage.

Among regions, however, car manufacturers have a strong inclination to make investments in locations where they may obtain cost advantages given the lower operative costs as happens for US in Mexico; for Europe in Czech Republic and in Slovakia; for Asia in China and South east Asia (Sturgeon, Van Biesebroeck, Gereffi, 2008; Sturgeon, Van Biesebroeck, 2011).

Within countries, automotive production and employment are gathered in one or few industrial areas. Sometimes, these clusters focus on specific aspects of the business, or on the manufacture of parts that share common characteristics as electronic (Sturgeon, Van Biesebroeck, Gereffi, 2008). These factors assure long life to the regional automotive clusters.

Global integration is typical of some activities of OEMs and larger suppliers, instead production is mainly organized in regional or national areas, except for some parts and components traded among different regions.

The image used by Sturgeon, Van biesebroeck and Gereffi (2008) to describe the GVC of automotive industry is the “nest”: vehicle development and engineering are concentrated in few specialized affiliated centers inside a market area; assembly plants and system providers determine the establishments of all other local and firms around them. So, there is the creation of few clusters, which are surrounded by national, local, and regional value chains (Fig. 3).

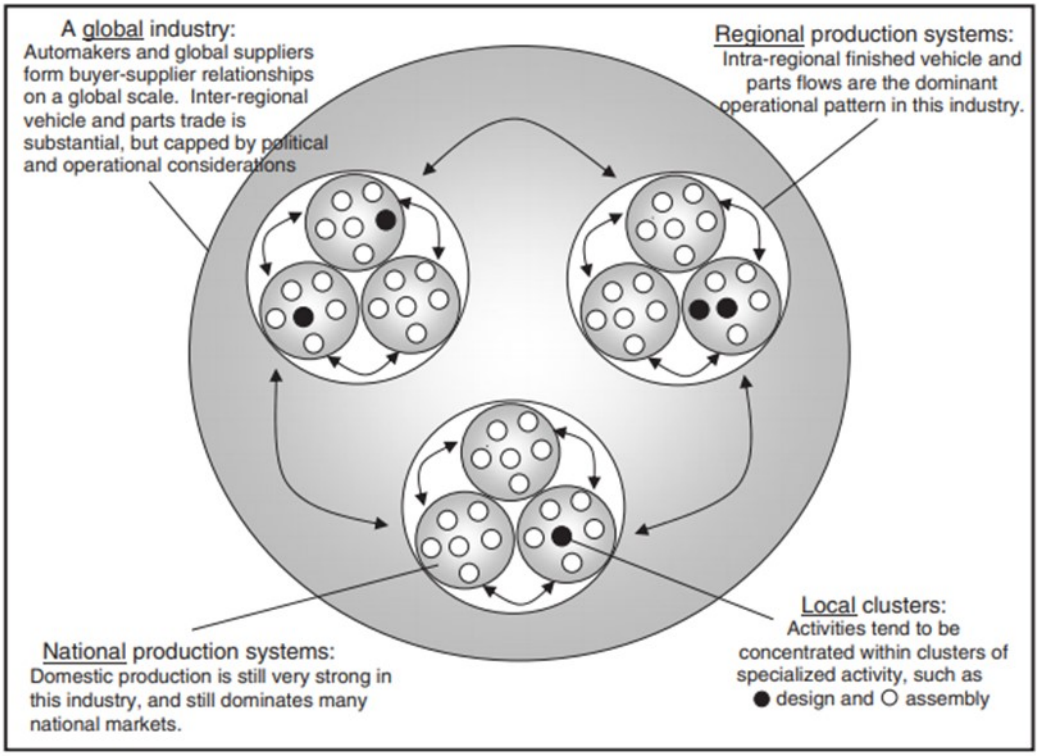

Figure 3. The 'nested' structure of automotive industry. Source: Sturgeon, Van Biesebroeck & Gereffi, 2008

This actual structure of the industry depends on consolidation of supply base that took place in the past years (Sturgeon, Van Biesebroeck, Gereffi, 2008). OEMs, in fact, till the end of 70's carried out activity of assembly and parts production concurrently. Since 80's the employment shifted on supply chain because OEMs reduced the in-house production process, transferring part of vehicle design to their leading suppliers and promoting the supply of complete systems and functions. This modification in procurement system pushed larger suppliers to invest in acquisition of firms with complementary capabilities to assure the hire of OEMs. This phenomenon was enhanced by some car manufacturers' decision to spin off their components/parts division creating some of the largest world suppliers as happened with GM and Ford with *Delphi* and *Vasteon* accordingly (Sturgeon, Van Biesebroeck, Gereffi, 2008) or, more recently, *FCA* with *Magneti Marelli*. The choice of automakers to outsource most of production process induce them to invest more in functions as R&D, marketing, distribution, integration, and aftersales services.

Moreover, when OEMs decide to set up final assembly plants in new markets often force their suppliers to follow them in the co-location of plants (Humphrey & Memedovic, 2003). This upstream decision was made to ensure a major competitiveness in the global market, more flexibility and promote the widespread adoption of a 'common platform' across different

market and product to ensure cost savings through economies of scales and keep the same level of quality and standards (Sturgeon, Van Biesebroeck, Gereffi, 2008). In fact, the emerging economies, till the end of '70s, have always been treated as 'outside' markets with their own specific models which with low modifications and innovation (Humphrey & Memedovic, 2003).

However, the creation of a 'global' car is quite difficult to reach as some factors affect the accomplishment (Humphrey & Memedovic, 2003). The characteristics of vehicle for having success on a market are influenced by customers' income, standards and regulations, driving conditions, consumers' preferences, taxation policies (Humphrey & Memedovic, 2003).

These facts are important in the *upgrading* pathway. One of the main issues of the industry is related to lack of standard and codification of modules/sub-system inside the industry (Sturgeon, Van Biesebroeck, Gereffi, 2008). Vehicle design and sub-system design activities are characterized by complexity and time spending and require managing flow of tacit information in each stage of the chain in addition to proprietary standards. The effect is the non-participation of some countries in the value chain. Largest suppliers, over time, have consolidated their capabilities in these areas, and the relationship with OEMs moved from captive and pure market to relational and long-term. The high level of freedom given to these companies has made the most of components industries bound to designers and system providers (Humphrey & Memedovic, 2003).

However, the presence of few car manufacturers, able to dictate standards and force suppliers in specific investments, and for all the dynamics inside the industry, it is described as producer driven, even if other factors limit the freedom of these players (OECD, 2016; Sturgeon, Van Biesebroeck, Gereffi, 2008).

The strong influence of OEMs is often bounded by *institutional context* and *industry stakeholder*. The regional locations of lead firms and top suppliers are also driven by politics pressures. Car manufacturers, in the late 80's, started investments in emerging economies as China, Brazil and India attracted by low-cost skilled labours (Sturgeon, Van Biesebroeck, Gereffi, 2008). The idea was to supply both local markets and export back in the developed economies. Idiosyncratic investments and the high visibility that assure this sector has made government protective towards import policy both of final products and other components (Sturgeon, Van Biesebroeck, Gereffi, 2008). These policies force OEMs to adjust their sourcing strategy to include regional production networks.

OEMs are free to determine their own strategy and their decision affect all the supply base. Regional and global integration occur together but the lack of a standard across all industry excludes participation of some countries. Nonetheless, once in a country is established the automotive value chain, it is protected by government due to the high visibility: it has the same importance that agriculture and energy industries assume in a nation. In a certain way, political interest and visibility seems to be the only factors able to shape the investments and strategies of OEMs.

2.2 Players and dynamics of automotive industry

Global trade was particularly stressed by protectionism policy and by duties of US to avoid the market penetration of China in the international markets (ANFIA, 2020a). The lower level of industrial production in Germany as well as the failure of Brexit agreement shaped the equilibrium of most countries with effects on domestic economies.

After the financial crisis of 2008-2009, the automotive sector experienced a phase of strong global expansion, recording an average annual growth rate of 6% (Ernst & Young, 2020 pg. 7).

In the two-year period 2018-2019, the sector experienced a negative contraction of more than 4%, due to the crisis in diesel engines (already started in 2015 with *dieselgate* scandal) and to the gradual emergence of the hybrid/electric vehicle and new consumption models centred on the car as a service (Ernst & Young, 2020 pg.7-8).

Given the strong geographical integration of production chains, in fact, all the main major operators have experienced a contraction between 15% for Toyota and 62% for Renault, with the FCA group losing around 45% since the beginning of the year (Ernst & Young, 2020 pg. 10).

The most resilient automakers seem to be Japanese companies Toyota and Honda, which have already shifted part of their production to hybrid engines (in addition to traditional engines) (Ernst & Young, 2020 pg. 10).

In contrast, European automakers such as Volkswagen and Renault were going through a complex transition. German and French car producers are the ones suffering the most negative effect (Ernst & Young, 2020 pg. 10).

Next years will be determined by a lot of changes. Electric motors represent the technological horizon all major car manufacturers will have to contend with (Ernst & Young, 2020 pg. 11). The spread of the pandemic has emphazised the race to electric, in fact, numerous partnership and aggregations have taken places (Ernst & Young, 2020 pg. 11).

	Global vehicle sales	Global distribution of production	Car production	Commercial and industrial vehicles production		R&D Expenditure	Import trade flow	Export trade flow	Top car manufactures	Top global suppliers of automotive industry
Total	91,5 million units	92 million units	67 million units	Commercial vehicles: 20,9 million ubits	Mid/heavy vehicles: 4,5 million units	in US$ billion	2.106 US$ billion	2.226 US$ billion	based on US$ billion revenues	
Countries' share in automotive industry	China 28%	China 28%	China 32%	USA 58%	Asia 71% (China 49%)	Europe: 60	Europe 46%	Europe 48%	Toyota (Japan)	Bosch (Germany)
	USA 23%	USA 13%	Europe 24%	Asia 26% (China, India, Japan)	USA 13%	Japan: 30	America 29%	Asia 27%	Volkswagen (Germany)	Denso (Japan)
	Europe 20%	Japan 11%	Japan 12%	Europe 12%	Europe 10%	USA: 18	Asia 21%	America 24%	Daimler (Germany)	Continental (Germany)
	Japan 6%	Germany 6%	Germany 6%			China: 8	Africa 3%	Africa 1%	Ford (USA)	ZF Friedricshafen (Germany)
	India 4%	India 5%	India 5%				Australia & Oceania 2%		Honda (Japan)	Magna (Canada)

Elaborated data from: ACEA, 2020a; Berylls, 2019; Forbes, 2020; Saglietto, 2020, Statista 2020a, Statista 2020b

Table 1. Major facts of automotive industry in 2019. Source: Own elaboration

Over the past decade, motor vehicle sales have grown from nearly 75mln in 2010 to 96mln in 2017, a growth of 28% (Saglietto, 2020). The contribution to the increase in demand (16.4 mln) is attributed 45% to the BRIC countries, 51% to the traditional markets of traditional markets of Western Europe, USA/Canada and Japan, and 4% to the Rest of the World (Saglietto, 2020).

The number of motor vehicles produced in the Asia and the Pacific region has increased substantially over time, while it has been relatively stable in other regions (ILO, 2020). At the end of 2018, nearly 52 million units were produced in the Asia and the Pacific region, representing about 55% of global vehicles production (ILO, 2020).

Some forecasts have highlight how in the next years the weight of Asia and Oceania in the automotive industry will growth, displacing the actual primate of Western Country by 2028. These regions would weight more that 50% of the total demand (Saglietto, 2020).

From the data of the table emerge that China dominates all the automotive sector: it is the largest producer and the largest consumer (Table 1). The consumption is increased of fourth time in the last decade, and the employment in this sector represent the 35% of the world employees in this sector (OECD, 2016; Statista, 2020a). China has evolved (since early 00's) into a highly capital-intensive production system. This change was driven by OEMs in response to increasing demand for motor vehicles in China in its metropolis (ILO, 2020).

Other top country producers are Mexico, South Korea, Brazil, Spain, France, Thailand and Canada. This top 12 country producers count for 82% of the global motor vehicle production. From a regional perspective, the global production of vehicle is carried out by Asia for 53% followed by 24% Europe, 18% North America, 4% South America and 1% Africa (Saglietto, 2020).

Europe is affected by the general reduction of car manufacturing driven by the decision of German automakers (11,4 million in 2019 at the global level) to move production outside Europe (now, more than 3 German cars every 10 are produced in China) except for countries as Czech Republic and Slovakia because they are the lead assemblers of German brands in Europe (Saglietto, 2020). However, the contraction of all European market is due to Covid-19 pandemic and to US protectionism policy: Germany, UK, France and Italy have suffered a loss of -9%, -14%, -5,5% and -19,5% respectively (Saglietto, 2020).

German automakers made in Europe 4 million of units, but the main production region is China with 5 million, followed by North America (1,5 million units) and Brazil (434 thousand units). 'Made in Germany' cars are around 4,6 million units and the main imports markets are UK, Italy and France. Their production counts for 24% worldwide. Japan automakers made around 28 million vehicles: around 10 million in Japan and 18 million 'overseas'. Their global production counts for 31% of share (Saglietto, 2020).

North America excels in the production of light truck with 57,5% of global production, followed by Asia with 5,35 million produced (Saglietto, 2020). The high importance of North America in the production of light vehicles is due to the choice of people as substitute of cars. In Europe, the greater share of light vehicle belongs to France, Spain, Italy and Germany that represent the 80% of the regional production (Saglietto, 2020).

About mid and heavy vehicle, the primacy belongs to China. Now, more than 1 vehicle out of 2 comes from China. In Asia, other countries are Japan and India with 506 thousand units and 256 thousand units respectively (Saglietto, 2020).

Even when manufacturing has shifted to countries with low labour costs, high-end design, R&D and product development have largely stayed anchored in high-cost and high knowledge intensive countries, so called early industrial leaders (ILO, 2020; OECD, 2016).

The demand for new products – electric vehicles and autonomous vehicles – is further disrupting the organization of work and production in the automotive industry (ILO, 2020).

In 2018, global electric vehicles sales exceeded 5.1 million units, an increase of 2 million units over 2017, while in Europe and the United States, sales increased by 385,000 and 361,000 respectively, over the same period (ILO, 2020).

In 2018, China sold nearly 1.1 million of electric vehicles (EVs) and had 2.3 million units on the road by 2018, making it the world's largest market (ILO, 2020). The next largest markets are Europe and the United States, with 1.2 million and 1.1 million units respectively. Norway is the global leader in terms of EV market share, with EVs accounting for 46% of its new vehicle sales in 2018 (ILO, 2020)

Electric vehicles represent a small fraction (2.2%) of automobiles sold worldwide. However, sales have been growing rapidly over the last decade and estimates suggest that the market for electric vehicles will continue to enlarge in the next years. "Research by the International Energy Agency forecasted that in 2030, EVs will make up 70 per cent of all vehicle sales in

China, almost 50 per cent in Europe, 37 per cent in Japan, more than 30 per cent in Canada and the United States, 29 per cent in India and 22 per cent in all other countries combined" (ILO, 2020 pg.19).

The demand for new products and services creates new challenges for sustainability issue as well as for all firms of automotive industry.

2.3 Future challenges and opportunities for automotive players

Automakers (OEMs) and suppliers have been operated in an uncertain automotive market. Car leaders are rethinking businesses entirely, looking for innovative products and solutions with unique appeal to customers due to the emergence of four main forces (Table 2).

Electrification	**Shared mobility**
Increased regulatory pressure, technological improvements, investments in charging infrastructure, and environment-friendly customers drive the growth of *e-powered vehicles*.	Preferences of younger, more urban customers to use *ride-hailing services*, along with saturation of smartphones and advanced 5G networks, will likely make shared mobility even more accessible and prolific.
New Entrants	**Technology**
Big technology and consumer electronics players are entering the automotive value chain. They have challenged existing business models and placed pressure on traditional suppliers to *innovate quickly* and avoid getting left behind by faster-moving peers and rivals.	Shifts in vehicle technology and functionality, such as proliferation of software and advances in *autonomous driving* have led to a convergence of automotive and technology, and have transferred significant supplier value from hardware to software.

Table 2. Four key transformative forces of automotive industry. Source: Deloitte, 2019

These drivers will affect in significant way the whole industry prompting existing and potential players to invest more in new trends and powertrains and moving in a direction that may lead to the creation of new value.

The link among the four transformative forces is led by the ability to propose a new 'green' approach to automotive industry. The focus is the attention on "*green mobility*" (Lanzini & Stocchetti, 2017). "It indicates all the technological and operational solutions, management and commercial decisions oriented to the reduction of negative environmental and social externalities produced by individual mobility and transport in general" (Lanzini & Stocchetti, 2017 pg. 211).

All the actions undertaken are under the name of g*reen solutions.* Most efforts focus on (1) the materials and components used for the production; (2) process technologies; (3) technological solutions to reduce the environmental impact of the all life-long vehicle and along the value chain (Lanzini & Stocchetti, 2017).

The clearest example of green mobility is represented by *green Car,* which converges under the name of *Electrified Powertrain Vehicles* (EPVs) or the set of pure electric and hybrid vehicles. Examples are: "(1) *Battery Electric Vehicles* (BEV) powered by batteries only; (2) *Plug-in Hybrid Electric Vehicles* (PHEV) with an external electric charging; (3) *Electric Charged Vehicles* (ECV) basically electric cars with range extender and fuel cell powered cars; (4) *Hybrid Electric Vehicles* (HEV) not rechargeable from the mains external" (Lanzini & Stocchetti, 2017 pg. 215).

The EPVs use a technology that is at embryonic state: (1) there is no standards across industry and (2) the share of adoption in final market is, up to now, quite low (Stocchetti, 2020). The entry share of new powertrain is constrained by both exogenous and endogenous factors as the industry is characterized by a strong technological lock-in (Stocchetti, 2020). The first hybrid car was introduced in the market 20 years ago, but the European market share adoption reaches double digits in 2019 only (Stocchetti, 2020).

The transition will happen when there would be a diffused standard(s) across industry and when the technology would reach economies of scale making products more affordable (Lanzini & Stocchetti, 2017). Now, even in case of monetary incentive, the share adoption is affected by economic factors delaying the adoption of new powertrain especially for low-end models (Stocchetti, 2020).

2.3.1 New technology, new entrants, and regulation act as main drivers for OEMs.

Tesla have increased its market value of three time in 2020 respect to Ford and GM, even if it did not sell the same vehicles volume (Tillväxtanalys, 2020). Moreover, some Tier 1 and 0.5 as Continental and Bosch have developed their own electric vehicles (Berylls, 2019). All these factors stress OEMs to chase new technologies and industry innovation.

Regulation affects the automotive industry from different points of view. One is the strong regulation about mandatory emission-reduction target, especially in EU region. European Union has always dealt with the issue of vehicle emissions. Over the years it has enacted several laws limiting the production of vehicles that are too polluting: from the initial target

applied from 2015 onward (EC 443/2009[9]) to a stricter objective in 2020 (EU 2019/631[10]). The set target was 130 gCO_2/km applied as a mean of European vehicle fleet between 2015 and 2019 and a stringent one for 2020-2021 (95 gCO_2/km). In 2030, the target is 57 gCO_2/km (ANFIA, 2020a). European Union aimed at applying the '*polluters pay principle*' for the most pollutant OEMs (Deloitte, 2017). If the average emissions for a manufacturer's fleet exceed the target each year, it has to pay a penalty of €95 for each subsequent gram per km in excess for each car registered (Tillväxtanalys, 2020).

European Union's commitment is part of the recovery plan to build a net-zero emission economy and society by 2050 (so called *Green Deal*[11]). "To attain the 2050 *climate neutrality*[12] goal, the transport sector needs to play its part. It needs to undergo a transformation which will require a drastic reduction of greenhouse gas emissions – 90% by 2050 – while ensuring affordable and healthy solutions for citizens"[13]. Europe has already enacted legislation to promote the recycling and reuse of vehicle material adopting a design

[9] Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles [https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009R0443 Access date 01/23/2021]

[10] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (for light and commercial vehicle) [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0631 Access date 0/23/2021]

[11] Europe fosters a new growth strategy that will transform itself into a modern, resource-efficient and competitive economy in which: (1) no more net greenhouse gas emissions are generated in 2050; (2) economic growth is decoupled from resource use no person and no place is neglected. This transition focuses on promoting (a) high-impact technological and social innovations that can help advance the sustainable transition in a relatively short timeframe; (b) knowledge enhancement, citizen empowerment, and international cooperation to have long term perspective. The 10 objectives are: (1) facing cross-sectoral challenges, (2) clean, affordable and secure energy, (3) industry for a clean and circular economy, (4) energy and resource-efficient building, (5) sustainable and smart mobility, (6) farm to fork, (7) restoring biodiversity and ecosystem services, (8) zero-pollution, toxic-free environment, (9) strengthening our knowledge in support of the European Green Deal, (10) empowering citizens for transition towards a climate neutral, sustainable Europe. [https://www.apre.it/ricerca-europea/horizon-2020/new-green-deal-call/ Access date: 01/23/2021]

[12] *Climate neutrality* means balancing emissions removing warming gases from the atmosphere. So, the warming emissions that are created by cars and power plants should be counteracted by the greenhouse gases removed from the air by the planting of new forests or through carbon capture technologies. Climate neutrality has a broader meaning respect to *Carbon neutrality*: it refers to the neutralization of other greenhouse gases (GHGs) and climate-altering substances in general, not only CO_2 emissions https://www.bbc.com/news/science-environment-46360212 [Access date: 01/29/2021]

[13] https://www.consilium.europa.eu/en/policies/clean-and-sustainable-mobility/ [Access date: 01/29/2021]

that take into account the 4Rs (ELV-Directive 2000/53/EC[14]) but the emergence of new technology, regulations, initiatives and incentives makes the direction clearer.

Other types of regulation force OEMs to increase transparency about operations in supply chain as French Duty of Vigilance law with Groupe PSA and Renault (Tillväxtanalys, 2020) EU REACH[15] (regulation on registration, evaluation, authorization and restriction of chemicals) and Industrial Emissions Directive 2010/75/EC[16].
Moreover, some governments have adopted public policy measures to incentive the adoption of car with new powertrain aiming at reducing the use of vehicles with traditional combustion engines (Tillväxtanalys, 2020). European states as France, Italy, Germany and Spain have been incentivized the purchase of new cars according to type of powertrain (hybrid or electric) and to car disposal (scrapping or resale)[17]. Also, China promotes the purchase of car with electric or hybrid powertrain especially in the metropolises (Ernst & Young, 2020).

Furthermore, OEMs themselves have increased their commitment adopting other initiatives aimed at protecting environment, society, workers and prevent climate change through a self-regulatory approach.

[14] Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles - Commission statements to minimize the impact of these vehicles on the environment, thereby contributing to the protection, preservation, and improvement of the quality of the environment with particular regard to the design of vehicles for recycling and recovery, the requirements for collection and treatment facilities and the achievement of reuse, recycling and recovery targets. [https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=celex%3A32000L0053 Access date 01/23/2021]

[15] REACH (1907/2006) is a European Union regulation, adopted to improve the protection of human health and the environment from the hazards that can be posed by chemicals, while increasing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the assessment of hazards that may arise from substances, with the aim of reducing the number of tests conducted on animals. REACH applies in principle to all chemicals: not only those used in industrial processes, but also those in everyday use, such as cleaning products or paints, as well as those found in articles such as clothing, furniture and household appliances. [https://echa.europa.eu/it/regulations/reach/understanding-reach Access date: 01/23/2021]

[16] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). It is a general framework to regulate the main industrial activities, acting first of all at the source, as well as ensuring a prudent management of natural resources and taking into account the socio-economic situation and the specific local characteristics of the site where the industrial activity takes place. [https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX%3A32010L0075 Access date: 01/23/2021]

[17] https://www.fleetmagazine.com/incentivi-auto-europa/#:~:text=Incentivo%20per%20auto%20elettriche%20(aziende,di%20un'elettrica%3A%205.000%20euro [Access date: 01/25/2021]

Volkswagen, by 2025, plans to reduce our total life cycle GHG emission of passenger cars and light duty vehicles by 30% compared to 2015, reduce the production related to environmental externalities (CO_2, energy, water, waste, volatile organic compounds) by 45% per vehicle compared to 2010 and increase the electric vehicles group fleet at least 40% by 2030[18]. Beyond the internal operations, Volkswagen drawn up the '*Code of Conducts for Business Partner*', establishing some rule and standard to follow in order to prevent environmental damage, human rights and monitoring of supply chain, especially for what concern some raw materials[19]. These rules aim at increase transparency and risks' monitoring of suppliers' suppliers also establishing punishments and rewards.

Toyota targets a reduction of 35% of CO_2 emission in all plants by 2030; reduces CO_2 emissions by 25% or more over the entire vehicle life cycle compared to 2013 levels[20]. It sets up also the '*Green Purchasing Guidelines*' which establish some standards to follow and increase transparency about chemical substances, indirect materials and CO_2 emissions[21].

Renault Groupe claims reducing our carbon footprint by 25% by 2022 compared to 2010 and CO_2 emissions in use (tailpipe & fuels production) by 50% by 2030[22]. It establishes '*Renault Green Purchasing Guidelines*' describing standard and rule to follow to reduce environmental impact. Its bigger effort is on increasing transparency of cobalt supply chain (tier-4), one of the main metals for the development of batteries of electric cars[23].

Daimler, since 2022, commits to transform all its European production plants in CO_2-neutral and reduce CO_2 emissions of the new passenger car fleet by 2030 more than 40% respect to 2018. Their commitment focuses also on how to reduce the consumption of energy, water, raw materials and disposals. Its '*Supplier Sustainability Standards*' asks firms to adopt labour and environmental standards and ensuring a support in developing it[24].

[18]Volkswagen, Mission Statement Environment. https://www.volkswagenag.com/en/sustainability/environment.html [Access date: 01/19/2021]

[19]Volkswagen, Code of Conduct of Business partner. https://www.vwgroupsupply.com/one-kbp-pub/en/kbp_public/information/nachhaltigkeit_neu_pub_2019/sustainability_requirements/basicpage_for_general_pages__html_13.html [Access date: 01/19/2021]

[20] Toyota, Environmental Report 2019. https://global.toyota/pages/global_toyota/sustainability/report/er/er19_en.pdf [Access date 01/19/2021]

[21] https://www.toyota-boshoku.com/global/company/procurement/green/ [Access date 01/19/2021]

[22] https://group.renault.com/en/our-commitments/respect-for-the-environment/carbon-footprint/ [Access date 01/19/2021]

[23] https://group.renault.com/en/our-commitments/for-a-shared-ethics/sustainable-purchasing/#pilliars [Access date 01/19/2021]

[24]https://annualreport.daimler.com/ar2019/non-financial-report/sustainability-at-daimler/sustainability-in-our-supply-chain [Access date 01/19/2021]

All these factors are shaping the entire upstream and downstream sides of automotive industry. Governments, consumers, and investors are now pushing OEMs to change their ways of working, culture, and products to reduce the effect of climate change. This will have far-reaching implications for the supply chain that urgently need to comply with their code of conducts and standards.

2.4 Italy participation in the automotive GVC

The Italian automotive sector is a strategic field for the national economy. The transformation of *FIAT* into *FCA* as well as the crisis of 90's forced most of its suppliers to broaden their horizons beyond the Alps (Sessa & Pirone, 2019). The result is that Italy can now count on a competitive automotive sector because it is in international value chains (Sessa & Pirone, 2019). Between 2014 and 2017, the rebirth of FCA factories, marked by the restructuring of historical assembly plants, has led to a boom in Italian exports and a shift in GDP from negative to positive (Sessa & Pirone, 2019).

Moreover, the Italian car production has also been qualitative, since the production of small cars has decreased, while that of semi-premium cars has increased and premium cars now covers 60% of the total, as never before in Italian history (Sessa & Pirone, 2019).

But in 2018 there was a return of the total production of motor vehicles (including vans) below the quota of one million pieces (Sessa & Pirone, 2019).

The Italian automotive industry is now facing the strategic and global nodes of the sector such as the transition from diesel to electrification, the rapid increase in the level of automation of cars, the generational evolution of customer tastes and demands (Sessa & Pirone, 2019).

Covid-19 pandemic has further slowed down all the Italian economic activities and ISTAT estimated decrease of GDP around -8,3% in 2020 and a partial recovery of 6% in 2021 (Saglietto, 2020).

In 2019, the automotive production had a decrease of -9,5% (ATECO 29: production of motor vehicles and their engines, car bodies and semi-trailers, components, and parts for motor vehicles) (Saglietto, 2020). Degrowth is due to the decreasing of diesel car market in Europe, the low European demand, and slowing down of Italian economy (ANFIA 2020b).

However, the strategic importance of automotive sector can be explained by investments made by firms in the industry: gross fixed capital investments are worth 14% of those of the

manufacturing industry; R&D investments are worth 1.7 billion euros (13% of the national R&D expenditure and 18.8% of the manufacturing industry spending) (Sessa & Pirone, 2019).

The size of companies reflects the traditional structure of SME: 46% of companies remain below 10 million euros, 35% are between 10 and 50 million euros; 53% of firms have less than 50 employees and 34% of companies between 50 and 250 employees (Sessa & Pirone, 2019).

The industry has registered -13,9% in the production of vehicles (ATECO 29.1), +6,7% in the production of chassis and trailers (ATECO 29.2), -7,9% in the production of components and parts for engines and frames (ATECO 29.3). Revenues and orders average of 2019 had a decline around -7,8% and -9,9% respectively (ANFIA, 2020b).

Italy is characterized by the paradigm of geographical polarization: the dynamics of exports, in fact, remains linked to Europe (Ernst & Young, 2020). In 2019, EU countries absorbed 67% of Italian exports in the automotive sector (Ernst & Young, 2020). Target markets are Germany, France, USA, Switzerland, UK and Spain (Saglietto, 2020).

The Italian automotive industry is the segments with the highest added value due to the excellence in the production of high-end and commercial vehicles, but also to the production specializations that characterize, in particular, the districts of the components (Ernst & Young, 2020 pg. 13).

Italy is the country that contributes most to German automotive supply chain (incorporating a share of added value of Italian origin equal to 2.4%, even ahead of Eastern European countries) (Ernst & Young, 2020). Germany absorbs about 20% of the added value that Italian manufacturing sectors allocate to the global automotive chain (Ernst & Young, 2020 pg. 14).

Italian automotive industry		**ATECO 29**							
		ATECO 29.1			**ATECO 29.2**	**ATECO 29.3**			
Vehicle sales	**Revenues automotive sectors**	**Vehicle production**	**Car production**	**Light and commercial vehicle production**	**Chassis and trailers**	**Parts and components**	**Employees**	**Firms**	**Multinational presence**
2,1 million units	€ 106 billions (direct and indirect activities)	915 thousand units	542 thousand units	373 thousand units	NA	Positive trade balance of € 6,5 billion	1,2 million workers Workers of industrial profile: (ATECO 29): 274 thousand Servicestrictly related to the use of vehicles: 424 thousand of workers Services related to automotive industry: 956 thousand of workers	201 thousand firms Firms of industrial profile (ATECO29): 5529	116 enterprises

Elaborated data from ANFIA, 2020b; Ernst &Young, 2020; Saglietto, 2020

Table 3. Main facts of the Italian automotive industry in 2019. Source: Own elaboration

The *vehicle sales* in 2019 registered an increase of +0,5% respect to 2018 due to light vehicle (ANFIA, 2020b). In 2019 there is a growing sale of cars with *alternative powertrain* (around 310 thousand with +19% respect to 2018). Hybrid cars have a +34% and full electric ones have +133% mainly due to economic incentive '*ecobonus*'. Traditional powertrains as diesel and gasoline have -22% and +26% registrations respectively in 2019.

The *domestic production of vehicles* had a decline in 2019 of -14%. The whole vehicle production is 915 thousand units even if in the last five years the production was higher than 1 million. However, 66% of vehicle are for foreign markets.

The domestic production of cars, in 2019, had a decline of -19,5% (542 thousand of cars) respect to 2018 and the 54% is destined to export (ANFIA, 2020b). The reason is the less demand of gasoline and diesel cars.

Commercial vehicles, lorries and buses had a decline of -4% in 2019 (373 thousand of vehicle produced in 2019). Light commercial vehicle is a strong component of automotive industry but had a volume production of 312 thousand of units with a -3,8% respect to 2018. High importance is mainly due to the presence of FIAT professional, Iveco and Piaggio plants. Italy, in fact, has 23 production plants of OEMs in its ground (ACEA, 2020a). The production of lorries is around 60 thousand (-5,6%), one of the highest averages reached in years 2017-2019.

Buses production is near to zero. This is mainly due to lack of efficient public transport plan to avoid traffic congestion and enhance the quality of vehicles.

The long-term relation of FIAT in Italy has induced FCA to promote investment, in fact, for 2019-2021 it is scheduled the launch of new models and new vehicle with electric or hybrid powertrain. Rumours about a possible merger with Groupe Renault make the market turmoil, even if there is no clear direction. However, in 2019 it has been announced the alliance between FCA and PSA (commercial vehicles group made of Peugeot, Citroën, DS Automobiles, Opel e Vauxhall Motors brands).

TRADE IN NEW VEHICLES AND COMPONENTS
ANFIA based on ISTAT data

	IMPORT	EXPORT	BALANCE
	NEW MOTOR VEHICLES		
Units	1,872,139	736,372	-1,135,767
Value in billion EUR	30.3	16.5	-13.8
	PARTS AND COMPONENTS		
Value in billion EUR	15.4	22	+6.5

Figure 4. Italian trade balance of vehicles and components. Source: ANFIA, 2020a

The *trade balance* in 2019 had different results (Fig. 4) (ANFIA, 2020b).

Total vehicles trade is negative because of less demand of diesel vehicle in Europe and the strong presence of foreign players in Italian market (around 1.9 million of vehicle imported and 736 thousand exported). France and Germany have 26% and 25% of Italian market share respectively. Negative balance is around €13,8 billion.

Car trade is negative: 1,7 million units imported and 478 thousand exported. The negative balance is around €14,2 billion value.

Buses and trucks trade is negative too: 166 thousand imported and 257 thousand exported with a positive trade value of €4,3 million.

Parts and components are positive especially for what regards engines items, mechanical parts (export has a value around 22 billion and import of 15,4 billion). The most important markets for Italian exports are German (with a value exported of 4.6 billion), France and UK. The most important import markets are German (3.9 billion value) followed by France, Poland, and China.

2.5 Research question

"While climate change is creating uncertainty for the automotive industry, sustainable business models can help firms to insure themselves against the impact of climate change and of social and environmental risks on their supply chains" (ILO, 2020 pg. 25).

Production and use of cars significantly cause greenhouse gas emissions and air pollution. A common internal combustion engine issues around 24 tonnes of emissions over its life cycle, about 23% of which occurs in production (ILO, 2020). The transport sector is the fastest-

growing contributor to GHG emissions, accounting for 24% of CO_2 emissions and approximately 14% of total GHG emissions (ILO, 2020). Road transport (cars, trucks, buses and two- and three-wheelers) is responsible for about 75% of overall transport emissions (ILO, 2020).

In the first chapter we saw how environmental upgrading is driven by different factors (technology, regulations, customers and cost savings…) and may represent a source of opportunity as well as a need. The major limitations of environmental upgrading are the difficulties in managing this issue along the value chain since the commitment of few (lead) firms is often unable to shape the approach along all procurement chain. The lack of resources and knowledge of suppliers as well as the opportunistic behaviour of some lead firms and information asymmetries may delay the global application of a green strategy. So, managing environmental issue along the value chain requires a lot of coordination efforts among firms as well as deals with constraints.

In the second chapter, we saw that automotive industry entails multifaceted supply chains, which over time have evolved into a global production network made by a huge number of companies. On average, each vehicle contains more than 20,000 parts, which OEMs source from thousands of different suppliers globally dispersed (ILO, 2020). The automotive industry is under immense pressure, both from governments, policy makers and consumers: these actors ask to improve the environmental sustainability of the production and of the use of vehicles (ILO, 2020). Beyond the commitment of the 2015 *Paris Agreement* on climate change, some countries and regions have outlined initiatives, programmes, and enacted laws to drive the reduction of the emissions and promoting the adoption of new vehicles (*Ecobonus*, *European Green Deal*, EU REACH, ELV-Directive 2000/53/EC…) (ILO, 2020). The incumbents, in turn, stress the race to new technology and powertrain and have adopted a self-regulatory approach promoting the greening of their operations as well as the greening supply chain through the adoption of code of conducts and initiatives aimed at reducing the whole environmental impact.

Since the greater impact on environment will not be generated by the final users of vehicle (as vehicles would not have a combustion engine but an electric one), most of CO_2 emissions and pollutant substances will be issued during the manufacturing process. So, most of the emissions will occur during the processing of steel, aluminium, plastic, or the manufacturing of batteries.

As suppliers provide most of parts and components to OEMs, their approach in limiting the environmental impact is extremely important. Since sustainability of automotive sectors also depends on suppliers' commitment – given the high emission issued during the processing of vehicles - it will be analysed how they react to.

As said in the second chapter, the automotive Italian value chain is one of the major manufacturing industries in Italy and one of the main players at international level. Given the embeddedness in the global economy, the aim of this thesis is study how *Italian suppliers face sustainability issue*.

The four forces (electrification, new entrants, shared mobility and new technology) induce firms to rethink their operations and their strategies (as said before, the Italian value chain suffered of less production of traditional and combustion engines). Next chapter examines how Italian firms manage difference forces (regulations, customers, users, market opportunities...), the concrete actions undertaken by firms (recycling, diversification, supply chain monitoring…) and the awareness of the environmental risks of the supply chain using also a GVC approach.

The main questions of this research are:

What are the main *drivers* of environmental upgrading of automotive suppliers?

What are the *actions and commitment* to reduce environmental impact?

What are the *gaps* and *the future perspective*?

An original survey that has been administered to Italian and Swedish suppliers will support this analysis. It is examined how regulations, internal and external factors influence the firms' strategy and the approach to sustainability; if their commitment is only linked to law compliance or their approach is more inclusive, considering also further process improvements linked to the use of recycled materials and renewable resources. Moreover, the survey explores how sustainability may be created through the value chain analysis and how it can be addressed.

In Sweden, the survey was supplied by *Tillväxtanalys*, the governmental agency for Swedish development and growth. As for the Italian survey, I administered it by addressing all firms that are associated with the Italian automaker industry association *ANFIA (Associazione*

Nazionale Filiera Industria Automobilistica), one of the main Italian trade associations members of *Confindustria,* who also collaborated in this effort.

Chapter 3 – Sustainable suppliers in Italian and Swedish automotive GVC

3.1 Data and methods

For the analysis of sustainability of Italian automotive value chain, we relied on two main actors: *Tillväxtanalys and ANFIA.* The first one was also engaged in the drafting of the questionnaire and managed the administration of the questionnaire to Swedish firms. The second actor, ANFIA, supplies the sample of companies and supported us in ensuring the Italian version of the questionnaire was readable for industry players. The number of firms registered in this trade union are 350 divided in three categories: components and parts producers, coachbuilders and designers, and manufacturers. Its main advice about survey focuses on the use of specific terms typical of the industry.

The questionnaire is divided in 4 sections (see ANNEX 1): why acting, how to act, knowledge gaps and reporting system. The first part analyses the drivers that push firms to undertake environmental upgrading. The three categories are regulation, internal motivation and external drivers. The second part refers to the actions that firms concretely pursue to make their operations and products/services greener: the use of recycled materials, the use of renewable energy and resources and the management of goods transportation. The third section studies the knowledge gaps in implementing a global approach in the management of whole supply chain. In this part, the survey wants to investigate the lack of awareness of sustainability risk in the value chain. The last unit focuses on the reporting system: how the administrative burden costs to firms in terms of time and money. In this section, it is analysed if the enterprises use new technology as blockchain and Cloud computing to ease the data collection and to better address the management of supply chain. The last section investigates parts of the financial data asking the total turnover coming from export, the major clients and from the selling of different categories of products as well as the number of employees.

The survey was sent through Survey Monkey in two moments ten days apart in November 2020. The response rate was around 17% (59 firms completing the whole survey). Responses come from Northern Italy (85%), Central Italy (10%), and Southern Italy and its Islands (2%)[25]. The size of firms of the sample are measured according to the criteria of employees and revenues are: 54% SMEs (less than 250 employees) and 44% large companies (more than 250 employees); 49% SMEs (less than €50 million turnover) and 47% large companies (more

[25] The 2% of the respondent firms do not indicate their origin.

than €50 million turnover). For the analysis, the respondents only will be considered. The Swedish survey was sent during March-May 2020

In the following, we are going to focus on the Italian survey first, and then compare results with the Swedish survey.

The *first part* concerns the descriptive analysis of Italian results offering a global view of the outcome obtained. To better address the environmental issue of automotive suppliers we will focus on four main topics: (1) the drivers leading firms to invest; (2) specific performances of firms; (3) environmental risks' monitoring of supply chain and awareness of supply chain risks; (4) the degree of involvement in innovation; (5) Covid-19 pandemic perspective.

The objective explanation of the data will include some parts of the ANFIA's interview to give a better understanding of phenomenon (for the full interview see ANNEX 2). The main issues are related to future perspectives, motivation leading firms to invest in sustainability and constraints.

The *second part* concerns the statistical analysis exploiting three different ways. Using statistical method (T tests and Cronbach's alpha), it will be investigated if exist some relevant differences among groups. The decision to analyse sustainability through statistical analysis is linked to the need of verifying if the participation in global economy, the reliance with a single customer or institutional context shapes the approach to sustainability issue.

The first two types of analysis regard the subdivision of the Italian sample in two different manners.

(1) firms which revenues comes from more than 50% by exports (Table 4). This way of analysing the Italian sample was made to verify if the participation in global economy as exporters moulds the approach of firms to sustainability.

(2) firms which register revenues more than 30% from a single client (Table 4). Since the literature highlight the great importance of lead firms play in driving sustainability, it will be analysed if a captive governance shapes the attitude of suppliers in sustainability issue.

This threshold was set considering the median of the firms' answers.

	Customer dependence (>30)	Customer dependence (<30)
N° of firms	25	34
	Exporters (>50)	Exporters (<50)
N° of firms	29	30

Table 4. Subdivision of Italian sample. Source: Own elaboration

(3) Comparison of results between Italy and Sweden. The aim of this analysis is evaluating if institutional context influences the attitude of a country toward sustainability issue. The total Swedish sample is made of 32 firms. This part of analysis will include a little introduction to automotive industry in Sweden. The main differences between countries are pointed out.

Each of this three-way analysis includes 14 variables gathered in 4 macro categories: motivation, performances, and environmental risk monitoring and awareness of the environmental supply chain risks. The variables are identified as follow:

1. Motivations: the Cronbach's alpha identified the latent variable under which 'gather' all the statements about motivations. The result identifies an acceptable level of reliability (ANNEX 3). The firms had to identify the level of agreement with statements from 1 (completely disagree) to 7 (completely agree). The variables are: (1) *regulation* which contains 6 items and the evaluation of each respondent can vary between 6 to 42; (2) *extra-firms drivers* which contain 5 items and the assessment of each respondent varying between 5 to 35; (3) *intra-firms drivers* which have 7 items and the respondents' answers can vary between 7 and 49.
2. Performances: firms were asked to assess their own performance respect to other firms of the value chain. The self-assessment was made using a scale from 1 (much worse) to 5 (much better). The variables are: (4) *complying with environmental regulation*, (5) *limiting environmental impact beyond compliance with regulations* and (6) *monitoring the environmental risks in your supply chain.*
3. Risks' monitoring: firms had to indicate their level of monitoring of the environmental risks both for direct and indirect suppliers from 1 (no monitoring) to 7 (complete monitoring). The variables are: (7) *all risks of tier 1 suppliers*, (8) *some risks of tier 1 suppliers*, (9) *all risks of tier 2 & 3 suppliers*, (10) *some risks of tier 2 & 3 suppliers.*

4. Awareness of the supply chain risks: for each risk (emission of greenhouse gases, use of chemicals and hazardous material, natural disasters and human rights), firms had to state their level of comprehension using a scale from 1 (no comprehension) to 7 (total). The variables are: (11) *emission of greenhouse gases*, (12) *use of chemicals and hazardous materials*, (13) *natural disaster*, (14) *human rights*.

3.2 Descriptive analysis

3.2.1 Motivations

The generical data about drivers are reported here below (Fig. 5). For each assertion was asked to each respondent to indicate a number from 1 (completely disagree) to 7 (completely agree) according to their experience. The number 4 means 'Neither agree nor disagree'. The assertions are sorted according to the original group and the table reported the mean and the standard deviation (on parenthesis) (Fig. 5).

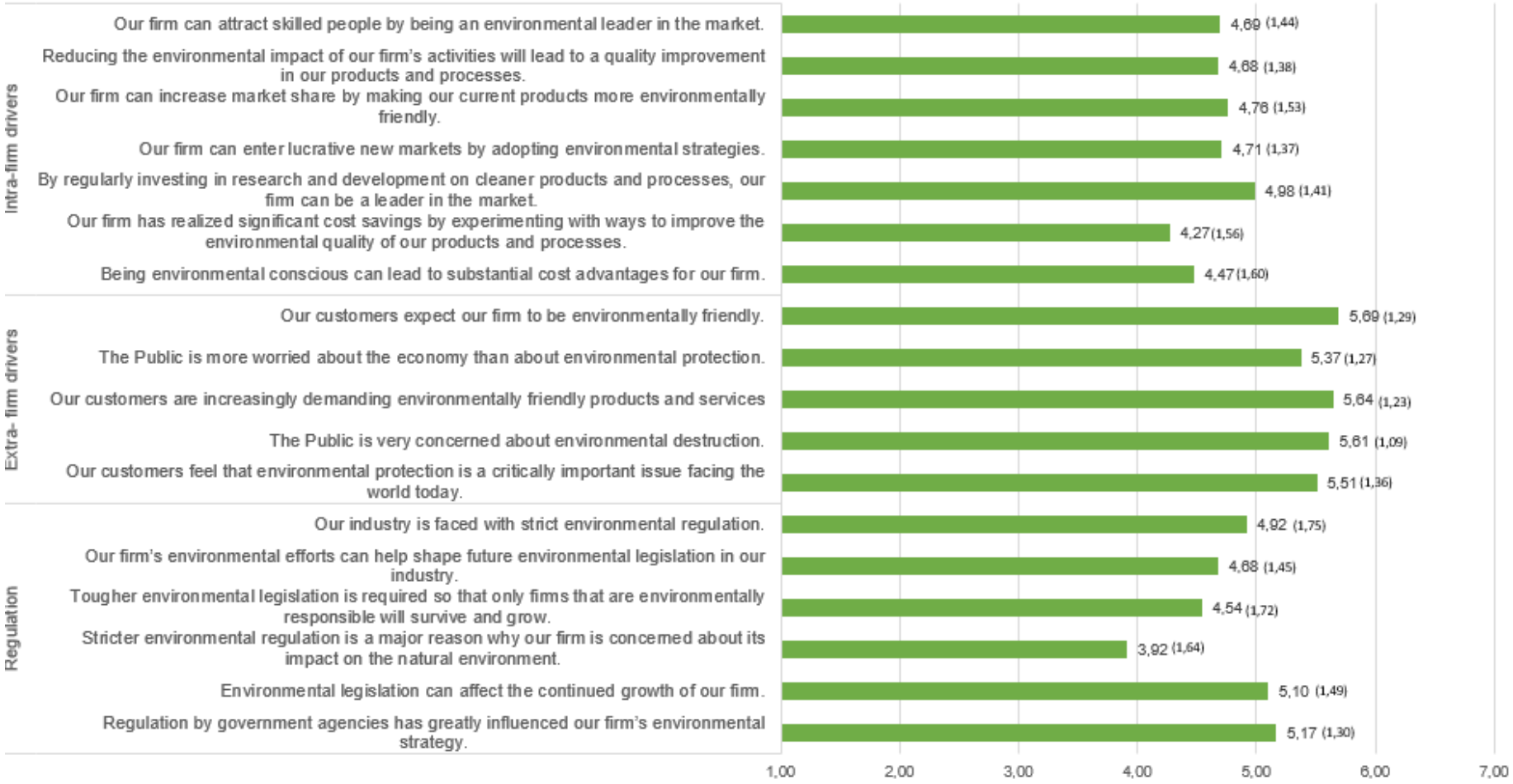

Figure 5. Statements' mean and standard deviation. Source: Own elaboration

The statements with the highest means are the 'extra-firm factors'; instead, the statements with the lowest means are related to the 'intra-firm factors'. The assertions related to extra-firm factors report also the lowest standard deviation. The statement with the highest mean is '*Our customers expect our firm to be environmentally friendly*' (5,69); instead, the statement with the lowest mean is the one related to '*Stricter environmental regulation is a major reason why our firms is concerned about its impact on the natural environment*' (3,92). These answers demonstrate that firms mainly invest when customers rely with specifications and requirements. This result is consistent with the statement explains that stricter regulation is not the major reason why firms invest in sustainability.

A particular mention should be done to the statement relate to the 'strength' of regulation in driving sustainability issue. This statement - '*Our industry is faced with strict environmental regulation*' – has the highest standard deviation (1.75). The high standard deviation is the result of different type of firms in the sample. Some firms may not relate exclusively with automotive industry and belong to other sectors as may happen to aluminium or rubber components. Moreover, the type of product made by firms influence the answer: firms which state to have a turnover for at least 50% by traditional combustion engines and transmission record a mean around 5,14. This is also consistent with firms producing electric engines and batteries which report a mean of 5,16. The firms which state to have a turnover for at least 50% by electronics and self-driving vehicles reports a mean of 4,6.

The answers with the highest level of 'agree' – from 5 to 7 - are the ones regarding the extra-firm drivers. All the answers report a level of agree superior to 75%. The assertions with the highest level of agree are: *'Our customers are increasingly demanding environmentally friendly products and services'* with 85% followed by '*The public is very concerned about environmental destruction*' with 83%. 78% of respondents agree with '*Our customers feel that environmental protection is a critically important issue facing the world today*'.

From ANFIA's interview emerge that OEMs plays an important role in shaping green features along the value chain (question: *What role do OEMs (customers) have in stimulating sustainability and how do they implement it?). "The role of OEMs is crucial because driven by the needs of the end consumer and by product sustainability regulations. Furthermore, they require their suppliers to follow the actions and behaviour too to comply with consumers' expectations and legal requirements. Even when the input is not regulatory, but it*

is a choice of the OEM, suppliers can only "adapt" to the OEM's requirements if they want to continue to maintain the contractual relationship".

So, the regulations' pressure and final customers are the main driver of OEMs, instead, for supply chain, OEMs represent the main drivers. OEMs, so, transmit their pressures along the value chain.

The fact that, in general, regulation is not the main driver leading to invest in sustainability is consistent with the lowest level of agreement of the statements, between 37% and 68% (rating from 5 to 7). This is also consistent with the assertion that stricter environmental regulation is the main reason why firms concern to reduce environmental impact: only 37% of respondents agree with this assertion; most disagree (35%) or consider it an indifferent motivation (28%).

Intra-firm drivers' category is the one that gave the lowest percentage responses about the reasons for investing. The level of agreement is around 44% - 69% (answers from 5 to 7). Only 46% of respondents agreed with the statement " *Being environmental conscious can lead to substantial cost advantages for our firm*."; and only 44% agreed with "*Our company has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes*". In this category, the higher level of agree is about R&D investments and their long-run benefits (69%).

The interview of ANFIA (question: *Why do companies invest in sustainability? What has driven and is driving companies to invest in sustainability?)* highlights how sustainability has become a strategic issue for automotive companies especially for automakers. "*Upstream companies (OEMs) must meet consumer expectations, and so, all the supply chain must meet the OEM's needs in order to be sustainable at the eyes of users*". However, there is not a full comprehension of sustainability along the value chain because most of them lack resources: *"According to the Capgemini survey, not all companies are in the same situation, not all of them have initiated a change of "corporate mentality" and a sustainable approach. However, in many companies there is a gap in terms of governance, where only a few have a central body dedicated to the supervision of sustainability objectives*".

3.2.2 Performance

The question about performances is made of 5 components (ROI, sales growth, complying with environmental regulation, limiting environmental impact beyond compliance with regulations, monitoring environmental risks in your supply chain and handling Covid-19 pandemic) (see ANNEX 1). We focus on three question below reported (Fig. 6). The question specifies: "*Compared to other firms in the automotive supply chain, how do you rate your performance?*". The answers are reported here below (Fig. 6).

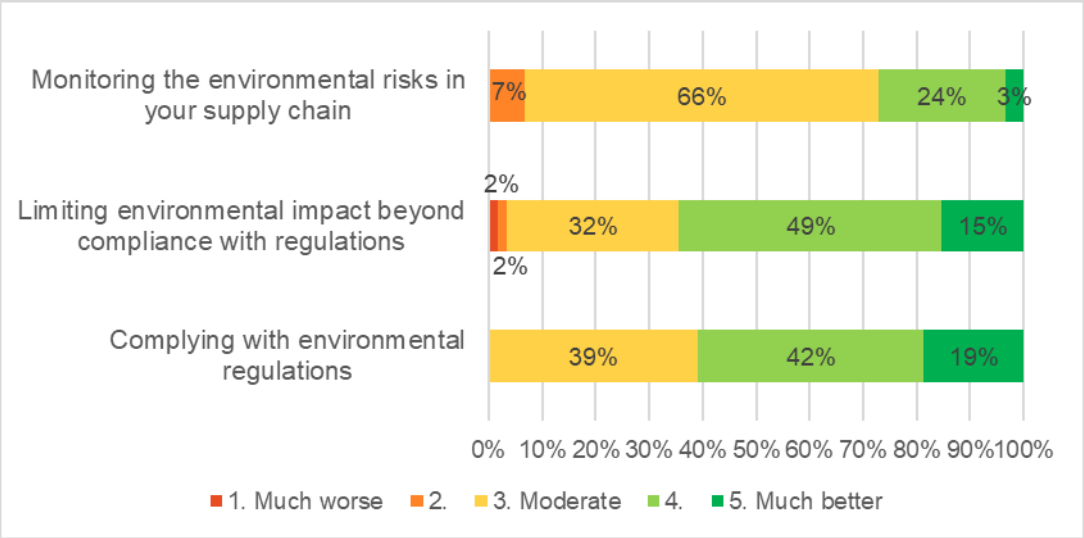

Figure 6. Firms' self-evaluation of performances. Source: Own elaboration

From the total sample emerge that companies evaluate their performance moderate. The performance measuring 'the limitation of environmental impact beyond the only compliance with regulation' registers at superior performance (from to 4 to 5) in 64% of respondents. This result may be in line with the presence of voluntary-based certifications as well as the presence of firms strictly dependent by a single customer (as we will see later). About 83% of respondents openly report at least one certification[26]. 51% of respondents report ISO 14001 certification (environmental management system). ISO 14001 provides a management framework for integrating environmental management practices, pursuing environmental protection, pollution prevention, and reduction of energy and resource consumption. These firms demonstrate their commitment to continuous improvement of their environmental

[26] Control carried out through company's website. Some firms ask email to deliver further information. Some firms may have more than one voluntary- based certification.

performance and, more generally, their attention to environmental sustainability policies. From the code of conducts of some OEMs emerge that having ISO 14001 certification is often valued when bidding for contracts or negotiating with clients who are sensitive to sustainability issues.

Other certifications of respondents are: 22% OHSAS 18001 (British standard for worker health and safety, now converted to an international standard with ISO 45001) and 57% IAFT 16949, a typical certification for the automotive sector.

3.2.3 Risks' monitoring and awareness of supply chain risks

To investigate better the monitoring of environmental risk of the supply chain, we ask to indicate a level of monitoring both for direct suppliers and indirect suppliers and the awareness of the risk of the supply chain. Environmental risk is defined as the "actual or potential threat of adverse effects on living organisms and the environment by effluents, emissions, wastes, resource depletion, etc., arising out of an organization's activities"[27]. Environmental exposures induce a harmful response and may affect soil, water, air, natural resources, or entire ecosystems, as well as the plants and animals - including humans.

The question about risks' monitoring focus on monitoring activities of firms: "*Do you have a system in place to monitor the environmental risks in your supply chain, Tier 1 suppliers respectively Tier 2 & Tier 3 subcontractors?*". The answers are reported here below (Fig. 7).

[27] https://crawfordgts.com/services/environmental-risk/environmental-risk-defined.aspx#:~:text=Environmental%20Risk%20can%20be%20defined,or%20biological%2C%20can%20induce%20a [Access date: 01/23/2021]

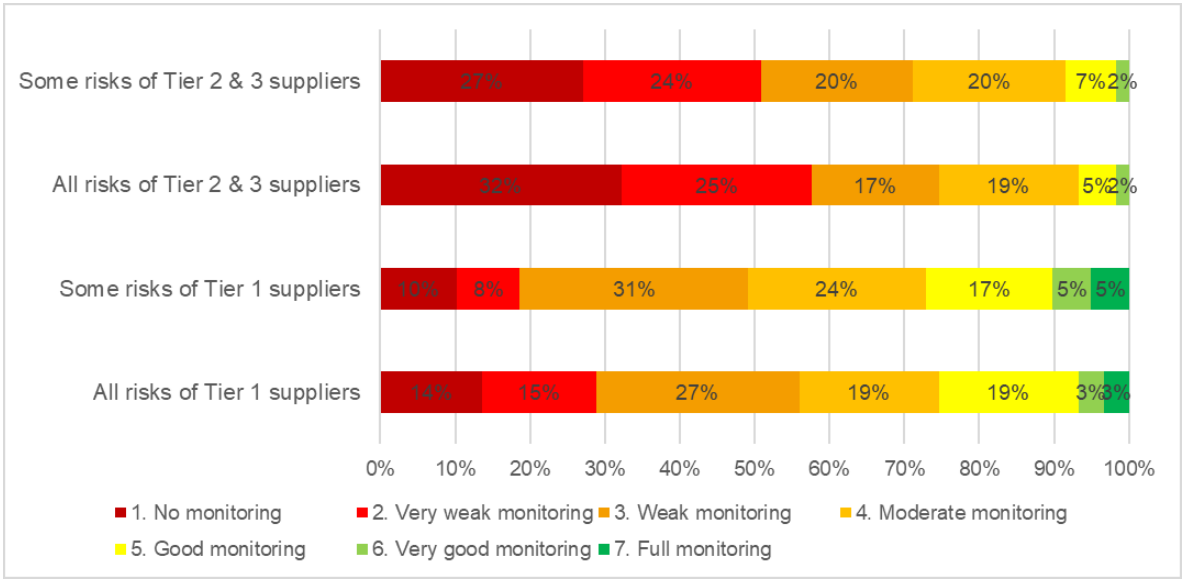

Figure 7. Environmental risks' monitoring of supply chain. Source: Own elaboration

Full monitoring is carried out by only 8% of the total firms and regard only the risk of direct suppliers, instead no one take full monitoring of indirect suppliers. The monitoring decreases according to the tier level of suppliers. More than ¼ of respondents do not carry out monitoring of indirect suppliers and more than 50% of firms have '*no monitoring*' and '*very weak monitoring*' (Fig. 7). For direct suppliers, the highest number of answers are around '*weak monitoring*' and '*good monitoring*'; for indirect suppliers the highest number of answers are around '*no monitoring*' and '*moderate monitoring*' with around 65% on average (Fig. 7).

However, considering both direct and indirect suppliers, most of firms find easy monitor only some risks of their suppliers: in fact, the % of firms carrying out '*no monitoring*' and '*very weak monitoring*' in all risks of direct suppliers are 29% versus 18% in some risks; instead, for indirect suppliers the % are 57% of all risks versus 51% of some risks (Fig. 8). This result is consistent in the light of high cost of monitoring as well as the lack of resources in managing sustainability issue, as ANFIA pointed out in the above answer.

Another point is the use of technology to control the supply chain. Only 12% of all respondents use blockchain technology and 19% cloud computing[28].

[28]Cloud computing and blockchain technology are the two on-demand and internet-based technologies. These two technologies provide different data to actors in the network. The main difference between the two is that information in blockchain technology is immutable, whereas data stored in the cloud is mutable. [https://www.upgrad.com/blog/blockchain-vs-cloud-computing/#:~:text=One%20common%20difference%20between%20the,in%20the%20cloud%20is%20mutable.

The % of companies using blockchain technology having registered at least a '*good monitoring*' are: 28% on all direct suppliers' risks; 42% on some risks of direct suppliers; 14% on all risks of indirect suppliers; and 14% on some risks of indirect suppliers.

The performance about cloud computing is higher: 36% of firms have at least '*good monitoring*' in all risks of direct suppliers; 36% on some risks of direct suppliers; 18% on all risks of indirect suppliers and 27% in some risks of indirect suppliers.

This result is reliable as firms using technology to monitor their supply chain perform better than the other (respect to the whole sample).

The question about *consciousness of supply chain risks* highlights how most firms do not have at least a '*good*' comprehension of the risks. From the question: "*What's your company understanding of following risks in your supply chain (Tier 1, 2 and 3)?*" emerges these results (Fig. 8).

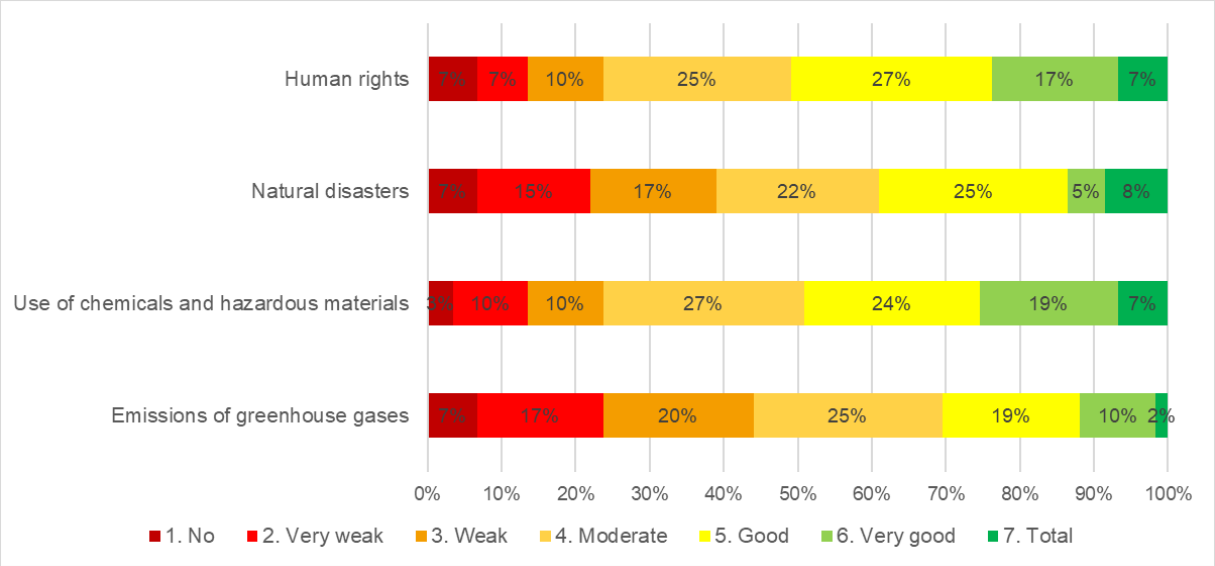

Figure 8. Awareness of supply chain risks. Source: Own elaboration

Most of firms report a level of awareness around '*weak*' (3) and '*good*' (5). '*Use of chemicals and hazardous materials*' and '*human rights*' are the categories demonstrating to have at least a '*good*' level of awareness' for around 50% of the respondent (Fig. 8). These groups have also the highest level of consciousness (considering rating 6 and 7). The category with the

&text=Cloud%20computing%20provides%20various%20online,and%20Software%20as%20a%20Service. Access date: 02/03/2021]

lowest degree of consciousness concerns the greenhouse gases emission, in which 44% of enterprises state to have an awareness level less than '*weak*' (Fig. 8).

From the descriptive result emerge that the comprehension of sustainability as well as monitoring of supply chain is a long journey. This result is consistent because of the structure of the Italian industry context. (Question: *What are the main difficulties/tensions that companies face?)*. ANFIA describes in few words the constraints of the Italian value chain: "*All these regulations require companies to use a lot of human resources and investment to be compliant, and often smaller companies find it harder to pursue these goals. It would be desirable smaller companies to begin pursuing the path of aggregation with other companies in the supply chain, to reach critical mass to make investments in sustainability more efficiently. The Italian scenario is dominated by the high fragmentation of the supply chain, with small and often single-customer companies. It is presumable, on the one hand, Covid-19 will slow down or postpone certain technological investments, on the other hand, it will make more companies aware that sustainability can also be pursued through good practices applied to working environment especially for employees of companies*".

3.2.4 Use of recycled materials and renewable energy

About more efficient use of resources, some firms state to recycle some parts of raw materials. Data highlights that the share of firms that use more recycled material are very low (to most extent – 100% recycling): it varies from 5% to 24% (Fig. 10).

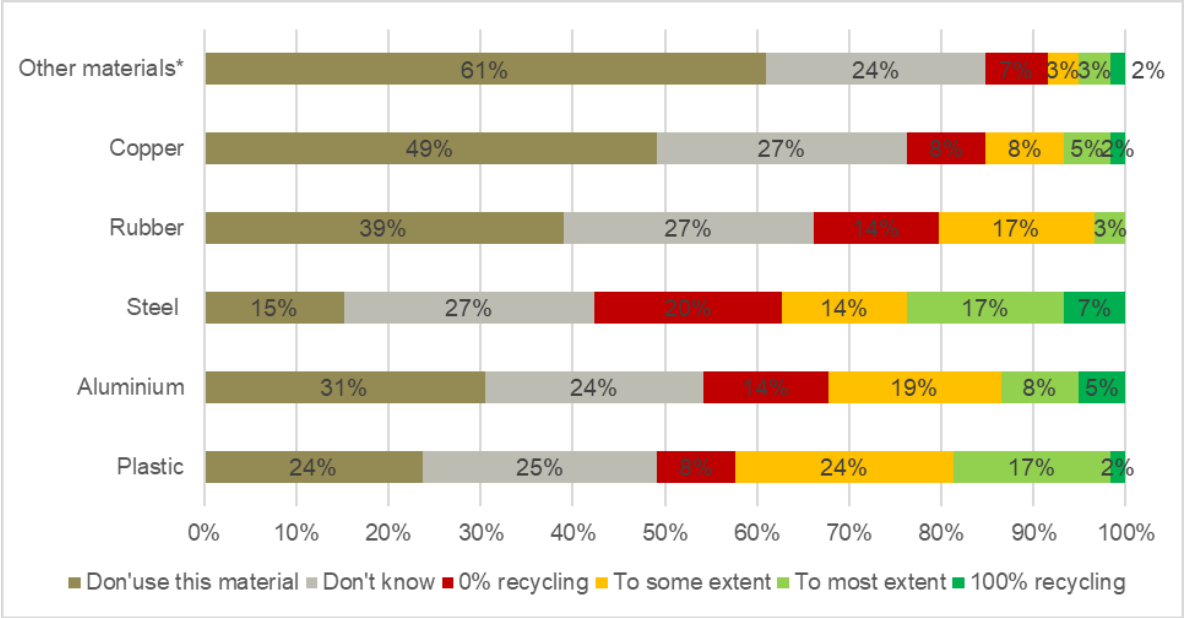

Figure 9. Materials' recycling. Source: Own elaboration

Firms report a level of commitment in recycling quite low (Fig. 9). Metals and alloys have the highest share of 100% recycled: 5% of firms recycle aluminium, 7% steel and 2% copper. 2% of firms recycle 100% of plastic. Also 2% of firms among 'other material' recycle 100%. 17% of firms recycle most of plastic and steel, 8% aluminium, 3% rubber and other materials and 5% copper.

The average share of use of renewable energy is around 31%. The share of use of renewable energy show that 27% of firms use more than 50% of energy from renewable resources; 25% of firms use a share of renewable energy between 30% - 49% and 33% of firms a share between 1% - 29%. 15% of firms do not use renewable energy.

Other kind of renewable energy (heating) shows a lower average use: 10%. 10% of firms use a share of renewable energy higher than 50%; 8% of respondents use a share of renewable heating between 30% and 20%; 30% of firms show a use renewable heating between 19% - 1%. 50% of firms do not use a share of heating renewable energy.

3.2.5 Future perspective

As has been mentioned in previous chapters, automotive electrification represents only the tip of the iceberg. There are numerous innovations that are changing the automotive industry, and it is important to see how suppliers have responded to these new challenges. Italian suppliers

are suffering the shift of products to electric and hybrid powertrain since most of them rely with traditional combustion engines and parts and components (Sessa & Pirone, 2019). When asked '*How large share of your total turnover in 2019 was from sales of*' companies responded as follows (Fig. 10).

The questions analyse both new technologies (electric engines, hybrid, batteries and electronics/self-driving vehicle) and the '*commodize*' one (traditional combustion engines and transmission and others.) (Fig. 10).

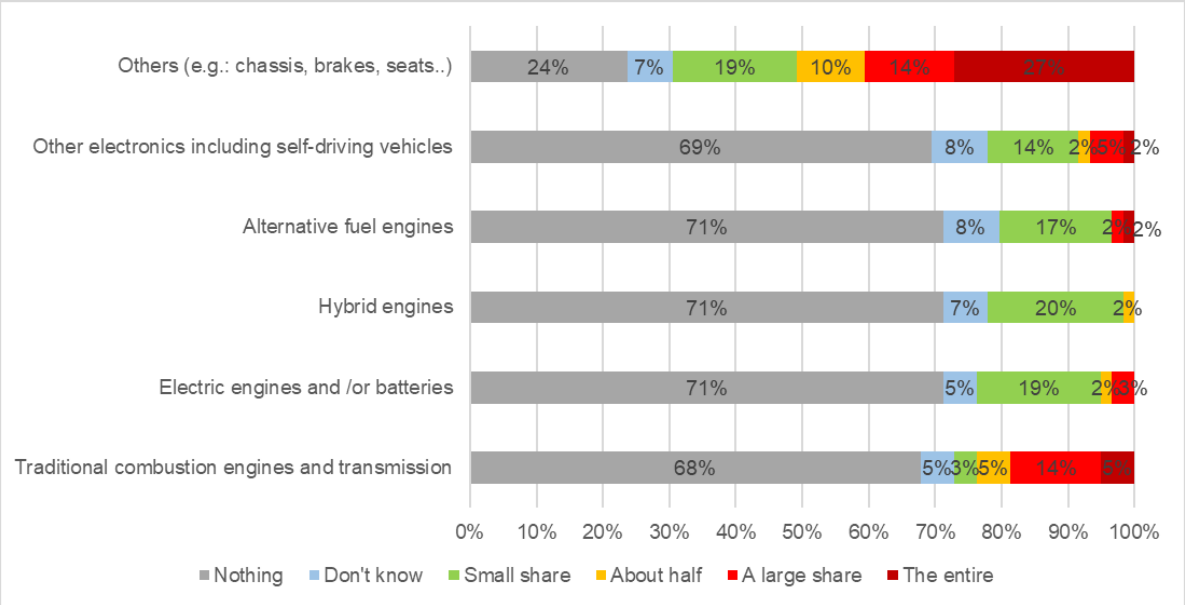

Figure 10. Sales by product type. Source: Own elaboration

From the respondent firms, most of them register a large share of sales coming from traditional engines (14%) as well as other (14%).

As can be seen from the above, production of one type does not necessarily exclude another, except when the entire turnover is generated by a particular category (see caption). In fact, 36% of all respondents did not diversify production, thus producing only one of these categories. No percentage of respondents were identified as having their entire revenue from hybrid engine production, electric production, and/or battery production. However, it emerges that 39% of respondents admit to having a small portion of their revenues coming from hybrid engine, electric, and/or battery manufacturing.

Another interesting factor is the diversifications implemented by the companies. To better understand how firms relate with different types of goods, we can divide the products into two categories: (1) '*traditional*' including traditional combustion engines and transmission,

alternative fuel engine and 'others'; (2) '*innovative*', consisting of hybrid engines, electric engines and/or batteries and other electronics including self-driving vehicles.

30% of firms have maintained production in at least one "traditional" industry, and have diversified by producing hybrid, electric motors and batteries and/or electronic devices and self-driving vehicles (innovative - traditional); 10% of firms diversified into traditional industries (traditional - traditional); 7% of firms diversified into new industries only (innovative - innovative).

3.2.6 Covid-19 Pandemic

Moreover, the Covid-19 pandemic has further amplified the challenges of the automotive industry. Even if firms state to have been managed well the pandemic (more than 80% of firms evaluate their performance among 4 and 5), it emphasises the upcoming innovation and approach to sustainability. This performance self-evaluation may be consistent with the governmental aid received by companies to face the pandemic. ANFIA pointed out the main issues for the future as well as the green approach of firms (post Covid-19 challenges) (question: What role will Italy play in a post COVID world?):

"*The Covid-19 pandemic is changing the development of MADE trends (Mobility, Autonomous drive, Digitalization and Electrification), with greater sensitivity to sustainability issues despite the increasing technological advances. This scenario, characterized by changes and uncertain future in the medium-long term, has driven Italian companies to adopt an exploratory approach, aimed at innovation to expand their skills to develop new products, new collaborations, and business models. Therefore, Italian companies must look at change, even radical if necessary. The idea of moving towards integration processes with other companies in the supply chain to meet the needs of OEMs that have wider production potential should not be excluded. Overcoming the dwarfism of Italian companies in the sector would guarantee the ability to provide integrated solutions, the maintenance within the supply pyramid*".

3.3 Statistical analysis

As anticipated, t-tests and Cronbach's alpha are used to analysing the differences of the three perspectives: (1) exporters, (2) customer dependence and (3) Italy and Sweden (Tables 5, 7, 9 accordingly).

T-tests allow to test if the means of two groups are statistically different from each other (Tables 5, 7, 9 report the mean of each answers for each group).

T tests were carried out assuming 'different variances' because it is more accurate than the one based on equal variances whenever the two variances in the population are not exactly equal.

As in De Marchi & Grandinetti (2013), these variables are considered continuous.

3.3.1 Exporters

We analysed the 14 variables according to the firms which revenues come from export for more than 50% or less (Table 5). In the table are reported the mean of answers for each group.

		Exporters (>50)	Exporters (<50)	Comparison
Motivations	Regulation	27,97	28,67	
	Extra-firm drivers	27,52	28,13	
	Intra-firm drivers	31,55	33,57	
Performances	Complying with environmental regulation	3,86	3,73	
	Limiting environmental impact beyond compliance with regulations	3,66	3,83	
	Monitoring the environmental risks in your supply chain	3,24	3,23	
Risks' monitoring	All risks of Tier 1 suppliers	3,28	3,47	
	Some risks of Tier 1 suppliers	3,59	3,70	
	All risks of tier 2 & 3 suppliers	2,55	2,33	
	Some risks of Tier 2 & 3 suppliers	2,72	2,50	
Awareness of supply chain risks	Emission of greenhouse gases	3,69	3,70	
	Use of chemicals and hazardous materials	4,28	4,53	
	Natural disaster	3,86	4,00	
	Human rights	4,17	4,57	

Notes: T-test (for continuous variables)statistics reported: * statistically different at 5 percent level; **statistically different at 1 percent level

Table 5. Statistical comparison of exporters. Source: Own elaboration

The analysis shows no statistical differences between the two groups (Table 5). The comparison between those exporting more (>50) and less (<50) does not exhibit significative differences unlike our expectations. The interpretation of this result depends on the fact that sustainability is a common practise in the automotive sectors regardless the embeddedness in global market. Moreover, even if firms have a strong reliance with the national economy – so export less – their Italian customers may rely with lead buyers. This fact explains why this measure is not suitable for statistical analysis.

The descriptive analysis, so, can fill the gap since some dynamics and trends may arise beyond the compliance with statistical analysis.

The tables 5 shows that 'small exporters' (<50) have a mean slightly higher than the other group. The 'big exporters' (>50) report a mean higher only in 'compliance with environmental regulation' and risks' monitoring of indirect suppliers.

Here below the assertions with the highest agreement and disagreement for each driver are reported (Table 6). Table 6 gathers the statements for each category (regulation, extra-firm drivers, and intra-firm drivers) with the highest means (on the left) and the ones with the lowest mean (on the right).

Exporters (>50)		**Exporters (<50)**	
Regulation			
Regulation by government agencies has greatly influenced our firm's environmental strategy	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment	Environmental legislation can affect the continued growth of our firm	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment
5,17	3,83	5,23	4
Extra-firm drivers			
Our customers are increasingly demanding environmentally friendly products and services	The Public is more worried about the economy than about environmental protection.	Our customers expect our firm to be environmentally friendly.	Our customers are increasingly demanding environmentally friendly products and services
5,72	5,07	5,67	5,57
Intra-firm drivers			
By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.	Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.	By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.	Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.
4,76	4,34	5,2	4,2

Table 6. Exporters statements' mean. Source: Own elaboration

Regulation. Exporters (>50) state as most important driver how regulation has affected their strategies (5,17); the less important driver is that regulation is not the only motivation that push firms to invest in green product and process (3,83). Exporters (<50) state as most important driver that regulation may affect the continuous growth of the firm (5,23); the less important driver is the same of the exporter >50 with a mean of 4.

Extra-firm drivers. Exporters (>50) assert that the most import drivers are the expectation about clients in producing greener products and services and the commitment of the firms in reducing the environmental impact (5,72 respectively); the less important driver is the interest

about economic growth rather than environmental protection (5,07). Small exporters say as most important driver the expectation of customers about reducing the environmental impact (5,67); the less important is the interest of the clients in green products and services (5,57).

Intra-firm drivers. The two samples report that the most important internal driver is R&D investments in products and processes and the possibility to be leader in the market (4,76 big exporters, 5,20 small exporters). Exporters (>50 and <50) state as less important driver the savings obtained by investing in green product and process (4,34 and 4,20 respectively).

The answers reflect the greater importance of customer in shaping the approach of firms to sustainability independently by the location (seaward or on national territory). This is consistent with the fact that this subdivision of sample does not catch difference among group.

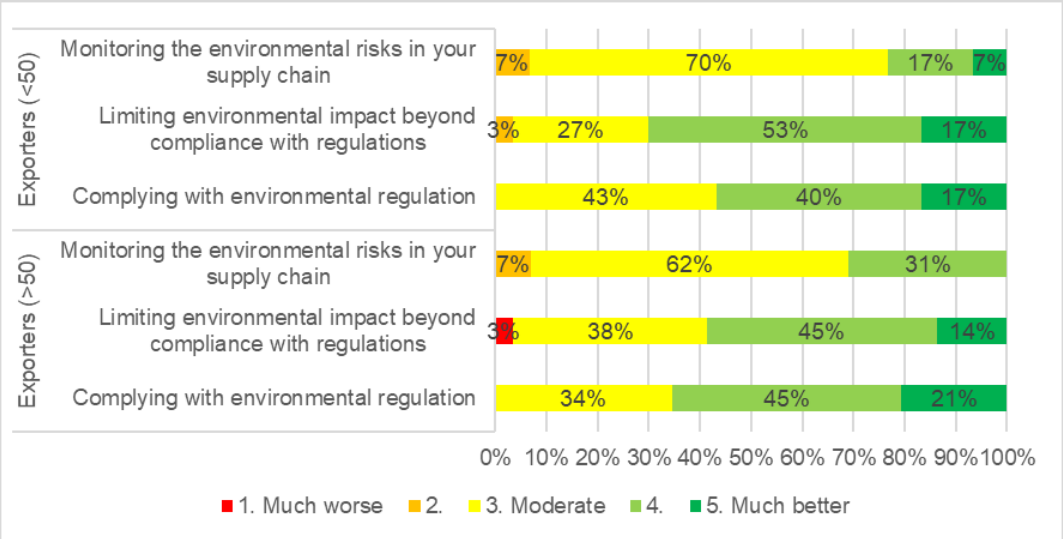

Figure 11. Exporters self-evaluation of performances. Source: Own elaboration.

The self-evaluation of performances shows that firms exporting more (>50) perform better in '*complying with environmental regulation*'. This result is effective also when we consider that big exporters shape their strategy according to environmental legislation (Table 6).

Supply chain monitoring shows a level of control between '*very weak*' (2) and '*moderate*' (4) for all the two categories (Table 5). The higher level of control is made by exporters <50 in direct suppliers and by exporters >50 in indirect suppliers (Table 5).

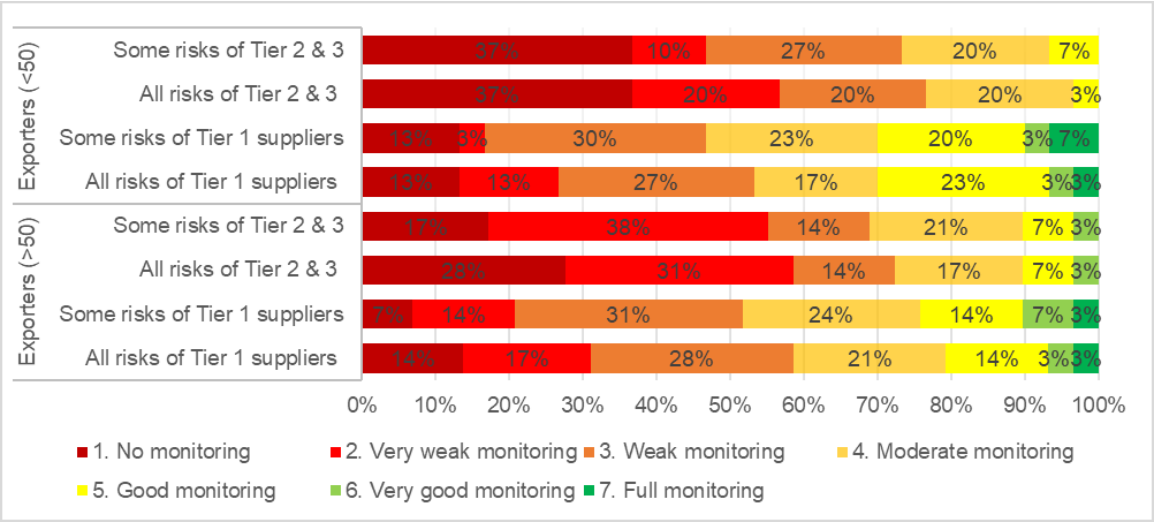

Figure 12. Exporters supply chain monitoring. Source: Own elaboration

20% of 'big exporters' (>50) say to have at least a good level of monitoring of all risk of direct suppliers and 24% in some risks of direct suppliers. Only 10% of respondent have at least a good level of monitoring in all risks and some risks of indirect suppliers (Fig. 12).

30% of 'small exporters' (<50) state to have at least a good level of monitoring in all risks and some risks of direct suppliers; 3% and 7% state to have a good level of monitoring both in all risk and some risks of indirect suppliers (Fig. 12).

Awareness of supply chain risks shows a level of consciousness of firms between '*weak*' (3) and '*good*' (5) (Table 5). The higher level of risk's knowledge is in '*human rights*' with a result near to 5 (good) (Table 5).

Small exporters seem to have a better comprehension of supply chain risks (Fig. 13)

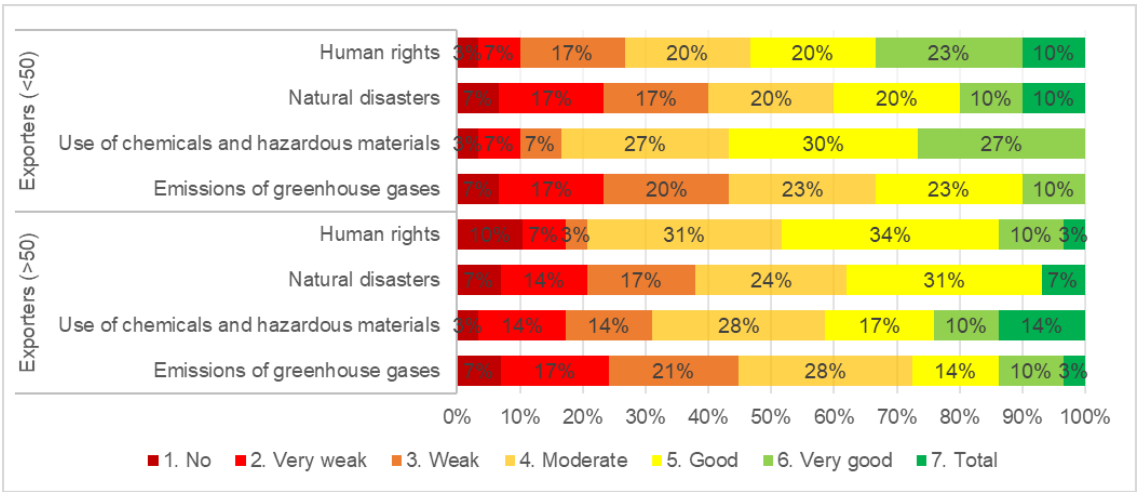

Figure 13. Exporters awareness of supply chain risks. Source: Own elaboration

The level of at least good comprehension of supply chain environmental risks for 'big exporters' (>50) are: human rights 47%, natural disasters 38%, use of chemicals and hazardous materials 41% and emissions of greenhouse gases 28% (Fig.13).

The level of at least good comprehension of supply chain environmental risks for 'small exporters' (<50) are: human rights 57%, natural disasters 40%, use of chemicals and hazardous materials 53% and emissions of greenhouse gases 33% (Fig. 13).

3.3.2 Customer dependence

As exporters show no statistical evidence, we used another way to verify if sustainability is shaped by other actors in GVC. The captive governance is used to prove if the strong dependence by a single customer affects sustainability performance of the value chain.

The firms relying mainly with a single customer perform better (Table 7).

		Customer dependence (>30)	Customer dependence (<30)	Comparison
Motivations	Regulation	29,40	27,53	
	Extra-firm drivers	28,44	27,38	
	Intra-firm drivers	33,96	31,55	
Performances	Complying with environmental regulation	3,80	3,79	
	Limiting environmental impact beyond compliance with regulations	3,88	3,64	
	Monitoring the environmental risks in your supply chain	3,32	3,17	
Risks' monitoring	All risks of Tier 1 suppliers	3,56	3,23	
	Some risks of Tier 1 suppliers	3,96	3,41	
	All risks of tier 2 & 3 suppliers	2,68	2,26	
	Some risks of Tier 2 & 3 suppliers	2,88	2,41	
Awareness of supply chain risks	Emission of greenhouse gases	4,12	3,38	
	Use of chemicals and hazardous materials	4,72	4,17	
	Natural disaster	4,32	3,64	
	Human rights	4,60	4,20	

Notes: T-test (for continuous variables)statistics reported: * statistically different at 5 percent level; **statistically different at 1 percent level

Table 7. Statistical comparison of firms' customer dependent. Source: Own elaboration

No statistical evidence emerges. Since lead firms are one of the most important actors - in GVC literature - in stimulating upgrading and knowledge, we moved into descriptive analysis because it seem to point out interesting results.

The firms relying with a single customer are more aware of the risks of supply chain and have a better performs also in the risks' monitoring of the supply chain (Table 7).

Here below the assertions with the highest agreement and disagreement for each driver are reported (Table 8). Table 8 gathers the statements for each category (regulation, extra-firm drivers and intra-firm drivers) with the highest means (on the left) and the ones with the lowest mean (on the right).

Customer dependence (>30)		Customer dependence (<30)	
Regulation			
Environmental legislation can affect the continued growth of our firm.	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.	Regulation by government agencies has greatly influenced our firm's environmental strategy.	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.
5,28	4	5,21	3,85
Extra-firm drivers			
Our customers expect our firm to be environmentally friendly.	Our customers feel that environmental protection is a critically important issue facing the world today.	Our customers expect our firm to be environmentally friendly.	The Public is more worried about the economy than about environmental protection.
5,76	5,56	5,65	5,09
Intra-firm drivers			
By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.	Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.	Our firm can increase market share by making our current products more environmentally friendly.	Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.
5,36	4,44	4,74	4,15

Table 8. Firms' customer dependent statements' mean. Source: Own elaboration

Regulation. Firms relying with a single customer (>30) state as most important driver how regulation has affected their growth strategies (5,28); the less important driver is that regulation is not the only motivation that push firms to invest in green product and process (4,00). Firms relying less with a single customer (<30) state as most important driver that regulation affects the strategies of their firms (5,21); the less important driver is the same of the firms relying mainly with a single customer with a mean of 3,85.

Extra-firm drivers. Firms relying with a single customer (>30) assert that the most import driver is the expectation about clients towards their suppliers in reducing the environmental impact of their activities (5,76); the less important driver is the customers' feels about environmental protection is as critical important issue of the world today. (5,56). Firms relying less with a single customer (<30) say as most important driver the expectation about clients towards their suppliers in reducing the environmental impact of their activities (5,65); the less important is 'the Public is more worried about the economy than about environmental protection' (5,09).

Intra-firm drivers. Firms relying mainly with a single customers (>30) state as the most important internal driver the R&D investments in products and processes and the possibility

to be leader in the market (5,36). Firms relying less with a single customer (<30) state as most important driver the possibility to increase the market share making greener product (4,76). The less important driver for both categories (>30 and <30) is the savings obtained by investing in green product and process (4,44 and 4,15 respectively).

The result of firms dependent by a single customer show that environmental regulation shapes the continuous growth as OEMs transmit environmental pressure along the value chain, as ANFIA said. Moreover, the customers' expectations are greater in firms relying mainly with a single client than the firms less dependent. The motivation in investing R&D is, again greater in this type of firms.

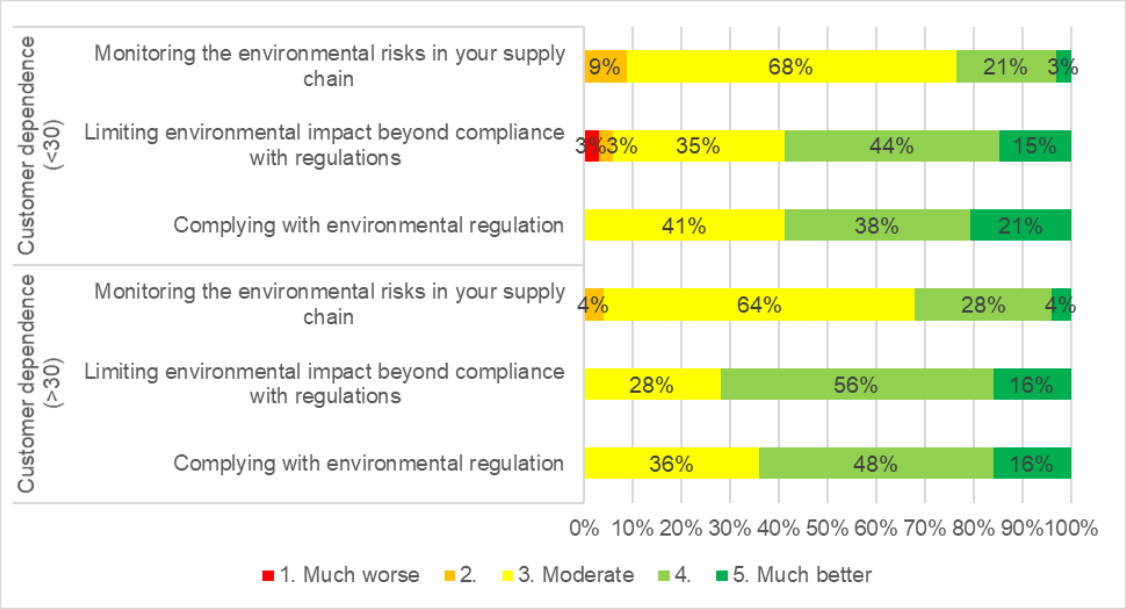

Figure 14. Firms' customer dependent self-evaluation of performances. Source: Own elaboration

The self-evaluation of performances shows reliable result according to what said before (Fig. 14): firms relying mainly with a single customer show a major attitude in limiting the environmental impact beyond the compliance with regulation (to increase the likelihood to collaborate with OEMs); as well as the better performance in monitoring lower tier suppliers (Fig. 16). These effects may be explained as firms dependent by a single customer may increase their knowledge due to the higher interaction and control exerts by lead firms on supply chain activities. This is consistent with monitoring of supply chain risks (Fig. 15) and awareness of supply chain risks (Fig. 16).

Supply chain monitoring shows a level of control between '*very weak*' (2) and '*moderate*' (4) for all the two categories (Table 7). The higher level of control is made by firms relying mainly with a single customer (>30) (Table 7).

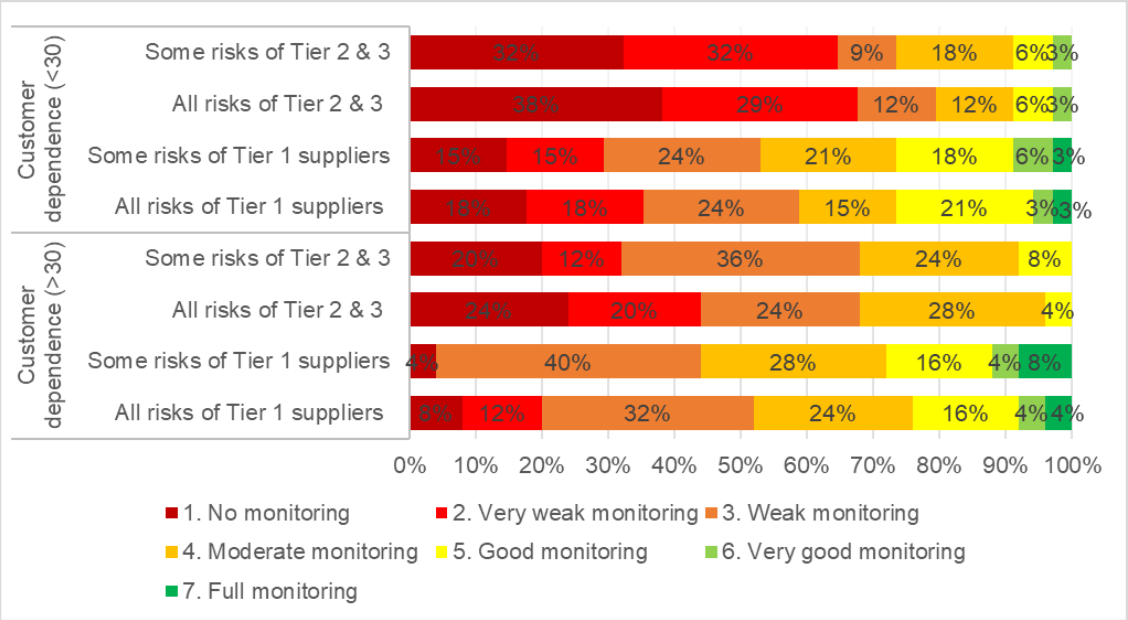

Figure 15. Firms' customer dependent supply chain monitoring. Source: Own elaboration.

24% of firms relying mainly with a single customer say to have at least a good level of monitoring of all risk of direct suppliers and 28% in some risks of direct suppliers. Only 4% of respondent have at least a good level of monitoring in all risks and 8% in some risks of indirect suppliers (Fig. 15).

26% of firms less dependent by a single customer state to have at least a good level of monitoring in all risks and in some risks of direct suppliers; 9% state to have a good level of monitoring both in all risk and some risks of indirect suppliers (Fig. 15).

Awareness of supply chain risks shows a level of consciousness of firms between '*weak*' (3) and '*good*' (5) (Table 7). The higher level of risk's knowledge is in 'use of chemicals and hazardous materials' with a result near to 5 (good) (Table 7).

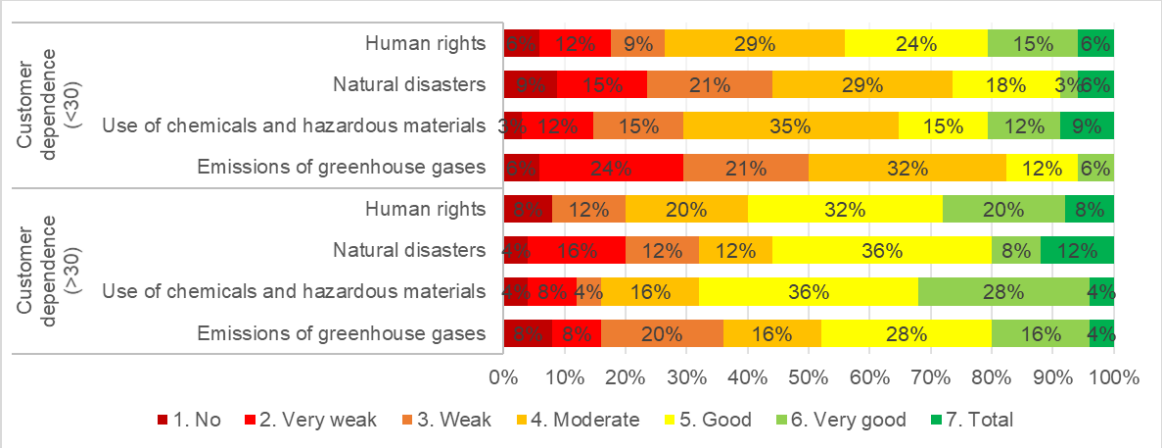

Figure 16. Firms' customer dependent awareness of supply chain risks. Source: Own elaboration

The level of at least good comprehension of supply chain environmental risks for firms relying mainly with a single customer are: human rights 60%, natural disasters 56%, use of chemicals and hazardous materials 68% and emissions of greenhouse gases 48% (Fig. 16).

The level of at least good comprehension of supply chain environmental risks for firms less dependent by a single customer are: human rights 44%, natural disasters 26%, use of chemicals and hazardous materials 35% and emissions of greenhouse gases 17% (Fig. 16).

Interesting result is the Use of chemicals and hazardous materials where firms dependent by single customers have a greater awareness. This effect is reliable when we consider the greater impact of EU REACH in increasing the monitoring along the value chain of the use of chemicals and hazardous materials. Firms relying with a single customer are, so, more aware of this kind of risk.

3.3.3 Comparison between Italy and Sweden

The same survey was submitted to Swedish automotive suppliers (see Tillväxtanalys, 2020).

The main differences between the two countries are: the types of final products and the industrial production: Italy excels in the production of cars and light vehicles with almost 1 million of units produced in 2019; Sweden made mainly cars and trucks with a total production around 409 thousand units. There are 10 OEMs assembly plants in Sweden and 23 in Italy (ACEA, 2020a). However, also Sweden has some historical automakers: Volvo and Scania-Vabis and Saab. The current situation is that Volvo, in Sweden, carry out the production of truck and owns other brands as Terex Trucks and Renault trucks; Scania

belongs to Volkswagen; Saab is produced in small volume only for Swedish people (Pols & Rise, 2017).

Beyond the quantitative data, the embeddedness in the automotive value chain may be analysed though other factor (as some structural facts may affect the industry organization of a country).

The share of direct manufacturing employment in total manufacturing by country is one. The European Union average is round 8.5% (ACEA, 2020a). Sweden has 90 thousand employees in direct manufacturing with a share of 14% (ACEA, 2020a). This percentage is one of the highest in Europe and it is similar to Slovakia (15.8%) and Czech Republic (13.7%) (ACEA, 2020a). As we said before, these eastern countries are the lead assemblers of German cars in Europe (Saglietto, 2020). Italy has a share of 4,6%.

Another different point is the share of car with electric powertrain: "in 2019, Sweden had the third largest market share of newly registered electric vehicles in Europe. 5.1% of all battery electric cars and roughly 8% of all plug-in hybrid electric vehicles in Europe were registered in Sweden"[29]. Around 20% of all vehicles registration in Sweden belongs to EPV vehicles; in Italy only 7%.

[29] https://www.statista.com/statistics/736413/number-of-registered-electric-passenger-cars-in-sweden/#:~:text=In%202019%2C%20Sweden%20had%20the,popular%20in%20the%20Nordic%20countries [Access date: 01/27/2021]

		Italy	**Sweden**	Comparison
Motivations	Regulation	28,32	28,19	
	Extra-firm drivers	27,83	26,97	
	Intra-firm drivers	32,58	31,06	
Performances	Complying with environmental regulation	3,80	4,03	
	Limiting environmental impact beyond compliance with regulations	3,75	3,97	
	Monitoring the environmental risks in your supply chain	3,24	3,42	
Risks' monitoring	All risks of Tier 1 suppliers	3,37	3,97	
	Some risks of Tier 1 suppliers	3,64	4,20	
	All risks of tier 2 & 3 suppliers	2,44	2,82	
	Some risks of Tier 2 & 3 suppliers	2,61	2,89	
Awareness of supply chain risks	Emission of greenhouse gases	3,69	4,47	*
	Use of chemicals and hazardous materials	4,41	5,37	**
	Natural disaster	3,93	4,30	
	Human rights	4,37	5,51	**
	Notes: T-test (for continuous variables) statistics reported: *statistically different at 5 percent level; **statistically different at 1 percent level			

Table 9. Statistical comparison of Italy and Sweden. Source: Own elaboration

There are no statistical differences among motivations, performances and risks' monitoring (Table 9). The statistical analysis of Italy and Sweden was carried out to verify if the emerging result were driving by institutional context. Some statistical differences emerged but some variables require descriptive analysis.

Here below the assertions with the highest agreement and disagreement for each driver is reported (Table 10). Table 10 gathers the statements for each category (regulation, extra-firm drivers and intra-firm drivers) with the highest means (on the left) and the ones with the lowest mean (on the right) for Italy and Sweden.

Italy		Sweden	
Regulation			
Regulation by government agencies has greatly influenced our firm's environmental strategy.	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.	Our industry is faced with strict environmental regulation.	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.
5,17	3,92	5,12	4,09
Extra-firm factors			
Our customers expect our firm to be environmentally friendly.	The Public is more worried about the economy than about environmental protection.	Our customers expect our firm to be environmentally friendly.	The Public is more worried about the economy than about environmental protection.
5,69	5,37	5,9	5
Intra-firm factors			
By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.	Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.	Our firm can attract skilled people by being an environmental leader in the market.	Reducing the environmental impact of our firm's activities will lead to a quality improvement in our products and processes.
4,98	4,27	5,38	4

Table 10. Italy and Sweden statements' mean. Source: Own elaboration

Italy and Sweden demonstrate that regulatory governmental forces and customer concerns are the most important drivers for environmental upgrading (Table 9).

Regulatory forces are the drivers considered less important for environmental improvements. Swedish suppliers neither agree nor disagree with the statement that stricter regulation is a major reason for improvements (Tillväxtanalys, 2020); Italian suppliers show disagreement (Table 10).

Customer' expectations is an important driver both in Italy and Sweden (Table 10; Tillväxtanalys, 2020).

Internal drivers is the category shaping environmental performance with minor force both in Italy and Sweden (Table 10). These answers are consistent because both countries indicate economy is more important than environmental protection (Table 10; Tillväxtanalys, 2020).

The most important Swedish 'internal driver' is the possibility to attract skilled people being environmental leader (Table 10; Tillväxtanalys, 2020); Italian suppliers show that R&D investment in clean product and process lead firms to be leader in the market (Table 10).

All the two countries assess their performances between 3 and 4 (values from 1 - much worse - to 5 – much better) (Fig. 17). Better performances are registered in Sweden in all the categories. The best performances are '*complying with environmental regulation*' and in '*limiting environmental impact beyond compliance with regulation*'. This is consistent with a better monitoring of supply chain risks in Sweden (Fig. 18).

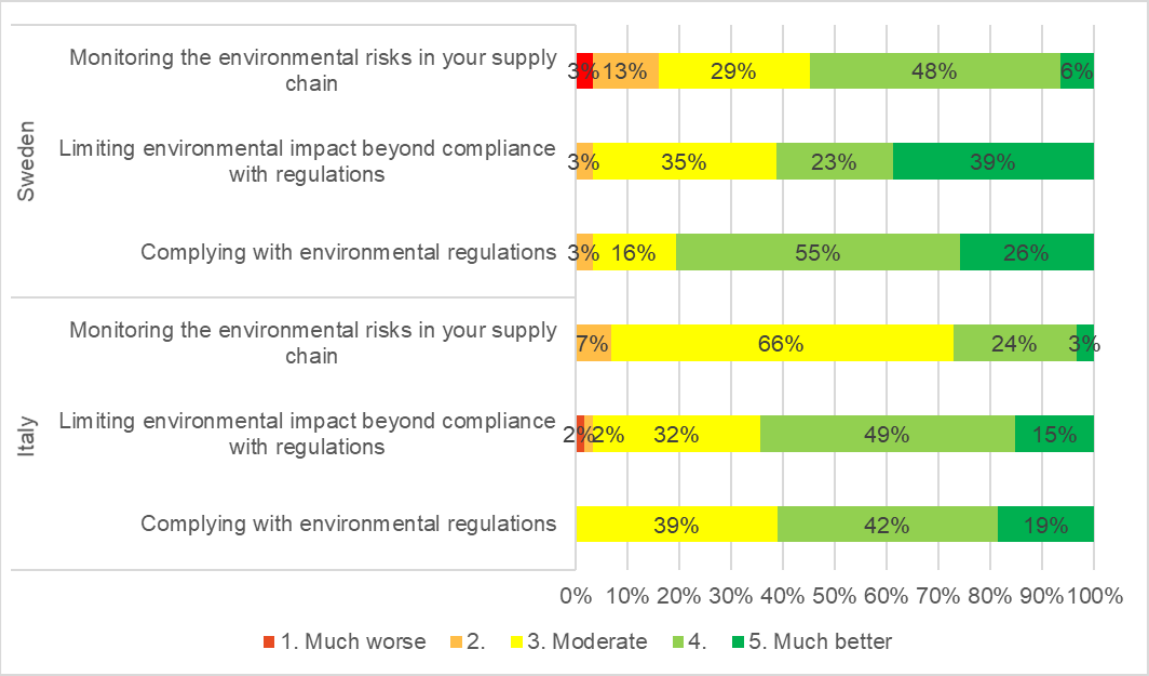

Figure 17. Self-evaluation of performances for Italian and Swedish sample. Source: Own elaboration

Supply chain monitoring show a level of control between '*very weak*' (2) and '*moderate*' (4). The higher level of control is made by Sweden in direct suppliers in indirect suppliers (Table 9).

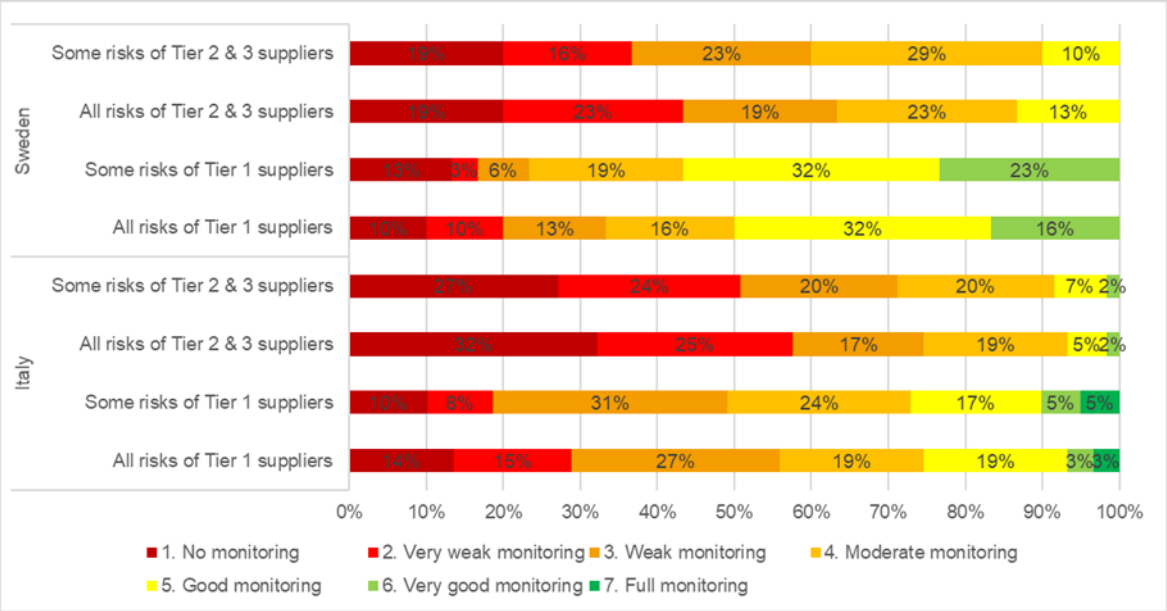

Figure 18. Italy and Sweden supply chain monitoring. Source: Own elaboration

The understanding of sustainability risks for direct suppliers is much greater than that for suppliers further upstream for both countries (Fig. 18).

25% of Italian firms say to have at least a good level of monitoring of all risk of direct suppliers and 27% in some risks of direct suppliers. Only 7% of respondent have at least a good level of monitoring in all risks and 9% in some risks of indirect suppliers (Fig. 18).

48% of Swedish firms state to have at least a good level of monitoring in all risks and 55% in some risks of direct suppliers; 13% state to have a good level of monitoring both in all risk and 10% in some risks of indirect suppliers (Fig. 18).

One mention should be done considering the commitment of Italian and Swedish supplier in the use of renewable resources and recycling of raw materials.

Swedish firms have a greater share of use of recycled materials. The % of firms that use 'most recycled' and 'only recycled' has an average share of 40% against a 20% of Italy (see Tillvaxtanalys, 2020).

Awareness of supply chain risks shows a level of consciousness of firms between '*weak*' (3) and 'very good' (6) (Table 9). The higher level of risk's knowledge is in 'human rights' with a result more than 5 (good) by Sweden (Table 9).

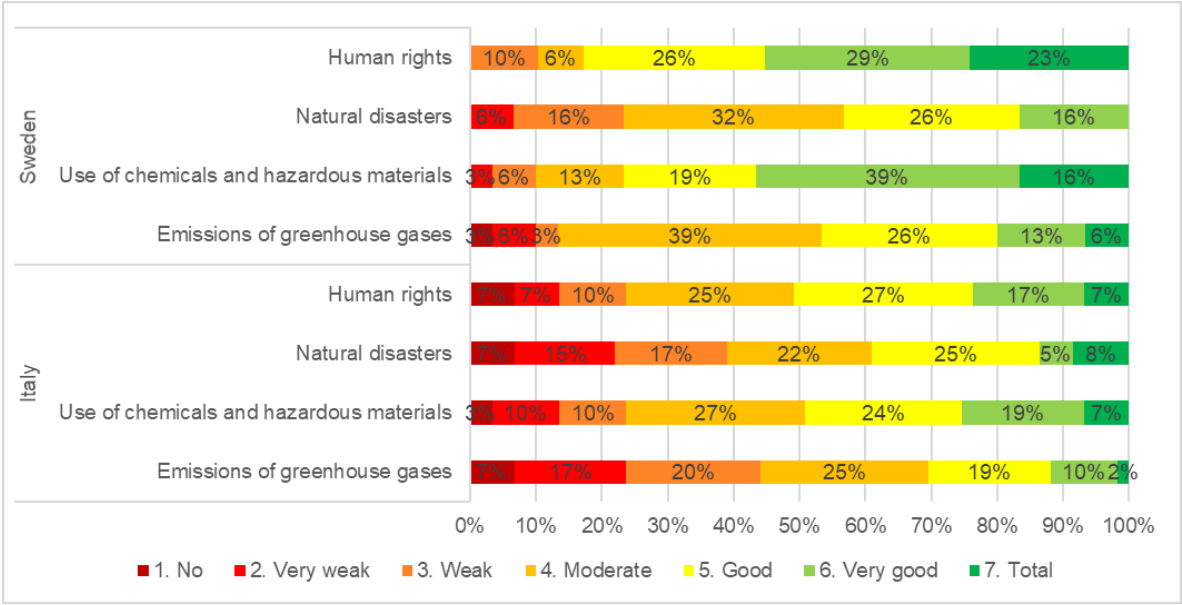

Figure 19. Italy and Sweden awareness of supply chain risks. Source: Own elaboration

Statistical differences emerge in awareness about supply chain risks (table 9). '*Emission of greenhouse gases*' reports a statistical difference of 5%; '*human rights*' and '*use of chemical and hazardous materials*' have a statistical difference of 1% (Table 9).

Emission of greenhouse gases shows at least a good level of awareness in Sweden for more than 40% of the respondent, in Italy about 30% (Fig. 19).

Sweden and Italy report at least a good level of consciousness of use of chemicals and hazardous materials of 70% and 50% respectively (Fig 19).

Natural disaster is the only variable not statistically different. Both countries claim at least a good level of awareness around 40% (Fig 19).

Sweden shows a good comprehension of human rights: 80% of the respondents state to have at least a good consciousness; in Italy only 50% (Fig. 19).

The effect of the greater awareness can be attributed to institutional context. Swedish government enacted strict laws aimed at reducing the environmental emission as well has a greater interest in sustainability given the effect of climate change and pollution on its land. Numerous studies and attention were carried out to track the effects and proposing solutions and initiatives as the one of Swedish commission on climate and Vulnerability.

3.4 Limitations

The main constraints of this analysis are enumerated here below.

Some answers may have little reliability. The respondent to the questionnaire provides answers according to what they personally know about the operation of the various departments of the company. What respondents say may not correspond to what actually happens within the company. The bias might be lowen if the respondents know well all the operations of the companies (managers). This issue may be overcome through a interview (as Sweden did to its respondents). This aspect influence also the statistical analysis. In general, the larger the sample, the more accurate and reliable the results will be. The sample size will influence the statistics analysis and the result of the study especially for what concerns the study of firms' customer dependent. As in De Marchi & Grandinetti (2013) a large sample will affect the overall result of research.

Conclusion

Since our goal was examined how Italian automotive value chain addresses sustainability issue, given the new challenges (electrification, shared mobility, new entrants and new technology), some interesting results emerged from the descriptive analysis and statistical one.

The descriptive analysis of the Italian value chain shows that firms are moving into changes. The greatest motivation for companies to invest in sustainability comes from customers' pressure (OEMs). Automakers experience regulatory pressures on final product (vehicles) and pass them along the value chain asking green products and services as well as commitment in reducing the environmental impact complying with standard and certification. This result is consistent with the fact that firms do not consider relevant stricter environmental regulation for investing in sustainability as well as the fact that firms' internal decisions are not sufficient to drive investments. Beyond the influence of OEMs, some firms face the stringent effect of regulation as those deal with traditional and more innovative sectors (traditional combustion engine and those that producing electric engines and batteries).

Italian firms find very difficult to monitor the risks of direct and indirect suppliers and they register poor performances. It is not possible to say what are the main constraints. Referring to literature and study, we can assume that low performances may be attributed to the fact that this activity is costly and time-spending and most of firms perceive no advantage in doing so (Villena & Gioia, 2020). Beyond the result of poor monitoring, firms perform better in controlling direct suppliers. However, the higher share of better performances regards the control of some risks of direct and indirect suppliers. This result may also be driven by the fact that firms prefer to monitor the riskiest activities as well the most strategic.

The consciousness of supply chain risks shows a discrete comprehension of the risks, especially about the use of chemicals and hazardous materials and human rights. However, this level of comprehension of the risks as well as the monitoring of supply chain may be improved. This result may be consistent given the lack of resources that firms are experiencing, especially for what concern sustainability issue: most of firms do not have a specific function dedicate to this matter.

Firms consider very important the investment in R&D for the creation of greener products and services. The data of *Osservatorio sulla componentistica automotive italiana* (2020) show that 73% of firms carry out R&D investment to improve mainly production process and

management process. 36% of firms invest 1-3% of their turnover in this activity and only 11% of enterprises more than 10%. Most of firms say as main obstacles the high innovation costs, the uncertain demand of innovative product and services and lack of internal and external appropriate financial resources. These data are consistent with the main issues highlight by ANFIA about constraints of Italian value chain in investing in sustainability issue (the disruptive innovation, lack of resources and dwarfism of firms).

The commitment of firms in investing in new technology is showed by the intention of diversifying into new sectors (hybrid, electric and electronics) as well as the birth of firms relying mainly with electronics as *Osservatorio sulla componentistica automotive italiana* claims as well as the explorative approach undertaken by some firms (ANFIA's interview, ANNEX 3). The commitment of firms in recycling raw materials is quite low. The ability of firms in increasing the efficient use will reduce the likelihood of environmental degradation and depletion of resources. However, most of firms use only a small share of recycled materials leaving room for improvements: better materials' management may better production's process efficiency with positive effect on environment (De Marchi et Al., 2019).

Regarding the division of the Italian sample between large (>50) and small (<50) exporters, no relevant statistics were found. We interpret this result as the fact that sustainability is not influenced by being present in the global economy and that it is accepted as common practice throughout the industry. In addition, firms relying mainly with the national value chain sell their products to other Italian firms who, in turn, sell to large lead buyers: this measure is ineffective in understanding what influences sustainability. The descriptive analysis shows, however, a better performance of 'big exporters' (>50) in complying with environmental regulation. This result is consistent considering the research implemented in the literature: most of firms comply with environmental regulation to increase the operations at international scale given the higher number of actors and forces (different country laws as well as standards) (Ponte, 2019b).

GVC literature shows how customers exert a strong influence on their supply chains. Even if no statistical evidence occurs in firms dependent by a single customer, descriptive analysis shows how lead firms can shape the approach of firms in sustainability. Lead firms strongly influence the strategy and knowledge of firms, especially awareness of the risks along the supply chain as well as the better monitoring of the suppliers. Lead firms' expectations and specifications, in fact, contribute to mould the approach of firms to sustainability issue (De

Marchi et Al., 2019; Ponte, 2019b). In fact, firms dependent by a single customer claim to perform slightly better in 'limiting environmental impact beyond compliance with regulation'. This result is supported by the fact that firms dealing with different customers face different standards and initiative that make difficult managing the various requirements; instead, firms experiencing a stricter control by a single customer is more incentivized to satisfy better its single clients. (Ivarsson & Alvstam, 2010). This is also consistent with the lack of standards used by OEMs to track the environmental performances of their suppliers.

Italy and Sweden show statistical difference only in the awareness of supply chain risks. This result show that motivations inducing firms of the two country to invest are the same as well as performances and monitoring of supply chain risks. Even if Sweden perform slightly better, the differences are not so relevant. Climate change has been had a wide impact on global supply chain as some areas are experiencing the most tremendous effects. The greater awareness of Sweden is explained by cultural factors and by institutional context (Khattak & Stringer, 2017) (strict regulation and commitment in reducing environmental impact and governmental commitment in addressing sustainability issue). Sweden, in fact, is the country with the lowest greenhouse gas emission and the country using almost 50% of the total energy from renewable resources. Furthermore, Sweden has experienced the effects of pollution and climate change on its land more than other European countries (acid water in more than 16 thousand of lakes with effect on flora and fauna, higher temperature, and strong precipitation)[30].

Most research of automotive industry stress the attention on the transition moment since the disruption of new innovations charge firms of a further pressure: the uncertain of current situation (amplified by Covid-19 pandemic) and the lack of a common standard across all industry have slowed down the investment pace and has postponed the adoption of new technologies by final users. The crisis induced by the spread of the Covid-19 pandemic is amplified by significant transformations in the global industrial chain, focused on huge investments for the development of both traditional engines with less emissions and electric batteries (Ernst & Young, 2020). BCG (2020) study foresees that automotive sales most likely will decrease between 14 and 22% among China, US and European markets in 2020. BCG (2020) has figured out three scenarios about economic situation and the effects on automotive sector.

[30] https://www.azocleantech.com/article.aspx?ArticleID=557 [Access date: 01/28/2021]

The first one offers a optimistic view with positive implication for virus and a total recovery for the economy, thanks to incentive and cheap credit. For the automotive sector, there is recovery of the previous vehicle demand losses with an increase of demand around 1-12%.
The second scenario is identified as the most likely. The virus remains or worsen and require a great urgency of governmental funds. The persistence may lead also to a financial market crack. The scenario for automotive sector is a flat growth of vehicle demand near to 0-5%. New vehicles wait for entering in the market with a severe portion of sales losses.
The third scenario is the more pessimistic. In this case virus changes and creates a second pandemic. All capital investments diminish with a severe shock on local and regional economies with frequent lockdown. The whole automotive supply chain will be disrupted with also a dramatic change in mobility. In this case, the vehicle demand has a negative growth around 6-28%.

Beyond forecasts, it will be necessary to verify if and how the COVID-19 has impacted and will impact the results collected in this survey, if there will be more care about sustainability and if companies will try to improve themselves through innovation.

Companies should consider the possibility to improve the production process to better manage resources and foster sustainability. The upcoming innovation may disrupt the most traditional sector (Deloitte, 2019) with greater effect on national economy and on employment. Firms should look at integration with other companies in the supply chain to meet the needs of OEMs, increase the potential production, share resources to foster innovation in order to propose them as a consistent value chain.

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Appendix

ANNEX 1: SURVEY

Sustainable suppliers in the value chain of automotive

Challenges and opportunities to make the automotive sector greener

The research questions how your company, part of the automotive sector, approaches environmental and social sustainability by addressing the tensions and issues related to it from different perspectives (e.g.: environmental objectives, demands and pressures of different stakeholders, supply chain involvement, change factors, skills shortages).

The research will look at 4 areas of study, broken down accordingly in the questionnaire:

Why act - What are the environmental upgrading factors in the production of vehicles?

How to act - From an initial focus on the production of hazardous substances and waste (due to legislation); to an increased focus on climate change and the use of secondary materials. What impact has this new 'more inclusive' approach had on the actions of companies at various levels of the supply chain?

Knowledge gaps - Are companies within the value chain aware of the sustainable risks in implementing such changes upstream, i.e. in the supply chain?

Reporting system - sharing information with companies in your supply chain and external information to stakeholders.

The estimated time for the compilation is about 7 minutes.

We assure you that the data will be processed only in aggregate form and for scientific purposes scientific purposes (more information at the link Privacy Policy) and that the answers provided will be treated anonymously.

We thank you again for your availability and take this opportunity to send you warm greetings.

1/5 Why act

Indicate your agreement (1 = completely disagree, 2 = mostly disagree, 3 = somewhat disagree, 4 = neither disagree nor agree, 5 = somewhat agree, 6 = mostly agree, 7 = completely agree) on the following statements:

1. The role of legislation

	1.	2.	3.	4.	5.	6.	7.
Regulation by government agencies has greatly influenced our firm's environmental strategy.							
Environmental legislation can affect the continued growth of our firm.							
Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.							
Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow.							
Our firm's environmental efforts can help shape future environmental legislation in our industry.							
Our industry is faced with strict environmental regulation.							

2. Extra-firm factors

	1.	2.	3.	4.	5.	6.	7.
Our customers feel that environmental protection is a critically important issue facing the world today.							
The Public is very concerned about environmental destruction.							
Our customers are increasingly demanding environmentally friendly products and services.							
The Public is more worried about the economy than about environmental protection.							
Our customers expect our firm to be environmentally friendly.							

3. Inter-firm factors

	1.	2.	3.	4.	5.	6.	7.
Being environmental conscious can lead to substantial cost advantages for our firm.							
Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes.							

By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.							
Our firm can enter lucrative new markets by adopting environmental strategies.							
Our firm can increase market share by making our current products more environmentally friendly.							
Reducing the environmental impact of our firm's activities will lead to a quality improvement in our products and processes.							
Our firm can attract skilled people by being an environmental leader in the market.							

2/5 How to act

4. Compared to other firms in the automotive supply chain, how do you rate your performance?

	1. Much worse	2.	3. Moderate	4.	5. Much better
Return on investment					
Sales growth					
Complying with environmental regulations					
Limiting environmental impact beyond compliance with regulations					
Monitoring the environmental risks in your supply chain					
Handling the Covid19 pandemic					

5. Does your company generate renewable electricity in-house and/or rely on a renewable electricity distribution company?

0% of electricity from renewable sources — 50% — 100% of electricity from renewable sources

6. Do you use renewable biofuels, biodiesel, biogas or renewable district heating?

0% of heating from renewable sources — 50% — 100% of heating from renewable sources

7. How much of the plastics, aluminum, steel, rubber and copper used directly in your plants to produce components and related products come from recycled material?

	Don't use the material	Don't know	0 % recycling	To some extent	To most extent	100 % recycling
Plastics						
Aluminum						
Steel						
Rubber						
Copper						
Other*						

8. How is the freight transported to your plant(s) and from your plant to customers?

	Mostly by truck	Mostly by train	Mainly by truck and train	Mostly by ship	Mainly by truck and ship	Mainly by train and ship	Intermodal transport
Freight to your plant(s)							
Freight from your plant(s)							

9. Is your company responsible for freight transportation?

	All freight	Most of the freight	A part of the freight	A small part of the freight	No
Freight to your plant(s)					
Freight from your plant(s)					

3/5 Knowledge gaps

10. Do you have a system in place to monitor the environmental risks in your supply chain, Tier 1 suppliers respectively Tier 2 & Tier 3 subcontractors?

Tier 1 suppliers sell products directly to you. Tier 2 firms produce products to the Tier 1 supplier. Tier 3 supplies raw, or close to raw, materials such as metals and plastic.

	1. No monitoring	2. Very weak monitoring	3. Weak monitoring	4. Moderate monitoring	5. Good monitoring	6. Very good monitoring	7. Full monitoring
All risks of Tier 1 suppliers							

Some risks of Tier 1 suppliers							
All risks of Tier 2 & 3							
Some risks of Tier 2 & 3							

11. What's your company understanding of following risks in your supply chain (Tier 1, 2 and 3)?

Tier 1 suppliers sell products directly to you. Tier 2 firms produce products to the Tier 1 supplier. Tier 3 supplies raw, or close to raw, materials such as metals and plastic.

	1. No	2. Very weak	3. Weak	4. Moderate	5. Good	6. Very good	7. Total
Emissions of greenhouse gases							
Use of chemicals and hazardous materials							
Natural disasters							
Human rights							

4/5 Reporting system

12. How large is the administrative burden (time consuming and cost for consultancy) to respond on all customers' environmental and human rights requirements given the size of my company and the sustainability risks?

Very big burden Reasonable Burden Very small burden

13. Are your company involved in an initiative for end-to-end supply chain transparency of sustainability risks based on *blockchain technologies*?

Yes ○ No ○

14. Are your company involved in an initiative for end-to-end supply chain transparency of sustainability risks based on *cloud computing*?

Yes ○ No ○

5/5 Further Information about your companies

15. How large share of your total turnover in 2019 was from export?

0% 50% 100%

16. How large share of your total turnover in 2019 was from the most important customer?

0% 50% 100%

17. How large share of your total turnover in 2019 was from sales of?

	Nothing	A small share	About half	A large share	The entire	Don't know
Traditional combustion engines and transmission						
Electric engines or batteries						
Hybrid engines						
Alternative fuel engines (LPG/CNG)						
Other electronics including self-driving vehicles						
Others (e.g. chassis, brakes, seats)						

18. How many employees had your company in 2019?

Less than 50 ○
Between 50 and 250 ○
Between 250 and 2000 ○
More than 2000 ○
Don't Know

19. How big was the turnover of the company in 2019?

Less than €50 million ○
Between €50 and €300 million ○
More than €300 million ○

Don’t know ○

20. I authorize the processing of data in accordance with art.13 of EU Regulation 2016/679 (General Regulation on data protection).

Accept ○

Do not accept ○

ANNEX 2: ANFIA'S INTERVIEW

What are the main challenges for automotive companies? Looking at the last 5/10 years what have been the main transformations of the automotive sector also considering the growing international competition?

Deep transformations have been taking place in the automotive sector worldwide for some years now and can be summarized with the **MADE** macro trend used by Roland Berger: new models of **M**obility, **A**utonomous Drive, **D**igitization, **E**lectrification.

M stands for the sharing of assets rather than their ownership, with the spread of new on-demand mobility services as the vehicle/mobility sharing. The development of smart cities is reshaping the traditional concepts of mobility and logistics because of the birth of new needs and new business models. The perspective for 2030 and beyond will enhance the role of mobility and service providers.

A refers to the emergence of technologies that implement autonomous driving. The current technology allows a level of autonomy of grade 2 compared to the 5 provided by the SAE classification (Society of Automotive Engineers which establishes standards and norms of the sector) based on the degree of human intervention required. Even if the technology is ready for level 3 (automated driving system in a driver-monitored environment) there are some constraints, including regulatory ones, that prevent it from spreading.

D concerns the development and adoption of digital functionality related to vehicle connectivity and to new on-board services. The digitization's diffusion of the automotive sector offers to OEMs the possibility to gather large amount of technical, personal and security data which can be better analysed through Artificial Intelligence schemes.

E, finally, stands for electrification: the use of an electric engine as substitute or complement to the combustion one. The technology behind electric vehicles (EV) is developing rapidly, although costs are still high, and incentives are necessary to encourage demand. However, the diffusion is closely related to the availability of charging infrastructure, a significant problem in many countries, including Italy.

What role does Italy play in a post COVID-19 world? What role will Italy play in a post COVID world?

The Covid-19 pandemic is changing the development of MADE trends, with greater sensitivity to sustainability issues despite accelerating technological advances.

This scenario, characterized by changes an uncertain future in the medium-long term, has driven Italian companies to adopt an exploratory approach, aimed at innovation to expand their skills to develop new products, new collaborations, and business models.

Therefore, Italian companies must look at change, even radical if necessary. The idea of moving towards integration processes with other companies in the supply chain to meet the needs of OEMs that have wider production potential should not be excluded.

Overcoming the dwarfism of Italian companies in the sector would guarantee the ability to provide integrated solutions, the maintenance within the supply pyramid.

Why do companies invest in sustainability? What has driven and is driving companies to invest in sustainability?

Sustainability has become a strategic issue for automotive companies. Upstream companies (OEMs) must meet consumer expectations, and so, all the supply chain must meet the OEM's needs in order to be sustainable at the eyes of users, as shown by a recent survey by Capgemini "The Automotive Industry in the Era of Sustainability" that analyzed the behavior of 500 automotive companies located around the world.

Sustainability, however, is not only seen as an element of reflection but also as a business model, so many car manufacturers claim to have global sustainability strategies with well-defined objectives and deadlines. Companies investing in sustainability have a clear idea that the efforts and resources placed in this area create a better return a better brand positioning, making the consumer more inclined to choose their product.

According to the Capgemini survey, not all companies are in the same situation, not all of them have initiated a change of "corporate mentality" and a sustainable approach.

However, in many companies there is a gap in terms of governance, where only a few have a central body dedicated to the supervision of sustainability objectives.

What does sustainability mean for companies in the automotive sector? What are the most important risks? How have the recent changes in the sector played out in terms of sustainability challenges?

Sustainability for companies means adopting "green practices in the company", a series of tools and organizational/management structures aimed at reducing the impact of business activity on the ecosystem and implementing a strategy oriented towards environmental sustainability.

In the case of automotive companies, the change of direction towards responsible business behaviour has been dictated by the introduction of regulations, mainly of EU origin, from

those for the reduction of greenhouse gas emissions (Greenhouse gas - GHG), to those for tracking the use of materials from conflict zones (Conflict Minerals), to the tracking of chemicals (REACH) and the tracking of highly hazardous substances in products (SCIP), and many others, such as the United Nations Agenda 2030 with its 17 objectives for sustainable development.

What are the main difficulties/tensions that companies face?

All these regulations require companies to use a lot of human resources and investment to be compliant, and often smaller companies find it harder to pursue these goals. It would be desirable smaller companies to begin pursuing the path of aggregation with other companies in the supply chain, to reach critical mass to make investments in sustainability more efficiently.

The Italian scenario is dominated by the high fragmentation of the supply chain, with small and often single-customer companies. It is presumable, on the one hand Covid-19 will slow down or postpone certain technological investments, on the other hand it will make more companies aware that sustainability can also be pursued through good practices applied to working environment especially for employees of companies.

What role do OEMs (customers) have in stimulating sustainability and how do they implement it?

The role of OEMs is crucial because driven by the needs of the end consumer and by product sustainability regulations. Furthermore, they require their suppliers to follow the actions and behaviour too to comply with consumer expectations and legal requirements. Even when the input is not regulatory, but an internal choice of the OEM, suppliers can only "adapt" to the OEM customer's requirements if they want to continue to maintain the contractual relationship.

What kind of companies are more inclined to invest in sustainability? (size, national/foreign market, 1st tier/2nd tier....)

Without specific data it is not possible to say who is more inclined to invest in sustainability. Some general considerations dictated by common sense may be done: the companies that invest more are the OEMs and thus the nearest ones which must meet certain requirements to be considered their suppliers. In the rest of the automotive supply chain, it is conceivable that most "enlightened" and “far-sighted” companies have started to implement certain sustainability actions to improve their visibility and their positioning on the market. It is likely

that companies with a greater propensity for internationalization also have a greater propensity to implement initiatives/investments in sustainability, this in relation to the type of market supplied and the type of OEM customer and the degree of propensity to sustainability of these.

As an association, what do you do to promote the sustainable model? What are your priorities?

ANFIA is the trade association that represents the automotive supply chain. It helps companies in their growth path and awareness of new issues, as corporate social responsibility, and sustainability.

The association's purpose is giving an updated analysis of the degree of development of its supply chain respect to ESG (environmental, social and governance) and sustainability issues, the realization of information meetings and training courses to increase "sustainable business mentality" and the provision of a technological tool to its members, at low cost, that can allow the preparation of the sustainability report.

ANNEX 3: CRONBACH'S ALPHA

To summarize all the statement about motivation we used Cronbach's alpha. It is a statistical method for measuring the internal consistency of a questionnaire consisting of items that are answered numerically (Likert scale). The internal consistency of a questionnaire means determining whether the answers - given to the various items - are consistent with each other. The result of Cronbach alpha test is reported here below.

	Italy			**Sweden**		
	Regulation	Extra-firm drivers	Intra-firm drivers	Regulation	Extra-firm drivers	Intra-firm drivers
Mean	28,32	27,83	32,57	28,19	26,97	31,06
Items	6	5	7	6	5	7
Sum of items variances	14,75	7,84	15,18	13,21	5,44	19,22
Variance of total score	32,73	16,82	64,92	39,25	11,32	88,19
Cronbach's alpha	**0,66**	**0,67**	**0,89**	**0,80**	**0,65**	**0,91**

Table 11. Cronbach's alpha calculation. Source: Own eleboration

We decide to name the underlying latent variables as follow : regulation, extra-firm drivers and intra-firm drivers.

The typical classification, regardless of the specific field of investigation, is:

- alpha less than 0.4: low reliability
- alpha between 0.4 and 0.6: uncertain reliability
- alpha between 0.6 and 0.8: acceptable reliability
- alpha between 0.8 and 0.9: good reliability.

All investigated items report a level of acceptable reliability and good reliability. Beyond the single item, all items were gathered under their own macro categories to ease the comprehension of the survey given the results obtained from Cronbach's alpha.