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Reshaping Urban Mobility:

Opportunities from the automotive industry crisis and the "peak car".

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ABSTRACT

The Automobile Industry is one of the most important sectors of the European economy. Together with the decreasing production and new registrations of passenger cars, another trend seems to have been arising over the years: Europeans are driving less and are likely to continue doing so. The effects of such a phenomenon – also known as "peak car" – are intertwined with mobility regulations and future urban development plans. Very little evidence, however, exits on how the current industry players, in particular carmakers, are adapting to the new scenario. In this dissertation, I explore what are the opportunities for the industry main players of the "peak car" and the following changes in both the dominant architecture of cars as well as of urban mobility systems.

CONTENTS

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INTRODUCTION

The aim of this dissertation is to discover and understand the opportunities created by the recent automotive industry crisis in the field of sustainable urban mobility and to analyse how carmakers are exploring these new opportunities.

My passion and interest for the automotive industry, a genuine curiosity about the most recent innovations in the field and the willingness to solve a problem that is affecting the overall mobility of my family inspired me in working on this project.

The automobile industry is a vital sector for the European economic fabric and its ability to innovate has always affected the prestige of the Continent's manufacturing industry.

Amid the financial and economic crisis that is affecting most of the developed world, leading car manufacturers have been facing a series of challenges during the last five years. Together with the decreasing trend of new passenger cars registrations, the crude oil price increase and the more stringent European regulations in the field of sustainable mobility halted industry's performance and profit growth in the continent.

Moreover, radical transformations in the trends of passenger car ownership and use in developed economies are changing the way individuals perceive mobility. The peak car phenomenon has set in various different cities around the world and underlines that there is a clear tendency towards car abandonment due to several interrelated economic, environmental and sociological factors. Mobility demand is changing rapidly and carmakers seem to be ignoring the early signs of this change.

The combination between shrinking demand, the saturation of the market and a reduced use of the car as a mean of transportation suggest that travellers might be looking for other modes of transportation as well as different vehicles to perform their everyday movements.

The peculiar characteristics of the urban environment require a completely different type of vehicles with respect to cars. When public transport is not available, urban electric vehicles enable mobility at the lowest possible cost, especially for commuters, contributing also to preserve the quality of life related to living in city centres. More generally, the analysis conducted reveals that, as far as passenger cars are concerned, traditionally powered vehicles are losing competitors compared to natural gas powered vehicles.

The hypothesis that car demand could halt and start decreasing thereafter has never been taken into consideration. The project unveils that, not only the demand has peaked and the market reached saturation, but also that the car as a product might have entered a phase of long-term decline that leaves room for the development of alternative modes of transportation.

This dissertation is structured as follows: in the first chapter an overview of the European automotive industry will be given, considering both production and registrations with a brief focus on the Italian market; chapter two investigates the "peak car" phenomenon going through the most important academic contributions on the subject and verifies whether the phenomenon characterizes also the Italian mobility; the third chapter aims at analysing the operating costs of various modes of transportation in order to link different means with different commuting profiles and suggests a way for rethink urban mobility. The conclusion suggests one possible course of action for carmakers on how to exploit the new opportunities in the field of sustainable urban mobility.

CHAPTER 1 - AUTOMOTIVE MARKET OVERVIEW

The Automobile Industry is one of the most important sector of the European economic environment. According to the data provided by the European Automobile Manufacturers Association (ACEA), Europe is one of the world's largest vehicle producer with an output of over 16 million passenger cars, vans, trucks and buses, averaging 20% of the world vehicle production. Exceptional records can also be found in other key figures: employment of over 2.2 million people as for the direct manufacture of motor vehicles and other 10.7 million indirectly related to manufacturing; largest private investor in R&D in Europe with over € 32.3 billion spent in 2012; highly innovative sector with a total of 9,541 filed patents in 2012, 55.6% of the entire patent application for the automotive sector in the world; promoting and sustaining the economic fabric of the continent through the Made in Europe; positive trade balance of € 91.9 billion in 2012; highest standards of sustainable mobility[1].

Despite the strength of the industry and its ability to innovate, the European automobile market has been facing a series of challenges during the last five years. From the second half of 2008 the banking crisis stalled economies: consumers and business have had hard access to credit, and especially for private individuals, the situation led to many difficulties in buying durable goods. As reported by the ACEA sales of all types of vehicles fell of around 20% at the end of 2008: in the next years, the industry continued to face a very sharp downturn that is driving the market far away from the exceptional records of 2007.

The financial and economic crisis of 2008 is definitely one of the causes that jeopardized the results of the automotive industry, but it does not explain the

[1] Source: ACEA, VDA, AAA, EUROSTAT.

whole picture. Other reasons for the under-performance may reside on the policies that most of the European countries have been implementing in the last years, for example promoting the use of public transports in order to decongest big metropolitan areas, as well as other issues like fuel cost, insurance cost, saturation of the market and social media.

In this chapter will be given a comprehensive view of the historical performance of the market as well as an analysis of the main drivers that may have affected production and sales of motor vehicles.

1.1 European Automotive Market

1.1.1 Production

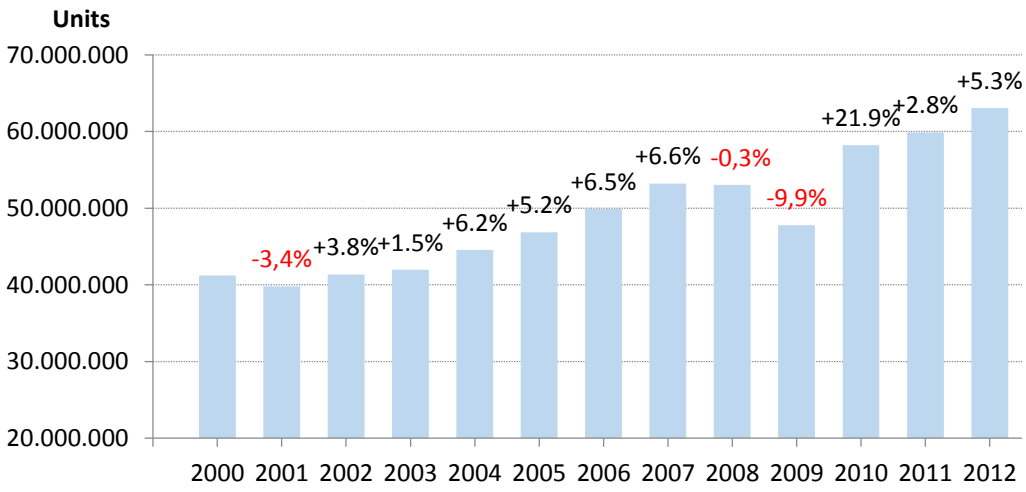
According to the data provided by the International Organization of Motor Vehicle Manufacturers (OICA), Europe has produced in the last decade one-third of the worldwide output of passenger car; however, in the years Brazil, Russia, India and China have taken the lead of the market gaining almost 40% market share, manufacturing more than 23.4 million vehicles in 2012[2].

As far as production of passenger cars is concerned, China and Europe together produce almost half of the entire world's output, while Canada, U.S. and Mexico are still leading the commercial vehicles production.

Among the BRIC economies, China is driving the world's car production towards a period of growth, partially due but not limited to its economic development. In 2011, China's passenger car production has exceeded the European one for the first time in history with an output of nearly 16 million units.

[2] OICA – 2000-2013; ACEA – The automobile pocket guide 2013

Graph 1: Passenger Car Production in the World| 2000-2012 Trend

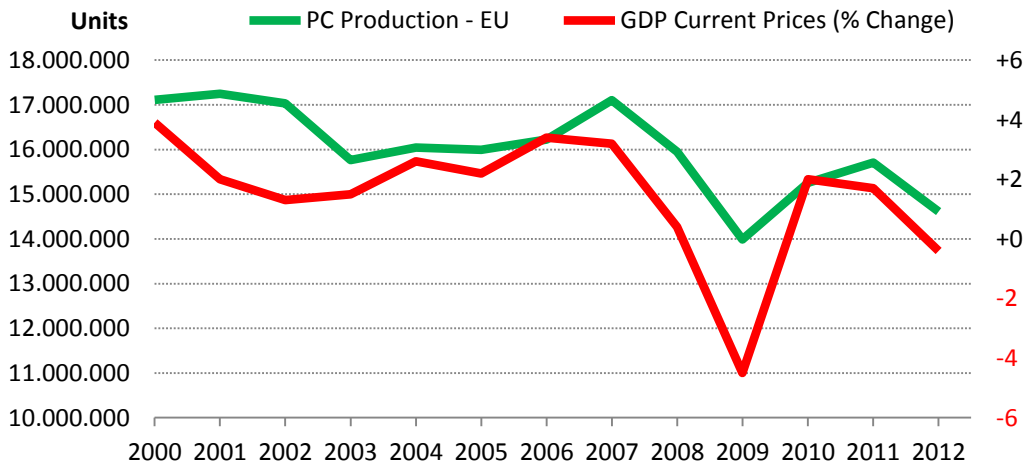


SOURCE : ACEA – 2013; OICA – 2013

On the commercial vehicle side, after two years of decline, the worldwide production trend shows a stable growth in the last 3 years, with a clear predominance of the USA as the main producer, followed by China and Europe.

Contrary to the world's performance, European passenger car production is facing a downward sloping trend.

Graph 2: Passenger Car Production in the EU and GDP | 2000-2012

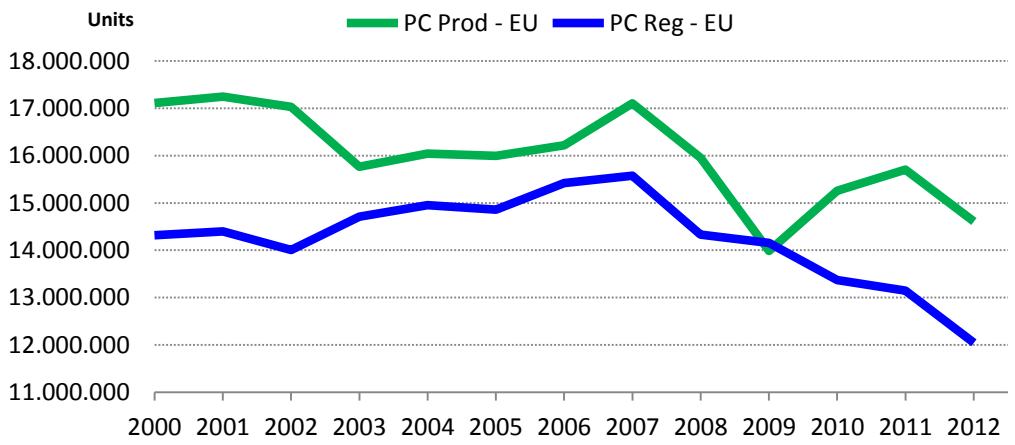


SOURCE : Eurostat – 2013; ACEA – 2013; OICA – 2013

As already said the European automobile market has recently been challenged by the financial and economic crisis started in 2008. Form the graph above it is possible to understand the influence of the Gross Domestic Product trend on production of passenger cars. Car production crashed with a strong level of synchronization with GDP mainly due to concerns about the strength of the European financial system, the collapse in consumer and business confidence, and the impossibility of banks and financial institutions to fulfil the credit needs of potential buyers. Car manufacturers, unable to react in time, started building up inventory and by early 2009, were forced to deeply cut vehicle production, shut down plants and make extensive layoffs.

Passenger car production has declined over the last 5 years, especially between 2007 and 2009, with an overall -15% from the year 2000. Even though production shows a certain level of synchronization with passenger car registration, data do not support a very strong statistical relation.

Graph 3: Passenger Car Production and New Registrations in the EU| 2000-2012



SOURCE : ACEA – 2013; OICA – 2013

With an output of 14.6 million passenger cars, production is not equally distributed amongst all the European members. Germany, France, Spain,

United Kingdom and Czech Republic produce more than 77% of the Continent's passenger cars output across 138 plants.

Table 1: Europe Top 5 Producers

2012	PC Production	Plants	PCP/Plant
Germany	**5,388,456**	**46**	117,140
France	1,682,814	36	46,745
Spain	1,539,680	15	102,645
UK	1,464,906	30	48,830
Czech Republic	1,171,774	11	**106,525**

SOURCE : ACEA – 2013

Since the 1960s Germany is the undisputed leader in Europe, especially thanks to the five big companies (Volkswagen AG, BMW AG, Daimler AG, Adam Opel AG, Ford-Werke GmbH) that dominate the automotive industry in the country, producing more cars than France, Spain and UK combined with an average of nearly 120,000 units per production/assembly plant in the territory.

Czech Republic, which between 2001 and 2005 has produced around 450,000 vehicles per year and from 2006 experienced a sharp growth mostly due to the arrival of new automobile production plants (TCPA in Kolin and Hyundai in Nošovice) and the implementation of the already existing ones (Škoda Auto), distinguishes itself for the second highest output-per-plant among the top five European auto producers. Škoda Auto produced in 2012 nearly 56% of the total output, coming before Hyundai (24%) and TCPA (20%)[3].

These figures underline a much broader trend that Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia have been gaining importance in the

[3] EU Office ČS, OICA – 2012, ACEA – 2013

European car production industry. Data show that in the last decade an increasing share of all the EU27 output has been manufactured in Eastern Europe: in 2000, these countries were producing around 8% of the overall output and in the last 5 years almost doubled the units produced. To stress even further the importance of these new players in the automobile production industry, Slovakia and Czech Republic are the top-two European countries as for motor vehicle produced per 1,000 inhabitants, respectively 167 and 112, compared to an EU average of 35[4].

Regardless of the location, number and output of plants across Europe, car manufacturers have been more and more concerned about their ability to drive a sustainable mobility. Sustainability continues to be an important issue for the European automotive industry motivating more significant efforts to reduce the overall environmental impact of vehicles, in order to ensure the automobile as a product is an environmentally sustainable one. To pursue this policy, manufacturers had to intervene on the whole production process, including original equipment manufacturers (OEMs), as well as on the product itself, coming up with more efficient processes to minimize the environmental impact and preserve scarce resources.

With the idea of being eco-friendly in mind, European producers have been implementing cleaner processes, diminishing the quantities of energy and water used to manufacture a vehicle, lowering also CO_2 emissions, scrap material and waste produced in the course.

Long-term strategies to reduce water consumption, together with application of re-circulation processes, led to a very sharp decline in the water consumption: between 2005 and 2012, the water per unit produced and the total water used went down respectively by 28.5% and 35.3%.

[4] ACEA – The automobile pocket guide 2013

Despite the presence of numerous features that increase the complexity of the production processes with negative effects on energy demand, OEMs and manufacturers are constantly working in developing new ways to improve energy efficiency. Because of the commitments taken in the last years, total energy consumption decreased by 10.7%, whereas the energy per unit produced fell by only 1.3%. These results, even if still positive, have to be analyzed bearing in mind that part of the total energy decrease as well as the energy per unit produced, were affected by lower volumes in production in certain years and weather conditions. Total and per vehicle CO_2 emission in the same period dropped respectively by 10 and 19% proving the industry's effort to drive automobile production through a more sustainable future[5].

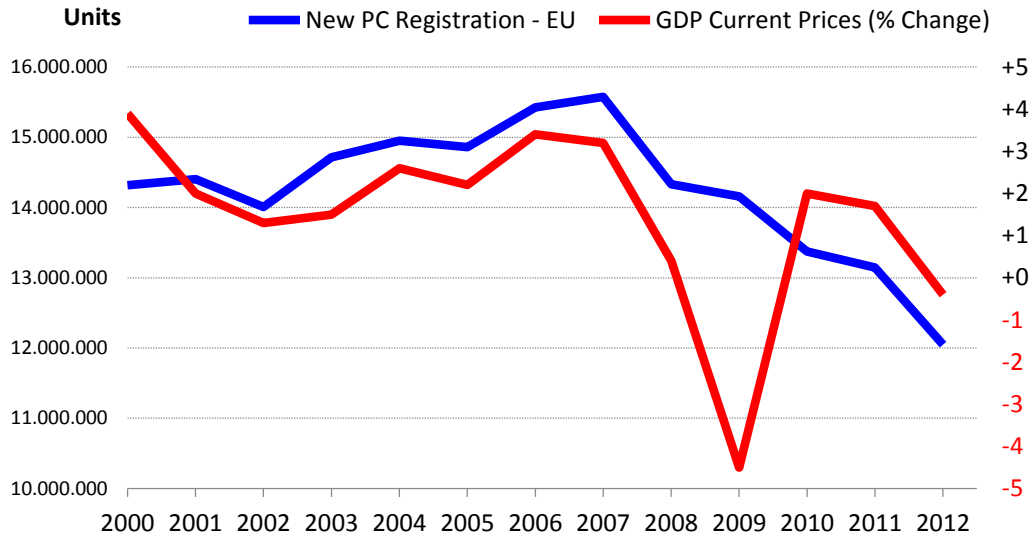
1.1.2 Registrations

Worldwide in 2012 were registered over 69 million passenger cars, +5.6% with respect to 2011. Asia (including mainly China, India, Japan and South Korea) accounted for a 35% market share, followed by America (NAFTA + MERCOSUR) 31.2% and Europe (EU, EFTA, Russia, Turkey and Ukraine) with 23.5% share.

Asia and America represent two very strong markets that grew respectively by 12.9% and 10.4% with respect to 2011. On its side, Europe with over 16 million passenger cars registered, is facing a negative trend with a -4.6% year-over-year. However, Russia is experiencing a very positive trend (+10.6%), whereas the EU is facing a negative period with over 20% decrease in 5 years.

[5] ACEA – The automobile pocket guide 2013, Society of Motor Manufacturers and Traders (SMMT)

Graph 4: New Passenger Car Registrations in the EU and GDP | 2000-2012



SOURCE : Eurostat – 2013; ACEA – 2013

As for production, also new passenger car registrations show a strong relation with European economic growth. Together with the economic performance of the Continent, other factors may be influencing the development of car sales: unemployment rate could be a predictive variable given that it includes both the ability to spend of individuals and mobility needs; crude oil price can potentially show a higher correlation with new passenger car registration influencing significantly running costs.

According to the annually data (2000-2012) gather to perform a statistical analysis, both hypothesis listed above are true. The linear model built on the idea that passenger car registration may be influenced by unemployment rate and the crude oil price shows statistically significant results.

```
Passenger Car Registration
Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)      21562771    1622882  13.287 1.11e-07 ***
CrudeOilPrice      -15396       5960  -2.583  0.02727 *
UnemploymentRate  -711532     178475  -3.987  0.00257 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '
' 1

Residual standard error: 577400 on 10 degrees of freedom
Multiple R-squared:  0.7011, Adjusted R-squared:  0.6413
F-statistic: 11.73 on 2 and 10 DF,  p-value: 0.002385
```

The two independent variables appear to be significant and the overall coefficient of determination (Multiple R-squared) indicates that current data predict with a 70.1% accuracy future outcomes and that the hypothesis that passenger car registration may be influenced by the two figures is verified with the same level of accuracy. Furthermore, the p-value shows a very low value indicating that the observation is highly unlikely to be the result of random chance alone, hence supporting the goodness of the model proposed.

By looking closer at consumer demand, it appears clear that the European market is also facing a series of changes. Small and medium segment cars (A+B+C) represent almost 60% of the entire demand, although lower-medium segment (C) experienced a sharp decline over the last 10 years. SUVs and MPVs (which in the last years included also Crossover SUVs) represent 25% market share, underlying the increasing tendency of customers to prefer multi-purpose vehicles able to fulfil different needs. Average engine displacement is around 1,600 cm^3 (decreasing since 2007) with an average power of 89kw/120 Hp (increasing since 1990).

The sustainability needs faced by the producers are also shared by consumers: demand for passenger cars have experienced a clear trend towards fuel efficiency. The demand for vehicles with emissions lower than 120g CO_2/km

is almost tripled in the last 5 years (+6.8% change 12/11), so that almost 40% of the new cars registered is polluting less than this threshold. These results, however are somewhat affected by different factors: recent European policies (Euro 3-4-5 emission standards) induced producers to respect limitations hence making previous technologies obsolete; incentives for low-emission vehicles have stimulated the demand in the last years; availability of technology gives the possibility to every consumer to buy technologies that before were reserved only to high-end customers; loopholes in the major EU tests allow car manufacturers to positively influence test results so, officially, tested cars are more efficient.

This drive towards fuel efficiency is also reflected by the increased diesel penetration in the European area. Over 50% of the new cars have diesel engines even though between 2010 and 2012 diesel powered cars represented just over 35% of the entire car fleet. Diesel penetration is the highest in Luxembourg and Ireland (respectively 76% and 73%) and lowest in Finland and the Netherlands (38% and 28%).

The amount of fuel that a internal combustion engine consumes per unit of distance, is directly related to the thermodynamic efficiency of the heat engine and other factors such as friction between the parts of the transmission system, rolling friction between the wheels and the road, presence of other internal forces (i.e. the air conditioning) as well as aerodynamic drag and mass of the vehicle. Concentrating on the engine, by virtue of the combustion process and overall engine concept, a diesel engine is from 20 to 40% more efficient than a spark-ignited petrol engine having the same power output. This is because diesel engines use the heat of compression to initiate ignition and burn the fuel in the combustion chamber, in contrast to petrol engines that use a spark plug to ignite an air-fuel mixture. Diesel engines have a higher compression ratio (usually between

15:1 and 22:1) resulting in 580 PSI pressure compared to around 200 PSI of petrol engines. Although higher compression ratios are helpful in raising efficiency also at low power or during idle time, they also create a greater amount of torque force acting on the crankshaft: heavier and stronger parts are required to resist to higher pressures and forces, leading to a poorer power-to-weight ratio than gasoline engines[6].

During the past few years, the whole concept of the diesel engine has been questioned and all car manufacturers have been trying to reduce engine's weight in order to further improve energy efficiency and polluting emissions. Above all, Mazda launched in 2012 a reinvented diesel engine using a surprisingly low compression ratio (14:1) rather than the more usual 16:1 or higher. Reduction in cylinder pressure gives different positive effects that were unavailable before: the cast-iron block can be replaced with a lighter aluminium casting, piston, rings and crankshaft can be made lighter as well as all the suspensions, brakes, chassis and bodywork. Reducing considerably the car's weight will improve energy efficiency and emission[7].

As it usually happens with new technologies, Mazda's new diesel engine presents some drawbacks (lower power, low reliability and reduced life cycle), but the company proved that there is still high room for improvement for high-efficiency diesel engines.

Even if diesel penetration for new cars in the EU is at its maximum since 1990, the trend might be changing again. Some automotive industry players, while working on improving diesel engines, at the same time are rethinking petrol ones. Ford Motor Company recently introduced the 1.0 litre 3-cylinder EcoBoost turbocharged direct injected petrol engine producing 99hp or

[6] I.e.: Volkswagen model Golf: 1.2 TSI Petrol – 105Hp (77kw) – 85Hp/Ton; 1.6 TDI diesel common rail – 105Hp (77Kw) – 79Hp/ton.
[7] "The Rebirth of the Diesel Engine" – The Economist, September 7th 2013.

123hp, part of a family that aims at achieving approximately 20% better fuel efficiency and 15% reduced green house emissions compared to natural aspirated engines. Ford was able to extract so much power out of such a small engine (the three cylinder block can fit onto an A4 sheet of paper) thanks to improved camshaft design and an exhaust manifold cast in the cylinder head; while other EcoBoost offerings start with an aluminium block, the 1.0 litre has an iron engine block which is cheaper to manufacture and it reduces the engine warm-up time by 50%. The necessary torque is provided by a turbocharger that can spin at up to 248,000 rpm. This engine delivers class leading petrol engine CO_2 emissions of 114g/km and 5.0l/100km fuel economy even though it has been proven that the 123hp version can consume down to 3.3l/100km[8] [9].

In 2012 the market leader was Volkswagen Group (Audi, Seat, Skoda, Volkswagen) which sold more than 3 million passenger cars (24.5% market share), followed by PSA (Citroen, Peugeot) with 1.4 million (11.7%) and Renault (Dacia, Renault) with 1 million (8.4%).

1.1.3 Vehicles in Use

Cars in the EU are on average 8 years and 4 months old but the average passenger car age varies country by country. In Estonia, Finland and Slovakia cars are around 12 years old, whereas other countries such as Ireland show considerably lower records. According to available data dating back to 2010, passenger cars are equally distributed between the three classes of age: 35.6% are more than 10 y.o., 32.1% between 5 and 10, 32.2% less than five. Data do not take into account recent economic developments in the Euro area so they have to be read carefully: many auto industry associations that are

[8] http://1l-ecoboost.fordmedia.eu/documents/factsheets/FS_Ford1.0-litreEcoBoostEngine_EU.pdf
[9] http://www.quattroruote.it/notizie/eventi/ford-focus-10-ecoboost-oltre-1600-chilometri-con-un-pieno

collaborating with research centres in the field, have recently reported that car age in some European countries is rising amid Europe's sovereign debt crisis[10]. Despite there is evident insecurity because of the ongoing euro crisis, it is believed that those customers that are not buying cars in this period, have not all switched to public transportation or car-sharing offers, they are delaying the purchase because of the current economic situation [11].

This may be the case considering other data and features: the European car fleet has been growing since 1990 although between 2010 and 2011 growth has slowed considerably. Europe has the largest car fleet in the world with 242.2 million passenger cars, followed by USA (130.7 millions) and Japan (57.7). Three quarters of the EU car fleet is registered between Germany, Italy, France, UK, Spain and Poland. On average Europe has 483 cars per 1,000 inhabitants, the highest density in the world: Luxembourg and Italy detain the highest car density (658 and 606), Hungary and Romania the lowest (298 and 203).

1.1.4 Trade

Production has always exceeded registration (with the exception of year 2009, recalling the excess of inventory in that year mentioned earlier) and this is a very strong indicator that Europe had, and still has, an important role in the worldwide car production. In order to overcome the deep crisis that is affecting the internal market, European car manufacturers are increasingly relying on the international arena to be profitable: in fact, the EU automotive industry is a formidable exporter all over the world, but mainly to Asia and Oceania (34%), NAFTA (26.8%) and EFTA and Eastern Europe (25.1%)[12].

[10] Verband der Automobilindustrie (VDA), Confederazione Nazionale dell'Artigianato e della Piccola e Media Impresa (CNA).
[11] VDA President Matthias Wissmann during a press conference in Berlin, July 2, 2013.
[12] Based on EUROSTAT 2012 data – Exports in value

In 2012, European trade balance of motor vehicles was positive considering both value and units.

Table 2: Trade in Volume - Million Euros

	YEAR 2011			YEAR 2012			% CHANGE 12/11		
TRADE IN VOLUME (€m)	IMPORTS	EXPORTS	TRADE BALANCE	IMPORTS	EXPORTS	TRADE BALANCE	IMPORTS	EXPORTS	TRADE BALANCE
Passenger Cars	24,273	93,606	69,333	23,670	107,887	84,217	-2.5%	15.3%	21.5%
Commercial Vehicles (up to 5t)	3,913	3,780	- 133	3,388	4,663	1,275	-13.4%	23.4%	++
Commercial Vehicles (over 5t) + Buses and Coaches	843	6,369	5,526	819	7,216	6,397	-2.8%	13.3%	15.8%
TOTAL	**29,029**	**103,755**	**74,726**	**27,877**	**119,766**	**91,889**	**-4.0%**	**15.4%**	**23.0%**

Table 3: Trade in Volume - Units

	YEAR 2011		YEAR 2012		% CHANGE 12/11	
TRADE IN VOLUME (in units)	IMPORTS	EXPORTS	IMPORTS	EXPORTS	IMPORTS	EXPORTS
Passenger Cars	2,176,517	5,153,725	1,932,420	5,914,655	-11.2%	14.8%
Commercial Vehicles (up to 5t)	326,756	362,268	269,972	428,402	-17.4%	18.3%
Commercial Vehicles (over 5t) + Buses and Coaches	24,573	856,242	92,838	245,186	277.8%	-71.4%
TOTAL	**2,527,846**	**6,372,235**	**2,295,230**	**6,588,243**	**-9.2%**	**3.4%**

SOURCE : Eurostat – 2013; ACEA – 2013

The U.S.A. represents the main destination of European passenger cars shipments, importing 23.2% in value and 13.4% in volume, followed closely by Russia and China. Both BRIC economies have grown very fast in the last years: China continuous growth led to a steep raise in imported units, scoring a +100% year-over-year increase in 2010, +39.2% in 2011 and +9.8% in 2012 ; Russia recorded a slower growth rate between 2009 and 2010 (+69.2%), caught up in 2011 with a +59% over the previous year and +47.9% in 2012[13].

The European automotive industry has always been in favour of further trade liberalization since trade agreements foster innovation, growth and prosperity for both parties. Accordingly, "the [European] Automotive industry is in favour of multilateral trade frameworks in the context of the WTO and supports the conclusion of the Doha Development Round,

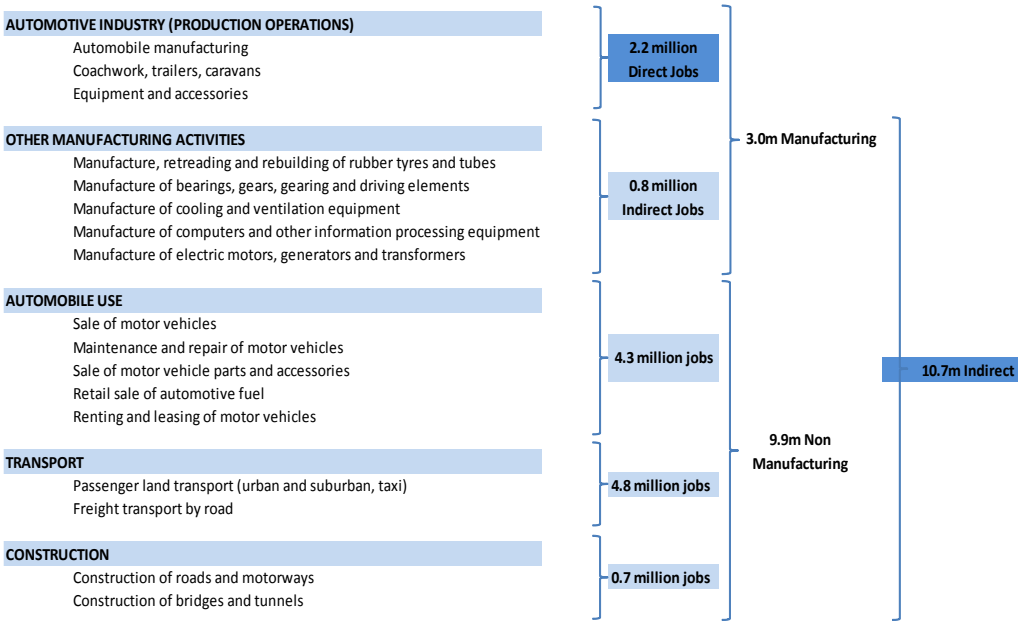
[13] ACEA – The automobile pocket guide 2013

provided that changes are introduced in the current Non-Agricultural Market Access (NAMA) text, which would offer the EU real access to the main emerging economies' markets. Further, agreements should prevent such emerging economies from using the NAMA flexibilities to shelter their industry from key EU sectors, including the automotive industry, by high tariff or non-tariff walls. For ACEA, the conclusion of the Doha Round, rather than the conclusion of a 'spaghetti bowl' of FTAs, is preferable"[14].

1.1.5 Employment

Exports and trade agreements are key to sustaining millions of jobs in the automotive industry and range of other sectors. The European automotive industry is a formidable employer: 12.9 million people work in the sector representing 5.3% of the EU employed population; among them 3 million of high-skilled workers represent 10% of the EU's manufacturing employment. The automobile sector employment is divided as follows[15].

Table 4: European Automotive Employment by Sector

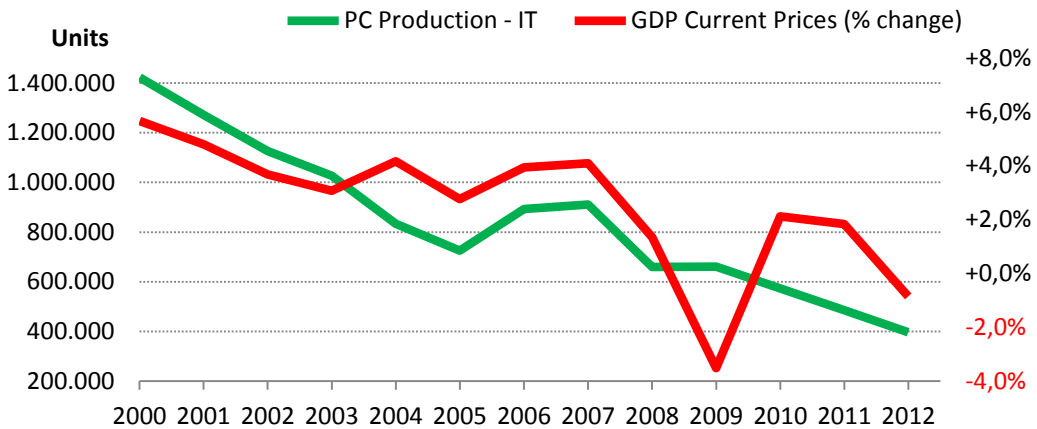


[14] International Trade: A Strategic Interest for Europe – ACEA October 10th 2011
[15] EUROSTAT most recent data – 2010

1.2 Italian Automotive Market

1.2.1 Production

Graph 5: Passenger Car Production in Italy and GDP | 2000 - 2012



SOURCE : Istat – 2013; ANFIA – 2013

According to the data provided by the Italian Association of the Automotive Industry (ANFIA), the economic crisis and the resulting drop in consumption have heavily hit production of passenger cars in Italy. Since 2007, the number of vehicles produced in Italy has declined steadily by -56% mirroring the Italian economic performance. Among the Italian manufacturers, Fiat and Lancia (FGA) were the most affected by the economic downturn, cutting production respectively by 57% and 77% in the same period.

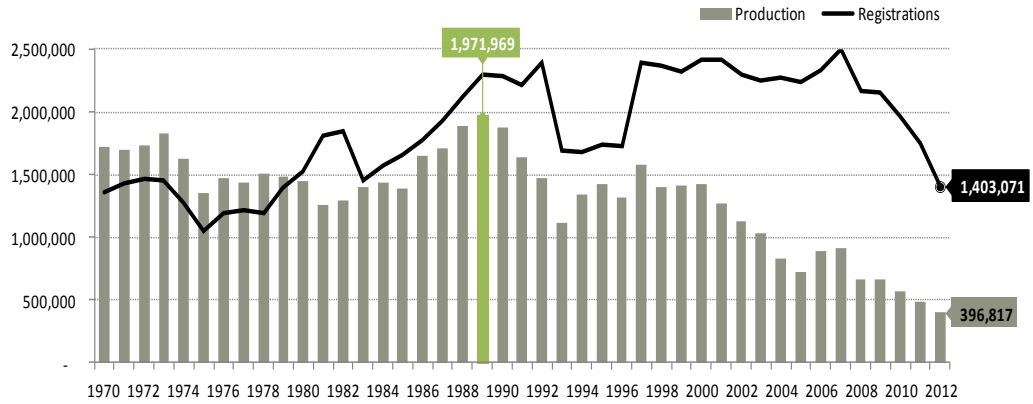
Compared to the other major European producers, Italian industrial production is following a different trend. Whereas in 2012 Germany, France, Spain and UK were able to satisfy, or almost satisfy, internal demand for passenger cars, Italy produced only 28% of the new passenger cars registered.

This is mainly because no significant foreign automotive producers are active in Italy, as a result of the country's inflexible and bureaucratic labor laws.

Fiat Group remains the only large manufacturer in Italy even though unfavorable economic conditions have given rise to uncertainty about the group's manufacturing presence in Italy.

Great part of the decline in the Italian production in the last years is attributable to the collapse of the passenger car output, which accounted in 2012 at almost 60% of the total, due to weak competitiveness and intense competition from production in low-cost countries.

Graph 6: Passenger Car Production and New Registrations in Italy | 1970-2012



SOURCE : ANFIA – 2013

FIAT as the biggest Italian passenger car manufacturer produces about two-thirds of its vehicles abroad, in China, Brazil, Turkey, Russia, Serbia, Poland and elsewhere. Furthermore, the recent integration with Chrysler increased the level of production outside Italy (Chrysler Town & Country, 300, 200 and 200 convertible are sold respectively in Italy as Lancia Voyager, Thema and Flavia), widening the gap between cars registered and produced in the country[16].

Despite the downsizing of the internal motor vehicle industry, the automotive part industry has recorded sales worth € 37.96bn in 2012 (-9% year on year).

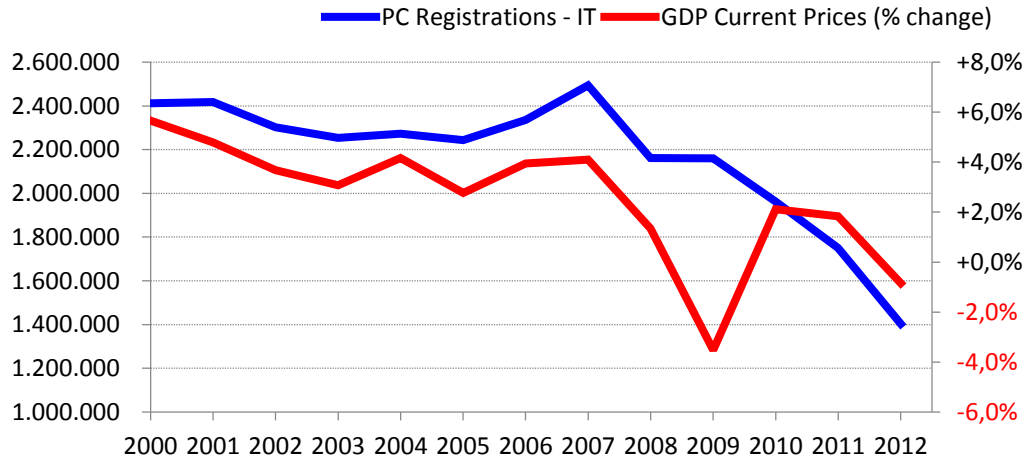
[16] *The Economist Business Unit*, Automotive industry report - Italy, December 2012

The reason for the economic performance of the component industry resides in its export-oriented perspective and also on some characteristics of the internal market: given the high density of cars per head, its relatively old car pool and the problems that private individuals have in buying a new car, Italy is a large market for, and producer of, automotive parts and services.

On the production side, positive results are coming from the high-end supercar brands: Ferrari produced 7,663 units in 2012 recording a +80% over ten years and +5% compared to 2011; Maserati produced 6,204 cars in 2012 and although performed poorly in the short term (+1% on 2011), grew by 78% in the last decade; Lamborghini despite producing just 2,197 cars in 2012 is the best performing supercar producer in Italy given the 396% increase in production over 10 years and +26% on 2011.

1.2.2 Registrations

Graph 7: New Passenger Car Registration in Italy and GDP | 2000-2012



SOURCE : Istat – 2013; ANFIA – 2013

In terms of number of vehicles sold, Italy is the fourth-largest automotive market in Europe, after Germany, UK and France, according to data from the European Automobile Manufacturers' Association (ACEA). Therefore, Italy has one of the highest levels of car ownership in the world: 606 private

cars per 1000 inhabitants, 885 considering those eligible to drive (18-70 years old).

As we can see from the graph above, since 2007 Italy has undergone a constant decline in volumes of passenger cars registrations, reaching the lowest level in 30 years at 1.4 million vehicles, -44% in 5 years with clear consequences on industrial production and employment.

Fiat-Chrysler Group[17] held around 29.6% market share in 2012 with 414,891 new registrations (-19.4% on 2011) followed by Volkswagen Group[18] (13.5% at 189,199 units) and Ford (7.1% and 99,065 cars). Other car manufacturers do not hold more than 6% of market share. Despite Fiat's predominant market position and the persistent crisis, that is affecting the Italian automobile market in the last years, Italian customers express a clear preference over foreign manufacturers that accounted for almost 70% of the market both in 2010, 2011 and 2012. Among them, while the market crashed by nearly 20% last year (for both Italian brands and foreign ones), some car producers performed countertrend: above all, Kia and Land Rover recorded a two-digit growth well above 30%.

Land Rover, which since 2008 has been wholly owned by the Indian car maker Tata Motor, has sold in 2012, 12,558 units in Italy confirming a worldwide positive trend thanks to Range Rover, Free Lander and Evoque models that have fully met consumers' needs.

Evoque for example is the first luxury compact SUV that has met demand for a very well finished and exclusive vehicle, but with dimensions and engines more appropriate at the current times. Italian customers' interest in compact SUV can be seen also in Kia performances: the south-Korean car

[17] FGA includes FIAT, Alfa Romeo, Lancia, Abarth, Chrysler, Dodge and Jeep.
[18] Volkswagen AG includes Audi, Bentley, Bugatti, Lamborghini, Seat, Škoda Auto and Volkswagen

producer closed 2012 with a positive balance in the Italian market (+39%) especially thanks to the best seller Sportage (+64% year-on-year) and the new Rio whose sales increased fourfold with respect to 2011.

The excellent records that the compact SUV segment (the one that includes for example the Toyota RAV4, Dacia Duster, BMW X1, X3 and Audi Q3) is showing in the Italian market is supported by the data provided by ANFIA and the Italian Ministry of Transport. While having a market share of just under 10%, it represents more than 60% of the entire SUV segment. Compact SUVs were the fourth most requested car types in Italy in 2012 and the only segment that is facing a positive trend over the last 3 years (+22% since 2010).

There are many reasons that are driving this positive trend: versatility makes possible to address to theses cars not only the ability to freely move around congested cities, but also to face unusual conditions such as snow-covered trails and dirty roads thanks to different kind of traction systems[19]; innovation and so the continuous arrival of new models, two-or four-wheel drive, diesel, petrol, hybrid or LPG and methane, which help to maintain customer awareness towards this kind of vehicles; flexibility which ensures the ease of driving like a sedan, MPV body boasting sporty lines; affordability attracts also those customers that before were interested in other segments, giving them a good alternative without compromising the value for money.

Another interesting factor that characterizes these compact SUVs regards the engine displacement and power: most of the models offered in the market have relatively small engines usually four or six-cylinders, diesel or petrol powered (some car manufacturers have also hybrid propulsions) delivering

[19] Many Compact SUVs have All Wheel Drive, Automatic Four-Wheel Drive, Selective 4WD but also 2WD. These systems are usually integrated with many different electronic controls to enhance safety, handling and drivability.

on average 130-150 Hp up to 250 Hp. In the recent years, compact SUVs, thanks to these characteristics, have usually taken the place of bigger SUVs since the newly introduced additional car tax is not applicable to most of the model and motorizations[20].

Dimensions, engine displacement, engine power and affordability seem to be the most common factors that are taken into account by Italian customers when buying a new passenger car. In fact, according to the Italian Ministry of Transport and Infrastructure, the top-ten models sold in Italy in 2012 are very homogeneous in their core characteristics. Top 15 bestselling models both in 2012 and in 2011 include mostly city cars and small family cars, with the exception of the Nissan Qashqai that is included in the Compact SUVs segment[21].

They have in common all the characteristics listed above: small and easy to park and drive in the Italian congested cities, small engines that range from a minimum of 800 cm^3 for the turbo diesel engine of the Smart Fortwo to a maximum of 2000 cm^3 of the Volkswagen Golf and the Nissan Qashqai, power output up to 235 Hp of the Alfa Romeo Giulietta and a price range between € 9,000 and € 20,000.

[20] According to the Art. 16, Section 1, of the Legislative Decree n. 201/2011, from 2012 onwards, owners of cars and vehicles for the transport of persons and goods with power exceeding 185Kw, must pay an additional car tax of € 20 per exceeding Kw. The tax is gradually reduced after 5 years from the construction date of the vehicle.

[21] According to ANFIA, in 2012, 49.6% of new cars belonged to A and B segments, 18.9% to C and D, 16% to SUV and 11.2% to MPV. Only 2.2% were luxury cars.

Table 5: Top 15 Bestselling Models in Italy | 2011 - 2012

MAKE/MODEL	2012	MAKE/MODEL	2011
Fiat Panda	117,784	Fiat Punto	122,010
Fiat Punto	79,724	Fiat Panda	115,616
Lancia Ypsilon	44,422	Ford Fiesta	65,070
Fiat 500	43,000	Fiat 500	60,029
Ford Fiesta	41,743	Lancia Ypsilon	54,824
VW Golf	32,523	VW Golf	46,168
VW Polo	31,847	VW Polo	45,276
Alfa Romeo Giulietta	29,875	Opel Corsa	40,674
Citröen C3	29,452	Alfa Romeo Giulietta	34,967
Toyota Yaris	28,095	Citröen C3	34,124
Opel Corsa	25,442	Opel Astra	30,705
Renault Clio	23,830	Nissan Qashqai	29,222
Nissan Qashqai	23,342	Renault Clio	28,635
Smart Fortwo	21,480	Toyota Yaris	28,086
Peugeot 208	19,262	Ford Focus	27,025

SOURCE : Processed data based on ANFIA and Italian Ministry of Transport – 2013

In particular, 46% of the new cars registered in 2012 have an engine displacement between 1101-1400 cm^3 of which 51% are petrol-powered, 26% diesel, 16% LPG and 7% compressed natural gas (CNG). Passenger cars with engine volume between 1401-1600 cm^3 represent 21% market share of which 81% have diesel engines, 11% petrol, 5.6% LPG, 1.2% CNG and the remaining 1.2% have hybrid solutions. Vehicles with engine displacement between 1601-2000 cm^3 represent the 19% of the market of which 94% is diesel powered. Finally, 8% of the new passenger cars have engine displacement up to 1100 cm^3 and 87% of which are petrol powered, 9% have alternative motorizations and 4% have diesel engines.

Despite diesel powered vehicles represented both in 2011 and in 2012 more than 50% of the market, the increase in fuel prices (petrol and diesel included) and the generalized fall in consumption pushed consumers towards

alternative motorizations: sales of these vehicles increased in terms of market share from 5.6% in 2011 to 13.5% in 2012 at 188,963 units.

In particular, LPG and CNG powered cars obtained a market share of 9.1% and 3.8%, respectively. Methane-powered cars could have had a higher market share but they have been penalized, if compared to LPG ones, by a poor filling stations network geographically concentrated in the centre of Italy[22].

Consistently with what said so far, and in line with the European perspective and the brief analysis of the benefits provided by the use of new efficient engines, the average CO_2 emissions that can be attributed to new passenger car registered in Italy in 2012 (126.2 g CO_2/Km), were classified among the lowest in the European Union, already below the limits set by the European Commission for 2015[23]. France and Italy recorded the lowest average emissions in Europe, followed by Spain and UK. Different factors influenced the result: among them, the car weight (Italy ranks fourth with its value of 1311 Kg), the engine capacity (Italy ranks second with 77 kW, namely 103 Hp), the distribution of LPG and CNG powered cars on the territory.

In 2012, in line with the Italian economic performance, new passenger car registration to private individuals decreased in terms of both volume and share. Private owners registered 894,245 new vehicles (63% of the market), a -22.8% change with respect to 2011 in terms of volume and a -3% in terms of market share. In addition, the business sector (which includes company cars, taxis, car rent and public agencies) underperformed compared to 2011 with a decrease in volume of almost 14%. This drop in consumption, especially for business customers, is to be attributed mainly to the negative

[22] The Italian automotive industry 2003-2012 – ANFIA 2013

[23] The European Commission has set the average target for all new cars to 130g CO_2/Km by 2015 and a further improvement to 95g/Km by 2020.
http://ec.europa.eu/clima/policies/transport/vehicles/cars/

effect of taxation: tax deduction for businesses and self-employed workers (excluding agents and sales representatives) was reduced in few months from 40% to 20% (by the "Fornero Law" and afterwards by "2013 Stability Law"), whereas within EU Members deduction can go up to 100%. Furthermore, the tax deduction threshold for those cars used by companies and professionals date back to 1997 and they have never been updated according to ISTAT indexes. VAT is deductible but just only by 40%, while in the major EU countries VAT tax deduction can reach 100%. For these reasons, the share of company cars on the market is lower than in France, Germany, UK and Spain.

For reasons attributable to tax related advantages, in 2012 new registrations increased in the Italian autonomous regions (Valle d'Aosta and Trentino Alto Adige). These regions could decide, based on their local statute, to adopt or not the obligations imposed by the IPT increase (provincial transcription tax) established by the Law No. 148/2011 and effective from September 17th 2011.

Table 6: New Passenger Car Registrations per Region, Top 7 | 2012

Region	Nr. PC	% Share
Lombardia	249,828	17.8%
Trentino A. Adige	171,715	12.2%
Piemonte	148,388	10.6%
Lazio	135,509	9.7%
Emilia Romagna	114,399	8.2%
Veneto	107,215	7.6%
Toscana	105,399	7.5%

Lombardy has the highest number of passenger car registrations in Italy for many reasons: first, it is the most populous region hosting 9.8 million residents and so more potential buyers; it has an high business density with very big companies and numerous corporate fleets; Milan is home of one of the biggest airports in Italy and so there is an high presence of car rental companies.

The North of Italy accounts for almost 63% of all the new registered cars (33.1% North-West, 29.8% Northeast), 20.8% in the Centre, 10.7% South and 5.6% in the islands.

1.2.3 Vehicles in Use

The reduction in sales volumes and the rising taxation and fuel costs, has led to a steady decrease in the replacement rate of cars (from 6.3 % in 2007 to 3.9% in 2012), leading to a progressive aging of the Italian car fleet. In 2012, for the first time in the recent automotive industry history, the number of vehicle in use fell to 37,078,274 (around 35,000 cars less than 2011). This turnaround, not worrying in itself, was followed by the failure to replace scrapped or dismissed cars, resulting in an overall aging of the fleet. The average lifespan of a car has been increasing due to the refusal or postponement of the purchase or replacement of the car by choice or necessity. A more moderate use of the car (decrease in average distance travelled) resulted in a longer car's life since the engine and other components are subject to less wear.

During the years 2000, 2001 and 2002 a total of over 7.1 million cars were registered in Italy, therefore those vehicles are now 11-13 years old and may be replaced in the short-term. On top of all, a progressive aging of the overall fleet has negative consequences on the environment and road safety: in the last 10 years has been put a great effort on innovation in these fields, driving down emissions, and increasing active and passive automobile safety. 2000s cars now have obsolete technology as regards environmental protection and safety.

To worsen the decreased in average distance travelled and progressive aging of the fleet, there is an high overall tax burden and in particular on vehicles, which heavily influences the consumers' spending power both in terms of car purchase and maintenance. Furthermore, the offer proposed by public

transport is not able to satisfy, evenly in the whole Italian territory, both the demand and the quality of service. At the end of 2012 the bus fleet, according to ACI, decreased by 0.9% (901 vehicles less than in 2011). New registrations have been just 2,131 (down 30%), resulting in an overall aging of the fleet in 2012.

As said, the average age of Italian passenger cars has been increasing between 2011 and 2012 but it is different depending on the type of fuel that powers the vehicle: petrol cars are on average 11 years and 7 months old, diesel 7 years, petrol/LPG and petrol/CNG 4 years and 10 months old. In 2005 cars in use older than 10 years represented 34.5% of the entire fleet, in 2012 they increased to 44.4%. Passenger cars with more than 20 years represent 12.2% of the 2012 fleet when in 2005 they were around 7.5%.

The percentage of petrol powered cars decreased over the last decade so that in 2012, 53.2% of passenger cars registered had petrol engines (in 2000 they represented 80.4% of the fleet), 39.8% diesel engines (14.7% in 2000), 5% petrol/LPG and the remaining 2% petrol/CNG. More than half of both petrol/LPG/CNG cars are registered within the Northern Italian regions.

Automotive fulfils almost all of the mobility demand of our country (around 80%). Italians prefer to move by car, however, some consensus is being lost due to several factors like:

- fuel costs
- the financial crisis and credit crunch
- decline in the households' purchasing power
- steady growth in cars' usage costs (insurance premiums, highways' tolls, parking, etc.)

- heavy taxation on cars (road tax, additional road tax, provincial transcription tax, VAT, excise duties on fuels, various taxes on motorization, etc).

As a result, mobility by foot and bicycle increased over the years as well as public transport usage, especially in large cities. Residents in metropolitan areas express interest and openness to sustainable and inter-modal mobility, solutions that seem to be one of the most dynamic and growing, to meet the entire urban mobility demand.

1.2.4 Taxation on Automotive Sector

Considering the influence that the fiscal burden has on purchase, registration, transfer of ownership, maintenance and running costs of passenger cars, it is worth to have a brief look at the fiscal taxation items as elaborated by ANFIA on data gathered by different Italian institutions. Taxes on automotive sector in 2012 amounted to € 72.73 billion, an increase of 3.8% compared to 2011, the year in which they had already exceeded € 70 billion (+4.8% on 2010). Due to a more modest growth of total national tax revenues in the same years (+1.7% in 2011 and +2.6% in 2012), the percentage represented by the tax burden on the industry increased, from 16.3% in 2010, to 16.8% in 2011, reaching 17% in 2012.

According to the different tax items of the life-cycle contribution of cars, the highest share of tax burden arises from the vehicles use during the year (items nr. 1+2+4+5+8+9), equal to 81,8% of the total revenue for a value of € 59.5 billion, an increase of 6% compared to 2011.

Table 7: Tax Revenues from the Automotive Sector | 2008 - 2012

Fiscal taxation items *Values in billion Euro*	**2008**	**2009**	**2010**	**2011**	**2012**	***Var.% 09/08***	***Var.% 10/09***	***Var.% 11/10***	***Var.% 12/11***
1. *Fuels*	32.59	30.03	30.34	33.26	37.37	-7.9	1.0	9.6	12.4
2. *Lubricants*	0.95	0.88	0.93	0.95	0.89	-7.7	5.8	1.9	-5.7
3. VAT on *Vehicles Purchase - Duties to the Office of Motorvehicles*	7.86	8.30	7.50	6.75	5.50	-9.6	-9.6	-9.6	-9.6
4. VAT on *Vehicles Maintenance and Repairing/Purchase of Spare Parts, Accessories, Tyres*	10.60	10.26	10.60	10.35	9.30	-3.2	3.3	-2.4	-10.1
5. *Motorway tolls*	1.25	1.27	1.42	1.78	1.73	1.3	12.3	24.9	-2.7
6. *Registrations / Transfer acts*	1.23	1.18	1.14	1.21	1.37	-4.5	-2.8	6.2	12.8
7. *Vehicles ownership/ Road Tax*	5.78	5.67	5.80	5.92	6.35	-2.0	2.4	2.1	7.2
8. *Insurance premiums (civil liability, coverage against fire and theft)*	4.23	4.10	4.09	4.48	4.62	-3.0	-0.3	9.5	3.1
9. *Others (Parking fees, Fines, etc.*	4.60	4.65	5.00	5.35	5.60	1.1	7.5	7.0	4.7
Total	**69.09**	**66.32**	**66.83**	**70.05**	**72.73**	**-4.0**	**0.8**	**4.8**	**3.8**

SOURCE : Processed data based on ANFIA, ACI, AISCAT, ANIA, AUTOPROMOTEC, FEDERPNEUS, ISTAT, MEF, MiSE, MiT, UP and other Italian sector institutions' data.

A dynamic that largely derives from the increase in fuel prices – double digits for petrol and diesel despite significant decrease in consumption (-10.7% for petrol and -10.4% for diesel) – which were particularly affected by several increases of excise duties and one percentage point rise in the VAT rate (the tax component of gasoline and diesel prices amount to 59 and 54% respectively).

Concerning the ownership of a passenger car, as evidenced by the data, it is clear that the tax revenues earned from the additional road tax introduced in 2011, not only were lower than expected[24], but also there was an overall revenue loss of € 140 million. The loss is divided as follows: € 93m lost VAT revenues, € 13m lost additional road tax revenues, € 19.8m of lost standard road tax, € 5.2m loss on IPT and around € 9m loss on the surtax on automobile liability insurance (RC Auto).

[24] According to what claimed by the Italian Government the measure should have taken €168 million additional revenues to the Italian Treasury.

A series of unforeseen and counterproductive phenomena caused this damage to the tax authorities:

- the reduction in new registrations of cars with power exceeding 185 kW (-35% in 2012, compared to -19.8% of the market as a whole);
- proliferation of "fake leasing" of cars with German or Czech license plate issued by commercial entities and used by Italian customers (without paying VAT, normal and additional road tax, IPT, fines, surtax on automobile liability insurance, and also the impossibility of impounding cars registered abroad, the possibility of avoiding "redditometro"[25], the difficulties in carrying out roadside checks and identify responsibility in case of accidents).
- vehicles' relocation abroad, cancelled for being exported to EU countries, but that continue to circulate throughout the country with German, Austrian, Bulgarian or Romanian license plate with the consequences described above.
- collapse of transfers of ownership for vehicles with power rating above 185 kW, -37% in 2012 compared to 2011.

Finally, as concerns the tax earning regarding the purchase of the vehicle, payment of VAT and IPT, equals 6.87 billion euro or 9.4% of the total. This item has faced a decline of 13.7% with respect to 2011, largely due to the sharp decrease in new car registrations in 2012 (-19.8%) - which followed the already important reduction of 2011 (-10.8%) - and the significant decline in the second-hand car market (-10.6%).

[25] The Italian for income tax assessment instrument. In short, this tool gives the possibility to tax authorities to indirectly determine a taxpayer's total income, based on the spending power of the same.

1.2.5 Trade

The automotive industry export (automobiles, car bodies and automotive components) totalled more than € 29.6 billion (down 1.7% compared to 2011) and import for € 28.5 billion (-21.9% on 2011), generating a positive trade balance of 1.17 billion Euro. This result was influenced by several factors. The decline of the domestic market for passenger cars has affected the contraction of import[26]; as a positive entity for the balance of trade, the excellent results of the components sector (+7.5 billion trade balance) that was able to exploit all its competitive factors to sustain the Italian export.

Another sector that recorded in 2012 a positive trade balance and a two-digit growth is the second-hand car export: provisional data show an increase in used cars exported in the EU of +134% in volume and +68% in value compared to 2011. This trend, as we saw earlier, is somewhat altered by the vehicles' relocation abroad phenomenon but can also reflect a real foreign customers' interest on Italian second-hand cars. In particular, over 25% of used cars were exported to Germany (+222% units and +110% in value on 2011), almost 10% to France and Lithuania, 9% to Poland and 7% to Bulgaria.

Consistent with the data concerning production of high-end supercars, exports of Ferrari, Maserati and Lamborghini have been steadily growing since 2001. Ferrari exported in 2012, 7,218 super cars (+9% year-on-year, +93% in ten years); Maserati exported 6,156 vehicles recording a yearly growth of 8.6% and 93% growth over ten years; Lamborghini exported 2,059 units or a 34% increase on 2011 and 420% increase since 2002.

[26] 70% of sales related to foreign brands and the flow customs included import of cars from foreign manufacturing sites of national producers.

1.3 Present - 2013

1.3.1 Europe

Considering the analysis conducted throughout this chapter, it emerges that the challenges that the European automotive market encountered during 2012 had some consequences on the year that just ended. In fact, in the first half of 2013 European automakers have slowed production to shed inventory that is building up as output exceeds vehicle purchases.

According to OICA in the first 6 months of 2013, the European manufacturers (EU27) have cut production by 3.9% with respect to the same period of 2012, at 7,536,834 units. In particular, despite the negative tendency characterizes almost all the countries in the continent (Slovenia, France and Poland cuts were on a range between 30-15%, Czech Republic -12.9%, Italy -6.7% and Germany -3.5%), Romania (+44.7%), Austria (+20.7%), Slovakia (+11.5%), Spain (+10.4%) and UK (+1.1%) performed countertrend. On a nine months perspective, European vehicle registrations have declined as the region's economy slumps, unemployment remains high and governments struggle to rein in spending. The UK was the only significant market to record an increase (+10.8%) whereas negative trend persisted across all other major markets: Spain -1.6%, Germany -6.0%, Italy -8.3% and France -8.5%. From a company perspective, best performers are Dacia (+20.6%), Jaguar (+16.5%), Seat (+10.4%), Land Rover (+8.5%) and Mercedes (+6.6%); market leader remains the Volkswagen Group with 24.8% market share at 2,230,313 units sold in 9 months followed by PSA Group and Renault Group. In September a great majority of the European most important markets posted positive developments from +3.4% in France to +12.1% in the UK and +28.5% in Spain. Italy (-2.9%) and Germany (-1.2%) saw a decrease in their car registrations. Overall, the EU market expanded by 5.4%

compared to the same month last year despite the fact that September 2013 record was the second lowest performance of the market since 2003.

1.3.2 Italy

As we saw earlier in the comparison between Italian passenger car production and registrations, in 2012 Italy hit an historic low especially in the first figure. In 2013 this trend is unlikely to change since production in the first 6 months has reached 222,848 units, a -6.7% decrease compared to the same period of 2012. Low demand and the shift of production abroad contributed to this poor performance.

In the first 10 months of this year, the market registered 1,111,520 units, down 8% compared to a year ago. Italy is experiencing the 26th consecutive negative month with volumes near to those of 1977. With the further VAT rate increase (22% since October 1st, 2013) and the persistent heavy tax burden on motor vehicles (both considering purchase, possession and use), the weakening of the automotive market is not going to end soon even though the decline has slowed compared to 2012.

Diesel engines maintain their leadership with a market share of 53.5%, followed by petrol (31.3%) and petrol/LGP (9%). Also in 2013, A, B and C-segment cars represent a significant share of new registrations followed by compact SUVs and small MPV. Northern Italy accounted for more than 60% of the market equally divided between North-West and North-East (with Lombardia, Trentino Alto Adige and Piemonte as the top three regions). Nothing changed with respect to 2012 as regards bestseller models: Fiat Panda, Punto, 500, 500L and Lancia Ypsilon take up the first five positions both in October and in the ten months cumulative ranking. In this way, Fiat Group maintains its leadership of the market with 28.5%, VW Group and PSA Group follow with 13.5% and 9.3% respectively.

CHAPTER 2 - PEAK CAR

In the first chapter, we have seen the magnitude of the automotive industry crisis from both a European and Italian perspective. Together with the decreasing production and new registrations of passenger cars, another trend seems to have been arising over the years: Europeans are driving less and are likely to continue doing so.

This phenomenon has generally been referred to as peak car (peak car use or peak travel) and is basically a hypothesis that passenger car distance travelled per capita has peaked in some developed countries. According to Goodwin (2011) the current views are that trends in car ownership and use in developed economies (a) are still on a long term growth path, with only temporary interruptions due to economic circumstances, (b) have reached their peak and will show little or no further growth, or (c) have passed a turning point and are now in long-term decline.

In this chapter I will try to better explain the concept of peak car and its origins, while verifying whether or not the hypothesis of diminishing distance travelled per capita can be applied to the Italian market.

2.1 Peak Car

2.1.1 History

Traditionally, the concept of peak car (or more frequently, peak travel) has been studied to understand and mitigate the environmental impact of the transport sector and thus study its implications on urban policy. According to the numerous articles written on the subject, the idea that car use and ownership would have and would eventually reach a plateau and stop growing further seems to date back to the 1930s. Officially, however, the term has been used in traffic forecasting by the UK Government since 1970,

for example in a study that predicted that car ownership would have reached its maximum level around 2010, with a parallel decline in car use (Tulpule, 1972).

According to a series of studies conducted by Millard-Ball and Schipper (2011), total activity growth has halted relative to GDP in recent years and if these trends were to continue, it is possible that an accelerated decline in the energy usage of car travel, a stagnation in total travel per capita and some shift back to rail and bus modes would lead to somewhat less carbon per unit of energy driving the absolute levels of emissions in 2020 or 2030 to be lower than what they are today.

Consistently, research by Puentes and Tomer (2008) found that total vehicle miles travelled in the U.S. began to plateau as far back as 2004 and dropped in 2007 for the first time since 1980. The study reported that per capita driving followed a similar pattern, experiencing a plateau after 2000 and falling rates since 2005.

Completing the research carried on by Millard-Ball and Schipper, an influential series of articles written by Metz (2010) (2012) suggested that over a 35-year period, average travel time, journey frequency, purposes of journeys and portion of household income devoted to travel have been relatively stable in Britain. Distance travelled, on the other hand, after experiencing significant growth over the chosen time period as people have taken advantage of growing incomes to travel faster, has recently ceased to grow hence supporting the hypothesis that in the UK a saturated demand for daily travel had already been reached.

The studies proposed are generally related to the second interpretation of the peak car phenomenon proposed by Goodwin, which states that growth has halted after having reached a stable saturation level. On a different perspective, Goodwin observed that a plateau might be the early sign of a

reverse to a declining trend because people are changing their destination choice and propensity to make car trips and not only their modes of travel (Goodwin, 2011).

Regardless of the interpretation of the current status quo and whether reached saturation will lead to a further growth or a decline in car use, scientists and researchers all agree on the fact that peak car is a complex, not completely understood and verified phenomenon.

Unlike the hypothesis of peak oil (Hubbert, 1956)[27] which mainly has its grounds on the ability of companies to extract oil form the soil, peak car appears to have more complex and interrelated origins which make it difficult for researchers to understand and predict future outcomes.

2.1.2 Theoretical Bases

Given the complexity of this phenomenon, the real drivers are still unknown, but a series of interrelated causes are being theorized by different studies. All of these studies are homogeneous in the unit of measurement: vehicle miles travelled (or vehicle kilometres travelled) per capita literally measures the total travel on roadways on a given period of time. VMT is commonly used to measure road safety performance in a particular country and as an indicator for international traffic safety comparison purposes; this indicator also shapes the transportation planning and programming of billions of public expenditure. Most importantly, this measurement has a direct correlation to fuel tax burden as a primary source of surface transportation funding. With this strong relationship VMT creates a paradox for public policies, since environmental policies aim at containing greenhouse gas emissions by

[27] According to Hubbert, the oil production curve is ''bell shaped'' but slightly positively skewed. Hubbert's theory was verified with good approximation for the case of oil production in the United States that peaked in 1971, and is now being applied to the worldwide oil production although it is not clear whether it will be supply or demand driven.

reducing the travel time and length, whereas fiscal policies rely on constantly increasing car travel to generate fuel tax revenues (Puentes & Tomer, 2008).

Among the researchers that have tried to understand the causes of this phenomenon, Newman and Kenworthy (2011) tried to summarize six interdependent factors that could help explaining peak travel. Other authors have contributed to explain it more thoroughly and add other perspectives.

According to the two authors the possible causes of the peak car use are:

1. Travel time budget
2. The growth of public transport
3. The reversal of urban sprawl
4. The aging of cities
5. The growth of urbanism
6. The rise in fuel prices

After briefly going through every point, the contribution of other authors will be added in order to give a complete understanding of the phenomenon.

1. Travel Time Budget

Venetian physicist Cesare Marchetti was the first to theorize that personal travel is mainly controlled by basic instincts rather than by economic drivers. His research addressed travel time budgets to be a psychological limit more than a technological and economic boundary, stating that cities have a similar average travel time budget of around one hour (Marchetti, 1994). Marchetti's wall suggests that when cities become more than "one hour wide", they stop growing and become dysfunctional. Similar concepts were also used in previous studies especially by Zahavi (1974) who tested that trip makers have a stable daily travel time budget both for macro and micro conditions.

More recently Newman and Kenworthy (1999) showed that cities always hit the wall when they are "one hour wide". While walking cities can expand to

5-8 km before becoming dysfunctional, transit cities can extend to 30 km wide, and automobile based cities can reach out to 50 km before hitting the wall. In recent times, as cities have become more congested and road rage turned out to be a bigger part of everyday life, people are choosing to live closer to where they work, hence reducing travel time and distance (Newman & Kenworthy, 2011).

In this direction, Metz (2010) suggested that saturation of demand for daily travel is to be expected since access to destinations increases – theoretically – with the square of the speed of travel, but the value of an additional choice is characterized by diminishing marginal utility (in practice, access increases more than proportionately to speed, but rather less than the square). In most metropolitan areas, transport policies were unable to plan sufficient road capacity to fulfil travel time budget needs and keep the average time travelled under one hour. Consequently, there seems to be a shift towards faster and higher capacity public transport to go around increasing road congestions and the constraint of parking availability for stationary vehicles.

The results of redevelopment and regeneration of high density suburbs, as stated by previous urban planning and public policies, affected the decision to move to a more central location where most destinations were located, hence lowering car dependence and reducing travel time budgets.

Although most of the studies agree on the fact that travel time budget has been constant over time, with technology development giving the possibility to travel faster and further, Mokhtarian and Chen (2004), after reviewing all the literature available at the time, concluded that travel time expenditures are not constant except at the most aggregate level. In particular, the authors found that travel time expenditures are partly dependent to some measurable features such as individual characteristics, type of destination and activity, as well as other characteristics related, for example, to the geographic location;

the interrelations between these factors, on the other hand, are still not well understood.

2. The Growth of Public Transport

Public transport patronage management was always considered by transport planners as a small part of the transport task since they expected car use would continue to rise with increasing intensity. In fact, especially in the U.S.A. but also in most Western European countries, historic records show a greater dependence on car as a major mean of transport. More recently this pattern began to change since, with the exception of the US in which car still maintains almost 90% of mode share, the shift to public transport and non-motorized modes was more pronounced in Germany, France and Great Britain. Lower young adults' car ownership (and availability), combined with a decrease in car usage, indicates that there is a clear tendency towards an increase in multimodality (Kuhnimhof, et al., 2012). Other similar results have been found by Newman and Kenworthy (2011) in some Australian cites where public transport patronage has increased exponentially in the last two decades. In general, higher public transport growth rates were found in large metropolitan areas of highly developed countries, while in more rural areas car still is the favourite mode for travel.

The relationship between car use and public transport use has been well documented, especially in its exponential characterization (Neff, 1996; Newman, et al., 2008; Newman & Kenworthy, 2011) but other different factors affect the demand for public transport. Travel expenditure depends on the ability of travellers to allocate a certain amount of their income to travel purposes: disposable income, occupation and car ownership highly influence travel choices as well as mode choices. Higher disposable income generally leads to a higher propensity to travel (both for work and leisure) (Metz, 2010; Millard-Ball & Schipper, 2011). The effects on public transport

demand are different: on one side, an increase in income can lead both to an increase in public transport use or to an increase in car ownership (and availability), which in turn reduces the demand for public transport; on the other hand, depending upon the income level, the demand elasticity for public transport with respect to car availability and income can vary. According to Paulley et al. (2006) the positive effects of income increase on public transport demand (especially on rail travel) will be higher as car ownership approaches saturation.

Positive relationship between economic wealth and public transport demand in most European cities has also been documented by Albalate and Bel (2010) who analysed several factors influencing supply and demand of local public transportation. Average price charged to urban transport users, fleet of vehicles available for public transport purposes, number of parking spaces available in the central business districts and average speed of public transport vehicles in operation are among the most influencing factors that drive public transport demand.

Fare elasticity (proportional change in patronage to proportional change in fares) can vary depending on the area (urban or non-urban), time of the day (peak or off-peak) and travellers (males or females, workers/students or unemployed). In general, travellers that live in the urban area, move on peak hours for work/study related reasons, are less price sensitive with respect to occasional travellers coming from a non-urban environment, although even for them an increase in fares can result in a higher elasticity and so a potential decrease in revenues for the public transport industry (Paulley, et al., 2006).

The number of vehicles available and their average speed (which affects the travel time budget), influence public transport patronage. A larger fleet reduces waiting time between two consecutive services, increasing flexibility and reducing travellers' time constraints; higher average speed reduces the

travel time and can give the perception of a higher quality service (dedicated bus lanes to indicate an urban environment designed for public transport, or technology advancements and investments aimed at improving rail infrastructure quality).

Availability of parking spaces has an inverse relationship with public transport use, since a higher number of parking lots incentivizes car use/ownership to the detriment of public transport. As it is generally the case, especially in urban/metropolitan areas and business districts, absence of parking determines a widespread demand for alternative mobility.

Multimodality has become the mainstream way to move around medium-to-large sized cities in most of the Western European countries, since it offers a great deal of time and routes flexibility. Although the phenomenon is more pronounced amongst travellers that live and move in the urban area, it has also reached a greater consensus among commuters who live outside the city but work in an urban context.

3. The Reversal of Urban Sprawl

Urban sprawl or, in continental Europe, peri-urbanization is a concept built around low-density and auto-oriented development. This phenomenon exists since ancient times and is a process of dispersive urban growth that creates fragmented and hybrid landscapes. With continued economic growth and an expanding network of public transport, people started to migrate from the city towards non-urban areas in search of a lower population density gradient. Areas that were created by this migration are characterized by a high automobile dependency since a great number of activities such as shopping and commuting to work require the use of the car.

In recent years this expansion slowed down and, in some countries, the phenomenon started a reversed pattern thanks to different initiatives. Among all, the concept of "smart growth", which has been used particularly in North

America and Western Europe, advocates a different model of development, focusing on transit-oriented development, walkable and bicycle-friendly land use. Together with proper urban planning and design the idea promotes higher residential density, efficient transport systems and sustainability.

The environmental characterization of this trend clearly targets car use and the resulting pollution. According to Newman and Kenworthy (2011) the effects of the phenomenon are already apparent in many Australian, American, Canadian and European cities (the latter are experiencing only the early stages), since urban density has already reached the peak in decline and now cities are coming back in faster than they are sprawling. The authors also pointed out the exponential relationship between density and car use given that, if a city slowly increases its density, the results on car use are more extensive than expected.

4. Aging of Cities

Almost all of the cities in the developed world are aging as their population is getting older. This phenomenon generally occurs when the median age of citizens rises due to rising life expectancy and declining birth rates. To worsen the phenomenon, there is also the additional impact created by the ageing of post World War I and II "baby boom" generation. This implies that, as people get older, they tend to move less and less frequently, heavily influencing travel demand.

Population ageing includes different factors and the future levels of car use are still hard to predict. As life expectancy increases, younger generations postpone transition to adult life and maintain their urban lifestyle facilitated by public transport and modern mobile technology (Metz, 2013). Furthermore, as the cost of owning a car increases (particularly fuel, insurance, parking and repairs), most young people simply decide not to own one. In various developed countries car ownership and availability among

young adults (age 20-29) has declined, much more strongly for men than for women (Kuhnimhof, et al., 2012), as so driving licence holding (Noble, 2005; Metz, 2012; Kuhnimhof, et al., 2012; Goodwin, 2012; Strokes, 2013). In particular Strokes noted that young adults' intentions are to "delay" learning to drive rather than not learning at all, but then a smaller portion actually get licenses.

The other side of the ageing phenomenon is that developed countries' urban infrastructures are aging and failing, and that funding has been usually insufficient to repair and replace it. Growing population and density in cities tend to stress transportation systems. Streets and highways are critical transportation conduits, so their maintenance and improvement is essential.

Crumbling and congested roads do not incentivize car use and neither mobility. A great challenge over the years has been engineering integrated transportation systems in order to make individual vehicle travel, public transport, cycling, and walking all as easy and efficient as possible in particular for the elderly and disabled. While such services can support growing urban populations, they must be accompanied by sustainability, providing environmentally friendly, energy-efficient solutions, since cities represent only a small percentage of Earth's surface but produce a disproportionate amount of greenhouse gas emissions and pollution.

5. Growth of Urbanism

The reason why older aged cities experience a declining car usage is also caused by the fact that old people tend to move from the suburbs back into the cities. During the automobile city growth this possible phenomena passed unobserved because young adults were expected to continue their life of car dependence (and so commuting) instead of moving back to the cities and stop using it (Leinberger, 2007).

New urbanism is a concept of urban design that promotes walkable downtowns and neighbourhoods, together with a transit-oriented development. Sustainable mobility through multimodality and car abandonment characterizes this idea. Similarities with the reversed urban sprawl are clear, however urbanism tries to suggest new urban design solutions to sustain future high density cities with green buildings and a re-development of brownfield lands.

Promoting sustainable and greener projects, with transit-oriented, walkable and suitable for cycling roads, can substantially decrease car use in metropolitan areas since technology and know-how for this change are already available, and in some cities the cultural change has already begun.

6. Rise in Fuel Prices

Oil price per barrel has always fluctuated depending on historical moments which correspond to periods of economic growth or crisis. In the 70s there were two crises that led oil prices to reach their maximum peak, and the same happened in 2008 when the value of crude oil has come to an all-time high of nearly $150 per barrel.

Regardless of fluctuations, an upward long-term trend on oil prices is expected considering the scarcity of oil and Hubbert's peak theory (Hubbert, 1956). Of course, it is not known exactly when the peak will be reached and neither when oil supply will end, however analysts and oil companies themselves predict that extraction costs will increase relentlessly (Newman, et al., 2009).

The Brookings Institution suggests that current researches do not sustain that fuel demand is overly responsive to its price (at least not in the short-run) and if so that, in terms of behavioural change, fuel prices changes have larger impact on aggregate fuel consumption than on total driving. The elasticities associated with fuel prices are obviously going to contribute to reducing car

use growth, though other structural factors may have contributed to cause peak car use since it set in well before the 2008 peak of $150 a barrel (Puentes & Tomer, 2008; Millard-Ball & Schipper, 2011).

Fuel prices affect travel budget that becomes higher share of disposable income; households, finding themselves stuck between constant or declining per capita GDP and rising fuel prices, need to decrease fuel consumption (both reducing VMT/VKT and/or increasing fuel efficiency) in order to maintain constant the amount of money allocated for mobility purposes. In Europe, this is even truer since average at-the-pump fuel prices are generally twice as high as average US prices due to higher average taxation (50% vs. 12%).

In a much broader perspective, costs of automobile ownership, insurance costs, congestion charging and parking are increasing and are affecting car ownership as well as usage (given the hypothesis of constant allocation of available resources).

7. Successful Traffic Reducing Policies

Growth of public transport, reversed urban sprawl and urbanism are all consequences of actions undertaken by governments to promote sustainable transport systems and reduce city pollution. Pedestrianisation of city centres, traffic calming, parking control, congestion charging, reallocation of road capacity are all tools of the smart growth theory that in most industrialized countries has taken the lead of urban development.

The European Commission aims at significantly reducing greenhouse gas emissions, reducing oil dependence and promoting less and cleaner energy use, while supporting transport growth and mobility through facilitating multimodal travel with a higher integration of modal networks. Pushing towards a higher share of public transport travel can potentially increase density and frequency of services, thereby generating a virtuous circle for

collective transport modes. A proper integration between long distance and urban passenger transport can then ensure efficiency also for long distance travel.

For this sake, the European Union is promoting the creation of a Single European Transport Area by enhancing multinational multimodality. Single European Sky and Railway Area are part of this project that will be based on quality, intermodal integration, accessibility and reliability of transport services. In the urban context, a mixed strategy that involves urban planning, pricing schemes, efficient public transport services and infrastructures for non-motorized and clean vehicles can reduce congestion and emissions. Alignment between urban mobility plans and integrated development plans is essential to gather all the elements together, and an EU-wide framework will sustain the implementation of interurban and urban interoperable schemes (European Commission, 2011).

While meeting the demand of travellers for faster and higher capacity public transports, railway systems (that include long and short distance trains, trams, underground and overgrounds) also reduce CO_2 emissions (when, as is largely the case, electric motors are employed and the electricity supply system is decarbonised) and sustain faster interurban and cross-national travel by offering seamless travel through integration of timetables, ticketing and information (Metz, 2013). Development of this mode of travel is, in fact, at the top of most of the traffic reducing strategies both at urban level and nation-wide, leading to a considerable renaissance of rail travel.

Furthermore, as recognized by Stocchetti (2013), the holistic approach that the European Commission policies are taking recently suggests that, for the sake of Sustainable Urban Mobility, the concept of car use has been challenged. While until 2009 regulations and directives pointed towards a implementation of functional performances of the car (less polluting, more

fuel efficient, safer and so on), now the European Commission is aiming at creating awareness that there are different alternative modes of mobility. A great effort is put in challenging the subjective assessment of the trade-off between the social costs and the benefits of owning a private vehicle.

8. Car Sharing

Car sharing is a model of access-based consumption (Bardhi & Eckhardt, 2012) where people rent cars for short periods of time and for short trips as the cost becomes prohibitive for longer distances. Born in Switzerland and Germany more than two decades ago, car sharing is generally proposed as an alternative to car ownership and has grown systematically in the United States and Western Europe.

According to Bardhi and Eckhardt (2012) car sharing has faced a successful development because it provides the benefits of private car use while avoiding the burdens of vehicle ownership. In this way, consumers are able to access vehicles that they could not afford to own or that they choose not to own due to concerns such as budget constraints or the environment (Kuhnimhof, et al., 2012).

According to the World Carshare Consortium, car-sharing services are available in more than a thousand cities across almost 30 countries, serving an estimated 1.7 million members. A great majority of the customers are US based since Zipcar, with more than 10,000 vehicles throughout the United States, is the worldwide market leader. Car sharing services are provided by different entities such as traditional car rental companies (i.e. Europcar, Avis or Hertz), car sharing companies (i.e. Zipcar) or by car manufacturers (i.e. Daimler Car2Go, BMW DriveNow, VW Quicar).

Empirical evidence indicates that car sharing can provide numerous transportation, land use, environmental, and social benefits (Shaheen, et al., 2009), especially where public transport and other modes of transport can be

used most of the time and a car is only necessary occasionally. It can also be an alternative to owning multiple cars for households with more than one driver. Furthermore, in an urban setting car sharing provides a higher flexibility than public transport despite being more expensive.

During the last 20 years, car sharing experienced various different stages of development. Between 1990 and the early 2000 the initial market entry and experimentation begun, in which car sharing providers assessed the potentials of the market, started building up fleets and fostered technological advancement for example through phone and internet automated reservations. From 2002 to late 2007, in a period of economic worldwide growth[28], companies experienced market growth and diversification alongside with positive network externalities that allowed to push forward the technological advancement and increase customer base (Shaheen, et al., 2009).

In the recent years, the market has entered a phase of commercial mainstreaming where the early majority of adopters is approaching this relatively new mode of urban transportation. Early followers are entering the market and are benefiting from favourable conditions, network externalities and knowledge created by first movers. Technological advancement is still active both as regards to user experience (reservations via smartphones, electronic payments, and GPS location of vehicles) and diversification of fleets (high-efficiency, hybrid and electric vehicles of different segments).

While car sharing is gaining momentum, market players and public institutions that are supporting these services, need to further expand their customer base (in particular attracting younger generations) in order to reach

[28] Economic expansion in the period preceding the 2008 crisis helped raising funds for large-scale capital investments and car sharing began to receive government's attention that created the basis for supportive parking partnerships and policies.

economy-of-scale advantages. Understanding which are the inner motives that drive customers towards choosing car sharing as an alternative mode of mobility is essential for configuring the offer. According to Schaefers (2013), his mean-end chain analysis, with some acknowledged limitations, suggested value-seeking, convenience, lifestyle and sustainability as motivational patterns for car sharing demand.

Convenience, value seeking and sustainability propose that it is possible that car sharing customers perceive this transportation mode as more affordable and environmentally friendly than a private vehicle. Indeed, car sharing allows to maintain unchanged (or even increase) the level of individual mobility and at the same time reduce car ownership and usage, by integrating with other mobility modes (Nobis, 2006) towards a more sustainable mobility behaviour. Car sharing is specifically designed to serve as connection between public transports and destinations in an urban context where different modes of travel are available.

9. Unemployment

In the first chapter the relationship between European unemployment rate and new passenger car registrations was presented; from the analysis proposed what emerged is that people don't buy cars if they don't have a job. Since travel increases with car ownership in terms of both trips, time and distance (Metz, 2010), it can be assumed that also the contrary is true: decreasing car ownership may turn to reduced travel. Consequently, if unemployment leads to lower car ownership, it leads also to lower car usage.

This is partially due to the fact that unemployed households have lower income than their employed counterparts, hence lower travel budget and different trip purposes (number of shopping and commuting trips may be comparatively lower).

A general distinction should be made in order to better understand the effects of unemployment on car use: long-term unemployment has a long term effect on income, thus also on car ownership and use; temporary unemployment has lower long term effects on income and, in theory, could affect at most car use since the lack of fixed revenues is only temporary. Young-adults unemployment can potentially have less intense effects on car use since, as discussed in the sections above, younger generations, living in a urban context, tend to already be less car dependent and more transit, walking and cycling oriented (they also have a more modest interest in car ownership (Kuhnimhof, et al., 2012)); commuters unemployment strongly affects car use and, depending on the duration of the state, also ownership.

According to the data provided by Eurostat, the economic recession the European continent has been facing in these years is having strong consequences on labour market and therefore on mobility demand. As long as these circumstances persist, car use is likely to decrease relentlessly.

10. Services Enabled by ICT

In recent years the world has entered a transformational period where the mobility of people and goods benefits from rapid ICT innovations that leads to better decision making, on a level that was not possible just a few years ago (Sweatman, 2012).

According to the International Communications Union (2013), almost 40% of the world's population has an internet access and 96% has a mobile-cellular subscription. Specifically, in the developed world mobile-telephone penetration is 128 devices per 100 inhabitants. Globally, the percentage of individuals using internet (fixed-broadband) has more than doubled in the last decade and in some developed countries (i.e. UK, US, Canada, Germany) has reached more than 80%. Fixed broadband services become more

affordable as penetration increases with a worldwide price drop of around 80% between 2008 and 2012.

The ICU expects more than 2 billion mobile broadband subscriptions in the world by the end of 2013, an average growth rate since 2007 of 40% making it the most dynamic ICT market. As a percentage of Gross National Income per capita (GNI), internet services are more affordable in Europe than in any other region in the world.

According to the data contained in the 2012 Eurostat survey on ICT, in the EU27, 87% of the population has a mobile phone or a smartphone, a third of which uses it to access the internet. Access to internet via mobile has seen an increase in the last few years, and the percentage of people that are using their mobile devices to surf on the internet has more than tripled since 2008. Nearly 40% of the users access to internet on the move on a daily basis, 14% through handheld devices. This is particularly true for younger generations in both absolute use and frequency.

Mobile internet usage increases as the level of computer skills and income increases. However, individuals that do not use internet on the move report that the lack of need is by far the most important reason why they do not access when they are away from home or work. Cost is listed as the second reason even though in Europe mobile internet services prices are among the lowest in the world mostly due to a highly competitive environment.

Internet on mobile devices is generally used to send/receive e-mails and participate in social networks as well as other activities such as reading news and newspapers, buying or ordering physical goods, digital contents, e-books or services (e-commerce in general).

European B2C e-commerce is developing extremely well as internet access has increased over time. The sector grew steadily over the last four years at

an average annual rate of 19% to reach a €311.6 billion turnover in 2012, surpassing USA and Canada (€294bn combined). Among the 529 million people that have internet access in Europe, almost one out of two is an e-shopper with an average expenditure of € 1,243 per capita. UK, Germany and France are the three leading countries and represent more than 60% of the total e-commerce sales in Europe. According to Ecommerce Europe, m-commerce represented 5.5% of total e-commerce

Having briefly seen the importance of communication technologies in Europe, understanding the influence that these have in general on travel demand and in particular, on car use can be less straightforward.

In general terms, the decrease in distance and time travelled can be – partially – explained by the increased possibilities offered by electronic communications since they enabled for example home working and online shopping, hence eroding part of the mobility demand for these kinds of travel. Furthermore, with the increasing popularity of various sorts of social networks sites, mobility for social interactions may have been affected too. This may be the case especially for younger generations that have greater access to social networks also through mobile applications. However, although the links between social networks and ICTs are clear, the relationship with travel behaviour is still difficult to assess.

ICTs are changing the need for travel and they can both substitute to it or facilitate it. (Mokhtarian, 2009). Understanding if and how new technologies can affect personal travel behaviour has been attempted by many studies (Lyons, 2009) without any clear answer since the focus was on whether ICT increases or decreases the number of trips made. More recently, authors have been studying the possibility that ICTs can modify the nature of travel demand (Aguiléraa, et al., 2012) especially considering new mobile

technologies and services related to them, but in this field there are many unanswered questions too.

What is clear by now is that since technology is expected to influence every aspect of households' lives in the next years, it is likely it will also affect their mobility demand as either a substitute or complement.

2.2 Peak Car in Italy

So far, the peak car phenomenon has been recognized in many developed countries, especially in metropolitan areas both in the American Continent, Europe and Australia. Among the European countries Italy has never been taken into account from the analyses conducted, probably because of the lack of precise data and/or the peculiarities that characterize the Italian market that do not allow a homogeneous comparison.

In this section, I will try to apply the theory of peak car to the Italian market and understand whether the phenomenon is verified.

2.2.1 Data Sources

The data that will be presented from now on have been gathered from different institutions and different observatories and since they were mostly obtained by surveys and interviews[29], they may not be representative of the entire population. However, sample size, stratification and timing of observations provide a good level of reliability. The "Istituto Superiore Formazione e Ricerca per i Trasporti (ISFORT)" provided most of the data through its observatory "Audimob"; other sources were Istat and Anfia. The data cover activity, vehicle ownership and use, public transport and fuel

[29] Features such as GDP per capita, car ownership and density, urban density and fuel prices were obtained by national databases.

prices. All transport fuels are included. The reference period depends on data availability: some series begin in 1970, others date back to 2000.

2.2.2 Mobility Trends

Italy has literally stopped. In 2012 the travel demand has reached another historic low since the "Audimob" observatory started recording data.

Table 8: Travel Demand Dynamics (absolute values in millions)

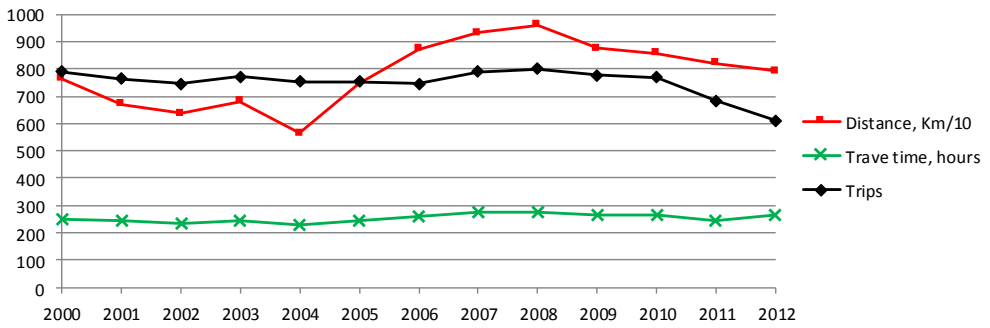
	2012	2011	2010	2009	2008	2007	2000
Total nr. of Trips in an average weekday	97.5	106.6	123.8	125.4	128.1	123.5	126.2
Total passenger*km in an average weekday	1261.2	1302.2	1381.4	1432.8	1561.0	1452.0	1216.2

Source: Isfort, "Audimob" Observatory on Italian Mobility

For the first time the total number of trips during an average weekday went under the 100 million threshold registering an 8.5% decrease with respect to 2011.

The economic crisis and the decrease in consumption and households' income are heavily influencing the travel demand and mobility of citizens; increased unemployment and decreased leisure-generated mobility further reduce travel demand.

Graph 8: Travel time (hours per person per year), distance (Km pppy) and trips (pppy), weekdays only



Source: Isfort, "Audimob" Observatory on Italian Mobility

Graph 8 shows the yearly personal travel demand on weekdays: travel distance and number of journeys do not follow the same pattern since, as the number of trips has remained relatively constant over time and only started decreasing recently, the distance travelled increased until 2008 and then started decreasing but with a slower rate. This may be the effect of the gradual lengthening of travel, mainly caused by urban sprawl that is "forcing" people to cover greater distances maintaining a constant travel time (consistent with the Marchetti's wall and Metz's theory[30]).

According to ISFORT the decrease in travel demand derives mainly from urban areas that registered a 16.2% decrease compared to 2011 at 58.6 million urban journeys (inside municipal perimeter and/or not greater than 20km) per weekday.

Table 9: Trips by distance (percentage values)

	2012	2011	2010	2007	2000	% Change 2000-2012
Urban trips (up to 10 Km)	70.4	72.5	73.3	73.5	79.8	-9.4
Medium Distance Trips (10-50 Km)	26.6	24.6	24.0	23.5	18.1	+8.5
Long Distance Trips (over 50 Km)	3.0	2.9	2.7	3.0	2.1	+0.9

Source: Isfort, "Audimob" Observatory on Italian Mobility

Table 10: Motorized travel, mode share, million of trips, % change

	Share (%)	2012	2011	2007	% Change 2011-2012	% Change 2007-2012
Public Transport	15.2%	6.4	6.8	5.9	-5.9%	8.5%
Private Car	79.6%	33.6	40.1	41.6	-16.2%	-19.2%
Motorcycle/Scooter	5.2%	2.2	3.6	3.9	-38.9%	-43.6%

Source: Isfort, "Audimob" Observatory on Italian Mobility

Travellers are shifting from urban trips to longer routes especially in the medium range. The increase in medium and long distance trips appears to be due to higher costs associated with urban living. These have forced a

[30] Metz in 2010 suggested that people are taking advantage of higher travel speeds to increase travel distance, maintaining unchanged travel time.

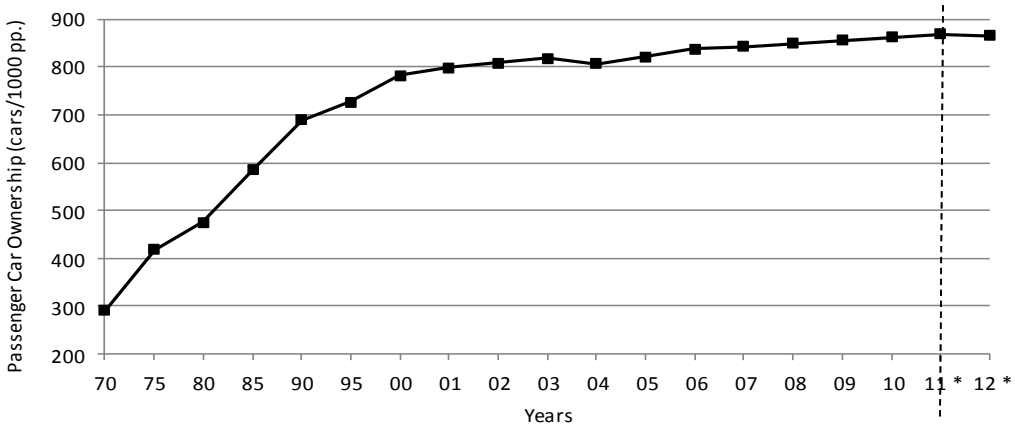
consistent share of population to move away from the city centre to look for less expensive housing arrangements and living conditions.

Considering the actions undertaken by a consistent share of travellers living in metropolitan areas or big cities (cut car use for short trips, increasing the use of public transport and/or car pooling with other people), and the dynamics of motorized travel in urban context all show a sensible decrease in travel demand over the last year. The negative trend persists for five years and has heavily affected car and motorcycle use. Even though public transport trips experienced growth over the period 2007-2012, they have been recently affected by the general travel reduction.

Private car remains the most preferred mode of transport and has, over the years, maintained a constant share which varies depending on city size: in big cities (more than 250,000 ab.) car share is lower to the advantage of public transport; medium-to-small size cities still show a clear prevalence of private car over other modes. Car dependence varies slightly on a regional level, with North-East and South showing a higher dependence, whereas North-West and Centre a higher interest in public transport. In general, Italian propensity to car use reflects both political and infrastructural factors as well as social ones. Public transport infrastructures are generally insufficient in meeting all the potential demand in particular in extra-urban areas where services are nonexistent or inefficient (under-dimensioned and old fleets, few on-peak services and connections). Hence, car use becomes more a necessity than a choice given that other modes of transport do not provide the same level of freedom to move and flexibility, especially in non-urban contexts.

Historically, car ownership was generally seen as a status-symbol by a consistent share of the Italian population. Over the last 40 years car ownership experienced a constant growth and only recently the pattern began to plateau reaching a saturation level. (*Graph 9*).

Graph 9: Passenger Car Ownership - Trend 1970 - 2012 - Population age 20-75



Source: ANFIA, ISTAT. Data for 2011 and 2012 are provisional

Despite the high level of motorization, there are factors that suggest that, after plateauing, Italy may experience a decrease in car ownership rate in the future. According to the Italian Ministry of Transport and Infrastructures, active driving licenses were around 37.6 million in January 2013, an overall decrease of 0.3% with respect to 2011. More importantly, new driver licenses issued reached a saturation level around 2004 and began to decrease thereafter: consistently with what found by Kuhnimhof, et al. (2012) also Italian young adults are increasingly less interested in car ownership and use, provided that the number of licensed divers between 18 and 24 years old decreased by 4.1% in one year (-19.2% considering only under 20). Furthermore, as already noted in the first chapter, the number of vehicle in use fell in 2012 for the first time in Italian history because of a failure in replacing scrapped or dismissed cars.

Amid the economic crisis that is affecting the Country, Italians are fighting with budget constraints. Car use has always represented an important share of households' expenditures and the recent increase in car related costs heavily influences the average kilometres driven per year.

The Italian Automobile Club (ACI-CENSIS, 2012) estimates that in 2012 the average annual operating costs, excluding depreciation, was € 3,425 (+4.5% over 2011), with fuel costs representing almost half of the final cost. Fuel prices grew on average by 18% annually (2012-2011), 42% in 5 years (2012-2007) and 78% over a 12 years period. Other fixed costs such as insurance and car tax grew as well.

As a result of rising costs, Italians are driving less. According to a combination of data from the Autopromotec observatory (on data provided by ICDP, an international research organization specialized in the automotive sector), and from the auto insurance observatory promoted by Segugio.it, vehicle kilometres driven decreased steadily since 1995 to an average of 10,600 km/year in 2012. A combination of decreasing per capita income, increasing operating costs, increasing unemployment (especially among young adults) and a reduction in travel demand are driving private car use to the minimum levels.

Hence, a new model of mobility is defined after five years of recession. A model in which it is clear that citizens progressively give up, for specific economic reasons and psychological motivations, to move outside the perimeter of the basic needs of daily life (work for those who have one, study, family). The leisure related travel demand, highly concentrated in urban areas, is heavily penalized in times of economic crisis and spending review.

Despite being far from economically efficient and being driven less and less every year, private car still maintains its share as the most preferred mode of transport of Italian travellers.

Table 11: Distribution of urban trips by length and mean of transport used (%)

	Up to 2 km		From 2 to 10 km		Over 10 km	
	2007	2012	2007	2012	2007	2012
Foot/Bicycle	57.6%	59.8%	9.5%	7.1%	1.3%	0.4%
Motorbike/Scooter	2.7%	1.3%	7.5%	5.9%	7.0%	3.0%
Private Car	36.1%	34.4%	71.8%	73.0%	76.2%	76.0%
Public Transport	3.6%	5.0%	11.1%	14.0%	15.5%	20.6%

Source: Isfort, "Audimob" Observatory on Italian Mobility

Tab. 11 underlines the magnitude of car dependence: Italians start to use the car as a mean of transport for trips that cover more than 2 km, and for those systematic trips especially outside the urban area. This is because the average speed of private motorized vehicles, both in the urban and extra-urban context, is comparatively higher than public transport. Indeed, considering the constant travel time budget (highlighted in *Graph 8*) private vehicles allow to cover higher distances (or allocate less time for the same distance) with respect to other means of transport[31].

From a demographical perspective, Italy is ageing. According to the last census made by ISTAT, the Italian population has aged dramatically in the last 40 years: in 1971, people under 15 represented 24.4% of the entire population while people over 65 just about 11%; in 2011 the demographics show a clearly reversed trend where kids under 15 years of age correspond to 14% while people over 65 years of age represent almost 21%. As previously noted, population ageing strongly affects mobility demand since elder people tend to live in urban areas where all the services needed are within walking distance. Hence, a higher percentage of the entire population is choosing to live in an urban context and these are the early signs of a reversed urban sprawl.

Urban sprawl has halted in some big cities around Italy, from North to South (*Tab. 12*), but the reversed trend may still be in its early stage. In fact, data continue to show a clear increase in medium-to-long distance trips (*Tab. 9*) making it difficult to understand if the phenomenon is actually happening.

[31] To be precise, Isfor analysis underlines that motorcycles and scooters can travel even faster than cars. However, especially in the North of Italy, there are some weather and safety related factors that influence individual decisions in choosing two-wheel motorized transportation. The results of this choices are well summarized in *Tab. 4.*

Table 12: Trends in urban density in some Italian cities (ab./sqkm), 1990-2012

	2012	2010	2005	2000	1995	1990
Roma	2,033	2,026	1,979	1,978	2,061	2,166
Milano	6,837	6,775	6,882	6,915	7,162	7,694
Napoli	8,082	8,088	8,221	8,440	8,626	9,140
Torino	6,710	6,725	6,682	6,655	7,084	7,562
Palermo	4,095	4,106	4,189	4,276	4,339	4,404
Genova	2,439	2,446	2,508	2,540	2,692	2,866
Bologna	2,636	2,624	2,595	2,635	2,700	2,913
Firenze	3,500	3,483	3,441	3,480	3,674	3,985
Bari	2,691	2,696	2,715	2,696	2,834	2,937

Source: ISTAT

Finally, from an alternative mobility perspective, some initiatives are emerging in numerous cities around Italy. Car sharing initiatives are among those that seem more convenient, they are usually provided by the same companies that manage public transport services in the city and give the possibility to freely move around city centres also in restricted traffic zones. However, most of them are still at an embryonic state and need to be implemented and developed in order to make them more flexible and user friendly. Given the inefficiencies of publicly managed car sharing services, some private providers have found room for market development: among them, Daimler's Car2Go seems to be the most promising even if it is active only in Milan for the time being.

In conclusion, it is clear that the overall Italian mobility demand is shrinking as the country is facing a profound economic, financial and political recession. Citizens are driving less but they are still highly car dependent given that public transports are not capable of meeting a great part of travel demand. Even though most of the theoretical bases of the peak car phenomenon are verified (constant travel time budget, decreased travel demand, reduced urban sprawl, ageing of population, rise in fuel prices, high unemployment rates and availability of car sharing services), profound inefficiencies in public transport management and the lack of precise and

homogeneous urban design policies, sustainable urban mobility measures and alternative mobility investments do not create momentum for car abandonment, not even for short trips. Furthermore, the fragmentation of data related to Italian mobility does not help precise researches in this field.

What should emerge from this chapter is that peak car appears to have set in various different cities in the developed world. Several authors recognize a clear tendency towards car abandonment and have outlined several reasons that may have led to this trend. Earlier researches recognized in some economic, environmental and sociological factors the possible causes of this phenomenon, while more recent contributions suggested a more behavioural and holistic approach.

Given the complexity that characterizes this phenomenon, precise origins have yet to be documented and peak car seems to be something more than just a mere sum of the consequences of the trends outlined above, namely a result of multiplicative effects between them. The effects of the phenomenon on mobility regulations and future urban development plans are clear, however other players in the automotive industry should take peak car into consideration. Stocchetti (2013) recognized that the phenomenon may irreversibly change the demand that carmakers will have to satisfy in the future and that the product "car" may change substantially to adapt to a more urban sustainable mobility.

CHAPTER 3 - THE FUTURE OF MOBILITY

The trends that emerged in Chapter 1 and 2 underline that mobility demand may change significantly in the future. Different modes of transport as well as different vehicles concepts are going to influence how people will move around urban areas and city centres. The development of integrated mobility systems has already begun. The implementation of public transport, new ways of using the car (car sharing, peer-to-peer car sharing, and carpooling) and a new set of innovations in urban mobility, are contributing to change the role of carmakers in the European arena.

Car manufacturers should consider "peak car" as it generates a different conception of car use and ownership. Neglectful of the various problems that the automotive industry is facing in these years, carmakers are still concentrating their effort in producing and designing cleaner, more efficient and smaller cars. Although some models have succeeded in meeting customers' needs, the stagnation of new registrations reveals that it is possible that the product "car", as commonly considered, needs to change its nature to be appealing and sustainable in the future. Few authors (Metz, 2010; Stocchetti, 2013) identified the saturation of demand, and observed that consumers have already taken advantages of the benefits the technology behind cars has to give.

This chapter investigates the Italian mobility by going through different collective and individual mobility means, some of which are coherent with the concept of sustainable urban mobility. It will also underline the increasing importance of Urban Electric Vehicles (UEV) and Personal Mobility Vehicles (PMV) in urban transportation and propose solutions to reinvent urban mobility.

3.1 Modes Comparison

According to the analysis proposed so far, it is clear that the automotive industry has been facing hard times in recent years. In most European countries, the car is being used less and started losing importance as a mean of transportation. In the European context, Italy behaves quite differently. Owning a car is more of a burden than a benefit (considering all the costs and disadvantages associated) and, in absolute terms, the amount of vehicle kilometres driven per year is decreasing. Nevertheless, Italians still prefer the car to other modes of transportation even for short trips.

This behaviour may be attributable to a shared perceived dichotomy in mobility supply: public transport or private car. Being public transport (buses, trams, metros, short and long distance trains) in the country generally inefficient (albeit with some exceptions), the great majority of Italians chooses the second and simpler mode, without actually calculating the real costs of this choice and further investigating other options.

The analysis proposed hereafter aims at comparing various ways to travel, calculating the total cost per kilometre of different commuting profiles, helping to assess which are the less expensive means of transportation depending on the distance travelled per year. This framework will then be useful in understanding the potential benefits of multimodality and of alternative mobility.

3.1.1 Data

The processed data were collected mainly from the ACI database and adjusted according to different factors. Other data were obtained by official sources such as companies' websites. Passenger cars were selected randomly by make and model but according to the characteristics and structure of the vehicles in use in Italy. The insurance premium for passenger cars and other

motorized vehicles highly depends on different factors. In order to make the evaluation more reliable, the insurance premium was calculated according to some specific parameters: the commuter was supposed to be male, 40 years old, married, living in Milan, self-employed and with an insurance merit rating of seven (7). Parking costs and entrance fee to the C Area (restricted traffic area) were excluded from the calculation. Public transport and carpooling costs were calculated as €/km per person, whereas all the other costs as €/km per vehicle.

Several scientific researches and academic papers contain intermodal cost analyses and comparisons. Some of the publications available (Condon & Dow, 2009; Keeler & Small, 1975) were used for public transport policies purposes, especially for determining under what circumstances one mode is more efficient than the others in converting resources in services. Other contributions (Buehler, et al., 2009; Rabl & de Nazelle, 2012) address a more sustainable and health related perspective but always form a policy maker point of view. The analysis proposed incorporates the frameworks of these earlier studies and, using commuting corridors (Wang, 2011), assumes a user perspective and a transportation cost minimization point of view.

3.1.2 Analysis

The analysis focused on the metropolitan area of Milan. Commuting has been divided into five categories according to the aerial distance between home and work: under 10 km, between 10 and 20, from 20 to 30, 30 to 40 and from 40 to 50 km. The hypothesis considers that the commuter works in the city centre of Milan and performs a round trip (home-work-home), 5 days a week, 10 months a year. The Marchetti's wall (travel time budget of around 1 hour) has also been considered when identifying the commuting categories: the 50 km upper limit was set according to the fact that none of the means of transportation considered can travel further in less than one hour.

The means taken into consideration include:

- *Public Transport*: the city of Milan offers different solution to transit such as buses, trams and metros. The degree of effectiveness and efficiency in sustaining mobility varies depending on the vehicle considered. Tram and subways travel at a considerably higher average speed compared to buses, however buses can reach a higher widespread availability of stops and services.
- *Passenger Cars*: different vehicles have different costs. The analysis considers the motorizations available at this time (diesel, petrol, compressed natural gas, hybrid and electric) and calculates the costs per kilometre for a selected car of each motorization.
- *Long-Term Rental*: although it is not a mean of transportation, this service enables mobility so it is included in the overall analysis. The service consists of a car rental contract that lasts on average 36/48 months and up to 80,000 kilometres depending on the vehicle selected. The monthly payment includes the car, insurance, maintenance (ordinary and extraordinary), tyres change, administrative costs for the vehicle and a replacement car in case of breakdowns.
- *Car Sharing* is also considered in the analysis. The service requires a registration fee plus a per-minute fare that includes the right to use the car, fuel, insurance, parking and entrance in the C Area. The first 50 km are included in the per-minute fare and exceeding kilometres are charged separately. Vehicles can be parked everywhere inside the Milan municipal area and can be taken outside the perimeter only if then returned back in the predefined area. The car can be also rented hourly and daily. More details can be found in the official website of Car2Go Milano.

- *Carpooling* represents an alternative way of organizing car journeys so that more than one person travels in a car. Carpooling allows reducing each occupants' travel costs (car costs are split among the passengers) and it is seen as an environmentally friendly and sustainable way of travelling. Arrangements are made through different ways: individual initiative, public websites, closed websites or smartphones applications.
- *Scooters* category includes all the two-wheel motorized vehicles that have a platform for the operator's feet or integrated footrests. As for cars, different vehicles have different costs. The analysis considers one of the best-selling motorcycles in Italy in the last years.
- *Urban Electric Vehicles (UEV)* are all-electric cars designed for short trips in urban areas. These vehicles are generally very compact and offer room for one or two passengers. The analysis considers an example of a lightweight electric quadricycle as a representative vehicle for this category.
- *Personal Mobility Vehicles (PMV)* are small size electric devices, conceived for individual use and short journeys in the urban environment. With relatively low top speeds (around 20 km/h) and an adequate operational range, they are particularly suitable for being used in the first and/or last phases of a multimodal trip. The analysis focuses on the products of Segway Inc. as the only PMV producer currently operating on a global scale.

The operating cost of a vehicle (in this case passenger cars, scooters, UEV and PMV) refers to the entire cost the owner bears for using the vehicle, including the depreciation of the capital needed to purchase the vehicle over a given range of use expressed in kilometres (technical life). The total usage costs plus depreciation, calculated according to some conventional standard

values of average annual travelling distance, provides the total amount of the operating costs expressed in euro per kilometre.

For evaluating the costs per kilometre, operating costs have been divided into two main groups:

1) Annual fixed costs not proportional to the distance travelled that include the road tax, motor vehicles liability insurance and interests share on capital purchased;
2) Annual variable costs proportional to distance travelled that include depreciation, fuel, tyres wear, maintenance and repairs.

The first group includes all the costs that the owner faces, regardless of the degree of utilization of the vehicle, while the second includes costs that are directly or indirectly related to the degree of utilization of the vehicle itself.

The average annual kilometres driven is an important factor since the overall operating costs varies depending on it. The annual average distance is defined as the number of kilometres travelled by the vehicle during the year. Unit variable costs are expressed in euro per kilometre, while fixed costs are spread on the average amount of kilometres travelled in one year: the higher the average distance, the lower the share of fixed costs on the total operating costs.

Public transport costs were calculated considering an integrated monthly ticket ("TrenoMilano") that includes regional trains for one specified route (i.e. round trip from Como to Milan) and all the public transports in the Milan municipal area. The monthly fare was divided by the average distance travelled per month to obtain the cost per kilometre.

For the 10 km range it was considered only the annual subscription to ATM (Azienda Trasporti Milanesi) divided by the distance travelled per year. Long-term rental costs were calculated considering the rental price per year divided

by the average distance driven per year and then adding fuel costs per kilometre. Car sharing costs consider the average urban speed for passenger cars as the fee is charged according to a per minute basis.

3.1.3 Results

Public Transport

Distance	Ann. ATM €	Km/year	€/km
10 km	330	4000	0.08
	Fare €	**Km/month**	**€/km**
20 km	57	800	0.07
30 km	69	1200	0.06
40 km	81	1600	0.05
50 km	92	2000	0.05

The cost per kilometre of public transport is the lowest of all the means of transportation and it is inversely related to the distance travelled. The analysis considers only the commuting transit and does not include other travel purposes. Ideally, if transit was used also for leisure related activities and journeys, the overall cost would be considerably lower.

Passenger Cars

	KM driven per year				
Model	**5000**	**10000**	**15000**	**20000**	**25000**
Volkswagen GOLF VII 1.6 TDI BLUEMOT.TECH - 90CV - Diesel	0.73	0.49	0.40	0.36	0.34
Fiat PUNTO 2012 1.4 SES 8V - 77CV - Petrol	0.66	0.46	0.40	0.36	0.35
Volkswagen UP! 1.0 68CV - CNG	0.54	0.37	0.32	0.29	0.27
Toyota YARIS 1.5 HSD - Hybrid	0.65	0.44	0.38	0.34	0.32
Nissan LEAF VISIA 80 kW - Electric	0.83	0.61	0.54	0.50	0.48

The ACI database was very helpful in calculating the costs per kilometre of different passenger cars even though some adjustments for the insurance premiums (according to the parameters specified earlier) were made in order

to improve the cost assessment. The analysis proposed highlights clear differences between models and motorizations.

The cost differential between diesel and petrol cars, although quite pronounced for very short distances, cancels off as the distance driven per year increases. Compressed natural gas cars are on average 20% less expensive to run with respect to both diesel and petrol powered vehicles. Hybrid cars are around 10% cheaper than traditionally powered car, especially considering a long-distance perspective.

Full electric cars represent a special case in this category. Although there is no doubt that electric cars are significantly cheaper to "refuel" than traditional cars, the total cost per kilometre is higher than every other vehicle. This is mainly due to a series of reasons. The initial price is considerably higher than other cars in the same segment and the insurance premium is almost the same. The reduced technical life due to batteries wear decreases the residual value, and maintenance costs are just a bit lower than traditional passenger cars.

Long-Term Rental

KMY	5000	10000	15000	20000
€/km 1° Y	1.54	0.81	0.57	0.45
€/km 2-3° Y	1.19	0.64	0.45	0.36

The selected service provider is ALD Automotive and the costs per km contained in the table above refer to the same Volkswagen Golf VII 1.6 TDI considered for passenger cars. The maximum distance travelled per year stops at 20,000 km because long-term rental contracts usually set that limit (together with the rental period). Costs are evaluated separately for the first year since they include the up-front payment that is mandatory for opening the contract. It is clear that there is no convenience in a long-term rental if the distance driven per year is less than the maximum allowed. Given that, at

the upper limit, the cost is equal to the one of a privately owned vehicle. Long-term rental is preferable to private ownership as it includes some additional services that save a considerable amount of time that can be allocated elsewhere.

Rental fees varies depending on the service provider, hence costs may vary accordingly. However, considering the market share and distribution of these service providers, prices are rather homogeneous so there would be only minor differences.

Car Sharing

Given its performance in Milan, Daimler's Car2Go was chosen for calculating the cost per kilometre for car sharing services. Excluding the one-time registration fee (€ 19), this service charges a per-minute fare of € 0.29 all included. Considering that "sharing" can only start and end within the Milan municipal area, and that the average urban speed is lower than or equal to 30 km/h, the cost per kilometre is around € 0.58/km. Under optimal conditions (no traffic and availability of parking spots) and for short distances, car sharing is preferable to car ownership because it avoids parking related problems and costs. In real settings, traffic jams and the time spent to find a parking spot considerably increase the cost per kilometre.

Car Pooling

The principle at the basis of car-pooling implies that all the seats in a car should be occupied. In this way, the cost per kilometre of the vehicle is split between the persons in the car. In theory, all the fixed and variable costs need to be divided between passengers. More often, only fuel and parking costs are shared reducing the benefits of this practice.

An integral or partial sharing of car costs enhances the competitiveness of privately owned cars (in the case of a total operating costs sharing it may be

more appropriate to refer to them as shared-ownership vehicles) as means of transportation. With carpooling, depending on the number of seats a car has, the cost per person per kilometre may be as low as one fifth of the total vehicle's costs.

Scooters

Scooter					
Model/KMY	**5000**	**10000**	**15000**	**20000**	**25000**
Honda SH - 300 ABS	0.30	0.23	0.21	0.20	0.19

ACI conventionally assumes that motorcycles can be used to travel for a maximum of 25,000 km per year. As for passenger cars, costs per kilometre were adjusted taking into account a modified insurance premium. The results show that scooters are nearly 50% cheaper to run than most passenger cars. Furthermore, these vehicles offer other benefits to commuters such as travel time reduction and parking availability.

In practice, it is unlikely that most motorcycles travel more than 15,000 km per year because sometime they are used as integrative vehicles to other modes, for example to reach the nearest public transport or instead of the car during spring and/or summer days when weather conditions allow a safe and comfortable journey. Furthermore, an important clarification should be made concerning this category: while public transport, passenger cars, UEVs and PMVs do not require a particular ability to be used or driven, motorcycles require certain capabilities that not every commuter has. Hence, while still useful, efficient and effective as means of transportation, scooters should not be thought as alternatives to passenger cars.

Urban Electric Vehicles

Urban EV - Estrima Birò					
KMY	**5000**	**10000**	**15000**	**20000**	**25000**
€/km	0.34	0.26	0.23	-	**-**

ACI database does not presently contain any data regarding alternative modes of transportation. The cost analysis followed the same framework used for passenger cars and scooters, adjusted for the characteristics of the vehicle considered.

The list price of the Estrima Birò is € 8000 plus € 4000 for the batteries. The technical life was estimated at around 75,000 km, calculated as the number of cycles the battery can support (2500) times the average range per charge (30 km). The insurance premium was set to be equal to the one of a lightweight motorized quadricycle even though some insurance companies may offer discounts for electric vehicles. The cost per kilometre of tyres change was estimated as twice the cost for scooters (considering the four wheels), whereas maintenance/repair was set to be equal to motorcycles standards.

Results underline that, regardless the relatively high initial price, this urban electric vehicle is extremely competitive on a cost basis.

While offering room for two persons (driver + one passenger) and most of the benefits of a small passenger car, the electric motors, the special battery configuration and the small dimensions help in maintaining running costs at a very low level.

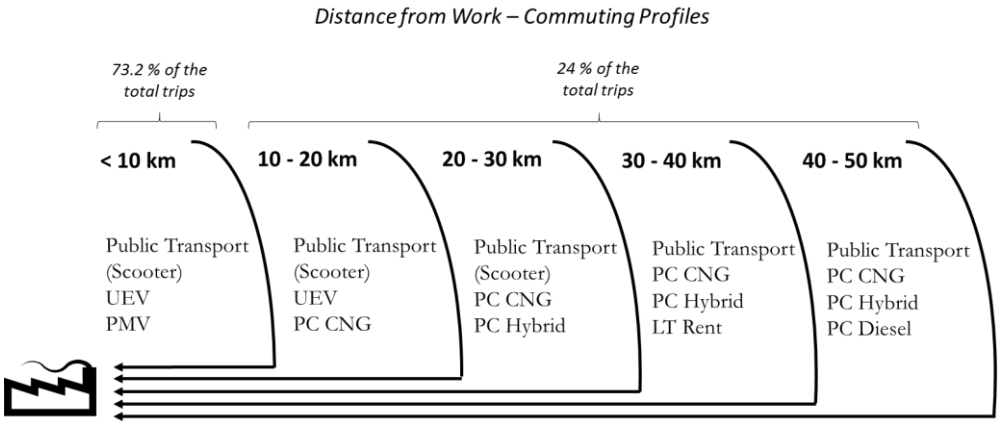
Given the operating range, the Birò is more suitable for urban environments and short/medium journeys, and the removable lithium-ion battery offers the flexibility needed in the city centre and allows to increase the operating range even when on-street electric outlets infrastructures are missing. Finally, the very compact dimensions ease the parking finding process since the vehicle can be parked on motorcycles' spots.

Personal Mobility Vehicles

As already said, the only personal mobility vehicles producer operating on a global scale is Segway Inc. As for urban electric vehicles, the cost evaluation followed the well-established framework used so far. Prices vary according to the different models chosen. On average, prices are around € 8,500.

As for UEVs, the technical life of personal mobility vehicles was estimated of around 30,000 km considering the average operating range and the average battery life. The Segway is road-tax free and the Italian rules of the road do not require a vehicle liability insurance. Tyres change costs were estimated of around € 170 euro every 15,000 km, while maintenance costs were supposed to be around € 1000 in a lifecycle including software updates and repairs. Overall, the cost per kilometre is € 0.36. Given its structure, it is unlikely that the Segway would travel more than 5,000 km per year.

3.1.4 Conclusions



From the analysis carried on it is possible to understand which are the most cost efficient means of transportation depending on the average distance from work. Public transport always wins under a cost perspective even though from a flexibility point of view it is a losing competitor compared to other modes. In real life, commuters may not have the possibility to use only public transport to travel from home to work and this is why the analysis considers other modes.

Under the 10 km threshold (according to ISFORT, 73.2% of the trips are made within this limit), scooters, UEVs and PMVs enable mobility at the lowest possible cost. The characteristics of these vehicles ensure also high flexibility, reduced travel time and near zero parking costs. Furthermore, the electric configuration allows maintaining and preserving the urban environment reducing pollutants emissions.

As the distance from work increases over the 10 km limit, some modes become useless to the advantage of other vehicles. Specifically, while scooters and urban electric vehicles still support mobility, the technological limitations of personal mobility vehicles make them ineffective in performing trips outside the municipal perimeter of a metropolitan city like Milan. Natural gas

powered cars start gaining importance at the upper limit of the 20 km threshold, thanks to relatively high fuel efficiency, low fuel costs and lower total running costs.

The 20 km limit represent an important changing point. All the electric vehicles considered fail in sustaining mobility due to operational range and average speed limitations. Bravest commuters may still contemplate the possibility of using motorcycles to travel to work considered the lower operating costs per kilometre. Passenger cars increasingly gain momentum when the distance increases, so that in the range between 30 and 50 km cars lead as means of transportation.

From the results overview, some means are clearly missing. First of them is car sharing. The analysis underlines that, while car sharing has grown exponentially over the years, the real cost saving advantage is true only under specific circumstances. In particular, if a person only need a car for trips to the grocery store or for occasional use, then it is wise to consider sharing rather than ownership. When considering commuting, however, the advantage vanishes. Commuters usually move during peak hours when traffic and congestions are at their highest levels and since car sharing offered in Milan is charged on a per minute basis, idle time will cost as much as moving time, increasing the overall cost per kilometre. Furthermore, the use of car sharing is limited to the municipal area in which, as we have seen, other cheaper modes are available.

Full-electric passenger cars are also missing. As already said, the high initial price and the low technical life increase substantially the overall operating costs of these vehicles, making them less attractive both for a frequent and occasional use.

Finally, carpooling. Although the practice has several potential benefits, it requires a very strong organizational effort by commuters. The degree of

complexity depends on a series of interdependent factors such as careful route planning, time schedules alignment, cost sharing agreements and other social and psychological issues. Considered the distinctive uncertainty of this practice, it was not included in the final overview in order not to influence the results. On top of all, from a cost efficiency perspective, carpooling is always encouraged in favourable conditions.

In general, the analysis proposed supports both a single mode and multimodal mobility perspective. Considering that public transport is the cheapest mode of transportation, it is clear that it should always be a part of a multimodal commuting. One of the most common configuration is using the car for the first part of the journey, leave it in an incentive parking facility and take public transports to complete the journey. Other options include the use of personal mobility vehicles for the first and last part of the travel or the use of scooters to go to the nearest public transport access. A multimodal commuting gives the possibility of lowering the average cost per kilometre on a scale that is directly related to the distance travelled with public transports.

The cost evaluation proposed, while helping commuters in choosing which mode of transportation best fits their mobility needs, also underlines that there is a potential demand for alternative modes of transportation other than cars. Urban planners and carmakers should rethink urban mobility through offering solutions to reduce travel time and cost, especially in Italy, where commuters on average travel for a total of around 30 km per day, 73.2% of all the trips are inside the 10 km radius, and where the costs of owning a car are among the highest in the European Union.

3.2 Rethink Urban Mobility

While today's business environment is characterized by rapid and extensive changes and a high degree of unpredictability, it has been proven that mobility business environment is facing some predictable important changes that are shaking its foundations, making sustained growth more difficult. It seems that many companies in the field are failing to recognize the problems and delay the efforts to remedy them.

In particular, carmakers seem to be concentrating on the short/medium-term performance instead of restoring long-term growth and competitiveness. It looks like they are trapped by ongoing structures, processes and initiatives, which are complex and difficult to alter. While in most of the European countries the automotive market performance is declining, the Asian market is continuously showing a sensible growth. For this reason, carmakers may not be encouraged in introducing new disruptive innovations that can potentially revolutionize the mobility environment until they have completely exploited all the existing opportunities offered by emerging markets. There are several risks behind these decisions; one of them is commonly known as leapfrogging. New entrants may introduce radical innovations that could eventually become the new technological paradigm, hence leapfrogging ahead of former leading firms. At the same time, developing countries may not want to repeat the same mistakes of highly industrialized countries, skipping inferior, inefficient, expensive and more polluting technologies, jumping directly to cleaner and innovative technologies.

The early signs of a changing concept of mobility are already quite clear but there are very few actual attempts in responding to these changes. Urban planners and leading carmakers already have at their disposal all the technology to start incrementally revolutionizing urban mobility.

3.2.1 Public Transport

As urban density increases and commuters prefer to live as close as possible to where they work, efficient public transport systems are the key to meet large-scale urban mobility demand.

Transit mobility is not a new concept in the transport arena, even though it has significantly changed and developed over the years. Urban design gave the possibility to public transport to gain momentum through transit-oriented policies such as dedicated bus lanes, light rail vehicles (LRV) and undergrounds implementation.

As shown in the analysis proposed in the paragraphs above, an efficient public transport system can provide greater benefits compared to traditional car mobility thanks to its higher passenger capacity and average travel speed. However, as it is the case in some urban areas, car is still the preferred mode of transportation and this limits the ability of urban planners to modify the environment in order to increase the acceptance of public transport.

Considering that cities have a fixed amount of road space available, creating dedicated lanes will reduce road capacity for private vehicles, leading to higher congestions and increased pollution. On the other hand, bus lanes could increase vehicles' average travel speed that, in turn, will convince more travellers in switching to public transport. Unlike restricted traffic zones that just move car traffic problems outside city centres, widespread dedicated lanes could increase public transport patronage, hence reducing the number of private cars outstanding.

Light rail vehicles (LRV), overgrounds and rapid transit represent the connection between the urban and the sub-urban environment. They generally operate on an exclusive right-of-way and can provide high capacity, high average speed and frequent services. These systems are well developed in a great number of metropolitan areas around the world and provide fast

connections between urban locations and between urban and sub-urban areas. They generally operate with different network schemes that depend on city size and spread of outside access points.

Currently, rail based public transport represents the most efficient and sustainable way of moving around large urban areas, even though these systems may be supplemented by other modes such as buses, trams or commuter rail, to offset certain infrastructural limitations like limited stops, long walking distance between stations and pre-determined routes.

As already stated, multimodality is the key to a widespread acceptance of public transport amongst travellers. Future cities need to design the urban environment to enhance flexibility by (a) synchronizing timetables between different modes by developing more complex algorithms to provide almost seamless interchanges, (b) investing in rail infrastructure both over and underground, (c) providing travellers with live updates on which is the fastest combination of transport modes from their location to their destination[32], (d) integrating even more fares and tickets.

A great effort on punctuality and incentives is necessary to secure a high quality public transport. Incentives may vary depending on the ability of public institutions to allocate part of their budget to sustainable mobility projects, but they should include strong discounts for those who prove not to own and use a private car.

[32] This could be achieved by developing a dedicated smartphone application that tracks the device location via GPS or A-GPS, and suggests the shortest (in terms of time) route to the destination with live updates according to delays and connections. To my knowledge, several Web applications serve as public transport route planners, however most of them are not flexible enough to provide users with live updates. These updates are useful especially in emergency cases like delays or sudden malfunctions on the line; being able to reprogram the journey can save time that is very valuable for travellers, especially commuters.

3.2.2 Change the Concept of Car

When Ford first introduced the car to the mass market with the Model T, the concept was a car large enough for a family to enjoy the pleasure of open spaces. All the features that characterized the models more than 100 years ago are still recognizable in modern cars: four wheels, engine, body, steering wheel, brakes, lights, seats, etc.

Technological advancement and numerous incremental innovations made cars safer, more reliable, powerful, comfortable and appealing. Innovation in the automotive sector has led to solutions that were unforeseeable even few years ago but did not changed the basic structure of the product.

The "peak car" phenomenon can be read in two complementary ways. The simplistic interpretation is that inhabitants of developed countries are buying less cars and driving less for a variety of reasons. A deeper understanding of the phenomenon leads to consider that maybe the car, as we know it, does not meet anymore the urban mobility demand and its concept needs to be changed. The idea behind this entire project is that the technology "car" has reached saturation as users have already taken full advantage of all its benefits. Furthermore, as sustainable mobility is changing individual preferences towards a more car-free urban development, the demand for radically different road passenger vehicles will deeply modify the automotive industry in the future.

Although carmakers routinely think more than 10 years ahead, presenting yearly various innovative and efficient prototypes of new passenger vehicles, no tangible effort in developing new mobility devices has been made. Auto companies are still approaching to car design and engineering as they did so far, while in the future, urban society in the developed world is expected to be more inclined to UEVs and PMVs use.

Urban Electric Vehicles

Vehicles such as the Estrima Birò, besides being significantly cheaper to run than passenger cars for short journeys, sustain a more environmentally friendly concept of mobility. Presently, some European car manufacturers include in their catalogues full electric vehicles. This solution is often seen as a way of reducing the average emissions of their new car fleet, rather than a clear effort in developing a fossil fuel free mobility.

Apart from Estrima which is a small reality operating in the Italian North-East industrial district and other small companies spread around Italy and Europe, Renault is the only car manufacturer in Europe that developed and marketed a proper lightweight electric quadricycle.

The design of almost all the urban electric vehicles available in the market is very simple and easy to duplicate. Most of them have a tubular frame, brushless in-wheel electric motors, lithium-ion rechargeable (in some cases also removable) batteries, polycarbonate body panels and plexiglass windshield and windows. Optionals vary depending on make and model but they generally offer quite the same comfort as a small utility car.

Given the simple design and structure, with very few and basic components, it is very difficult to believe that other leading European car manufacturers do not have the capabilities of producing such vehicles, considering the technology they have at their disposal.

It is true that the market for urban electric vehicles may be limited at this time. However, the analysis of automobile market trends in most European countries and the implication of the peak car phenomenon suggest that the size of the demand could increase exponentially in the next years as the European Union and the local authorities tighten pollution reduction regulations.

Moreover, the automotive market has been quite frequently characterized by a technology-push strategy, in which innovations are introduced to create the need that then drives demand. Considering the development of urban electric vehicles, car manufacturers can experience a hybrid push-pull strategy. On one hand, the demand for small, versatile and electric vehicles is already building up by itself especially in big metropolitan areas; on the other, carmakers could incentivize and increase the spread of UEVs by pushing new products into the market, creating awareness and acceptance.

The agility through traffic, ease of parking, zero emissions, very little maintenance and reduced operating costs make lightweight electric quadricycles perfect for vehicle sharing solutions, too. In this way, carmakers would be able to give prospective customers a real taste of the capabilities of these vehicles and at the same time understand in which direction focus the efforts of research and development departments.

Even with the present structure, configuration and technology, urban electric vehicles can easily meet short-to-medium distance mobility demand in urban areas especially where and when public transport do not fulfil the needs of travellers.

Personal Mobility Vehicles

Personal transporters represent another new frontier of urban mobility. They are small size electric devices, conceived for individual use and short journeys in the urban environment (typically to cover the last part of a multimodal trip), with relatively low top speeds (around 20 km/h) and an adequate operational range. Firstly designed as devices that help limited movement capability individuals' mobility, they were soon used for a variety of applications.

Many challenges undermine the creation and maintenance of a low carbon transport society. Urban air pollution caused by vehicular emissions, waste of energy and resources caused by the consumption of fossil fuels, traffic accidents and fatalities, detriment to human health caused by overdependence on motor vehicle use, economic cost of traffic congestion, degradation of public transport services due to decreased use and management and social need for public transport services to ensure mobility, are just some of the problems the developed world societies are facing in recent years.

The recent European Union policies for sustainable urban mobility, while maintaining a regulatory approach, also push towards creating a virtuous cycle of voluntary reduction of car use. However, a systematic process of substituting cars with electric vehicles in urban areas is essential to the future well living in city centres. PMVs represent a suitable technological innovation to assist in achieving this goal. Apart from the technological limitations that mainly relate to power output and battery range, the main concerns derive from regulatory standards, social acceptability and infrastructure adaptation.

PMVs such as the Segway are used in almost all the developed world but mainly in niche markets such as guided city tours or as patrol vehicles for law enforcement agencies or city watches. In Europe, personal transporters are typically allowed within city limits where pedestrians and bicycles are allowed, even though there is not a clear and unified way of defining personal transporters as proper vehicles, and the regulatory standards vary significantly between countries. In some nations, the use on public roads is permitted, but often with restrictions.

Social acceptability concerns arise when trying to understand how wide the demand for these vehicles would be. Demand depends on which the intended use of the product is and, at this time, personal mobility vehicles are

used only for very specific purposes, rather than as proper means of transportation. Regulatory frameworks influence how people see these vehicles and the current confusion in defining how, where and whether personal transporters can move around cities creates uncertainty among potential customers. Moreover, the comparison of these vehicles with bicycles, considering the current design and technical aspects, drastically reduces acceptance[33].

As for today, personal mobility vehicles' technology and structure are not optimal for daily use and commuting. Some elements need to be introduced in order to increase comfort and practicality, such as weather protection, removable battery, storage space, comfortable driving position and safety features.

Unlike UEVs, personal mobility vehicles have attracted some car manufacturers' attention. General Motors (EN-V), Toyota (Winglet), Honda (U3-X) and Hyundai (E4U) concepts of personal transporters may hit the production line in future years. The overall configuration of these electric vehicles allows very special and unique designs and it fosters the incorporation of the most recent innovations and technologies in the fields of connectivity and autonomous driving capabilities.

One way in which personal mobility vehicles would be able to sustain commuting without changing the current design, is through a close integration with public transport services providers. By combining the high flexibility of PMVs with the range offered by public transport, these vehicles might become appealing also to daily commuters. Being able to access train and/or subway carriages, charge the vehicle while travelling and then

[33] From a cost perspective, there is no incentive in using personal transporters instead of bicycles. The initial price and operating costs are not in favour of PMVs. Bicycles are healthier, greener and easier to use than PMVs and they have almost the same performances.

continue the journey to work would increase drastically the operating range of personal transporters. In particular, trains may have the maximum level of compatibility with PMVs since carriages could be easily designed to contain several vehicles and the electricity needed to charge every unit could be taken directly from the same grid that powers the train.

A type of mobility that includes the use of personal transporters requires also a certain level of infrastructural changes and adaptations. Since PMVs can only travel on sidewalks (or pedestrian areas) and bike lanes, an increasing proliferation of this mode of transportation will require the development of the existing infrastructures in order to facilitate mobility for example by expanding the bike lanes network.

Apart from public transport that has been proven to be the less expensive mean of transportation, the analysis conducted in this chapter unveils that for each different commuting profile there is a set of modes that minimize transportation costs.

Depending on the distance between the residence and the workplace, workers who assume a transportation costs reduction perspective may choose different vehicles for commuting. For distances longer than 20 km, passenger cars still maintain their leadership as means of transportation, especially those with CNG and hybrid motorizations. Under the 20 km threshold, UEVs and PMVs increasingly gain importance.

Together with scooters, small electric vehicles are the key for reducing traffic and pollution in urban areas, in particular in metropolis like Milan. While providing several benefits to the society and the environment, these vehicles also minimize transportation costs for those commuters who cannot use public transport to go to work.

Leading car manufacturers should consider producing very small urban electric vehicles, in order to meet the demand that will be generated around the two pillars of sustainable urban mobility and transportation costs minimization. Relying on their ability to innovate and quickly reach economies of scale and profitability, carmakers can successfully introduce in the market products and solutions with superior characteristics with respect to existent competitors. Together with product reliability and innovative solutions, price competitiveness could be another key element to attract even more customers to this type of vehicles, given that one of the main obstacles to a widespread acceptance of UEVs and PMVs appears to be also the high initial price.

CONCLUSIONS

Production and registrations of new passenger cars in Europe have been facing a downward sloping path in the last years showing a strong synchronization with Europe's GDP growth. As the economy in the European continent recovers, the levels of both production and registrations may not get back to those of 2007.

Despite a growing effort of industry market leaders towards producing fuel-efficient and less polluting vehicles, the continuous rise in crude oil prices and the more stringent regulations concerning pollutants emissions of cars have halted the long-term growth of the automobile market. Moreover, numerous indicators suggest that the European market has reached saturation as drivers fail in replacing old cars and the motorization rate peaked in many countries.

In addition, the "peak car" phenomenon underlines that Europeans are driving less and are likely to continue doing so. According to numerous researches conducted in the field, peak car could represent the early sign of a turning point after which the trends in car ownership and use in developed economies are expected to face a long-term decline. Even though the precise causes of this phenomenon have still to be defined, environmental policies that aim at containing greenhouse gas emissions by reducing travel time and length, traffic reducing policies and an increased awareness of other modes of sustainable mobility, seem to have contributed to the rise of peak car. Furthermore, the holistic approach assumed by the European Commission that aims at creating awareness among travellers of the importance of reducing the gap between social costs and benefits of using the car, especially in metropolitan areas where the impact of traffic has stronger consequences, might have contributed as well.

Aside from the role of Governments and Institutions in regulating the levels of pollution and traffic, individual choices of travellers participated in reducing car use. Younger generations seem to have lost interest in owning a car and even being entitled to drive one, whereas elder travellers changed their choices of destination and propensity to make car trips probably because they have progressively gave up to move outside the basic needs of daily life (for example by reducing the leisure related travel demand).

Individual choices are clearly influenced by many different factors. Some scholars, in trying to assess the influence of ICT on mobility demand, unveiled that many different Internet services such as online shopping, telecommuting and various online social networks might have affected the propensity to travel of individuals.

All the factors considered throughout the entire project underlined that urban mobility is starting to change. The combination between the analyses conducted in the first chapter and the implications of the peak car phenomenon suggests that the modes of transportation might radically change as well. Few authors recognized that the saturation of demand for new passenger cars might be the sign that consumers have already taken advantage of all the benefits the car had to offer and now they are looking for other modes of urban transportation. Under this assumption, the third chapter investigated the Italian mobility by assessing the operating costs of various modes of transportation. The analysis gave the expected results.

While the cost evaluation proved, not surprisingly, that public transport is the cheapest method of transportation, the analysis concerning other modes showed very interesting results. Assuming a transportation costs reduction perspective, the choice of the most suitable means of transport for commuting depends on the average distance driven per year.

Using the car is worthwhile only when public transport is not available and for performing long-distance commuting. In the urban context and for short distances other modes were proven more suitable and economical. In particular, urban electric vehicles and personal mobility vehicles showed the highest potentials among all. The electric configuration and the simple structure make these vehicles highly suitable for the urban environment and for supporting the concept of sustainable urban mobility.

While the cost analysis proposed could help commuters in determining which are the cheapest mobility solutions considering the distance travelled every year, the challenging purpose of this project is to unveil a potential new market that carmakers should explore in order to maintain long-term growth and profitability.

The opportunities offered by reinventing urban mobility are numerous and, potentially, very rewarding. Yet, as urban electric vehicles and personal mobility vehicles are concerned, it appears that most of the leading car manufacturers have not planned to produce such vehicles. Hence, there is no rising pressure in challenging the status quo of the European automotive industry and the disruptive technological changes are almost null. It looks like the idea of car-dependence has become inherent in the current everyday life so that, if some truly innovative solutions emerge, they automatically appear non-compliant with the current idea of mobility. Then, an important question arises: why are carmakers not supporting a systemic shift towards sustainable urban mobility?

To give a complete and exhaustive answer to this question it would be necessary to perform an in-depth analysis of the past, current and future strategic patterns followed by leading automotive industry players that goes beyond the scope of this project. However, assuming an industry level

perspective, it is possible to recognize some causes of the automotive industry inertia that prevent the successful expansion of alternative niches.

Smith and Tushman (2005) underlined that organizational performance depends on the ability of organizations to combine processes of exploring opportunities with activities of exploiting current markets. Often, as the dimensions and the complexity increases, organizations tend to focus on the exploitative activities, leaving variance-increasing actions to smaller and more flexible firms.

In the case of the automotive industry, many sources drive industry stability and most of them are generally related to the role of carmakers as essential organization for the European economic fabric. The wider socio-economic setting contributes as well.

Car manufacturers worked very hard in the past to create, maintain and develop products and process technologies in order to support a powerful business model. The continuous improvement of the products (increase efficiency, performance, safety, comfort, etc.) and processes (for example progressive automation and vertical disintegration) clearly determined the overall technological trajectory that aimed (and aims) at meeting the regulatory requirement and current customers' needs, with the lowest possible risk for the business. Economies of scale, learning curves, positive externalities, availability of specialized suppliers and a widespread "market share increase" mind-set produced a strong technological lock-in effect that carmakers seem to be unable to escape. The history presents numerous attempts that challenged the business logic of the automotive industry by introducing passenger cars or technologies completely new to the market; unfortunately, they had short, if not null, life. An example could be V.O.L.P.E. Car. The Company started in 2006 as a joint venture between automotive research centres and renowned universities and relied on the

skills and abilities of more than 280 engineers, designers and specialists in different fields. Soon after the lunch of their first vehicle in the early 2012, the Company interrupted all the digital communications with prospective customers and dealers and, at the time being, there are no precise information available on what happened.

More generally, the characterization of the automotive industry as economically and socially critical in the European economic environment allows the existing structure to enjoy a privileged status. Inevitably, once established as a vital sector, policymakers have been reluctant to enforce potentially punitive environmental regulation. For example, it is interesting in this regard that Denmark, Norway and The Netherlands, lacking a native automotive industry, are at the forefront of environmental regulations in the field and among the most car-free countries in Europe. In addition, the car became firmly ingrained as a consumer durable cultural icon, so much that other solutions are often depicted as a threat to individual freedom to move. Social, economic and cultural factors are barriers that prevent entrance and spread of radical innovations and carmakers usually exploit these opportunities as a protection for their existing products and business models.

Vehicles manufacturers do not have any incentive in changing the existing technological paradigm because it is the one that preserves and exploits all the knowledge and capabilities that have been developed in the years. Sustained innovations drive the competitiveness only within a specific technological trajectory and are perfect for targeting existing customers' needs at the lowest possible cost.

Conversely, disruptive and architectural innovations such as urban electric vehicles are characterized by a very high level of uncertainty and target an unknown customer base. The lack of a well-defined market and unattractive margins collide with the firms' risk aversion and ability to allocate scarce

resources and that is why these projects are not backed in and usually rejected.

Understanding whether is it necessary to restructure the automotive industry as a whole and the business models of its participants in order to introduce a new concept of urban mobility is addressed to further researches. However, from the analysis conducted it appears that the automotive industry can sustain a technological transformation towards more urban and sustainable vehicles without the need to make fundamental changes to operational practices, norms and strategies.

As previously stated, urban electric vehicles and personal mobility vehicles are consistent with traditional passenger cars as they are conceived to cover only urban mobility, and not mobility as whole. These vehicles are the perfect example of how carmakers could sustain long-term organizational performance by exploiting and exploring. Traditional passenger car will continue to exist, while the new market will be explored and developed.

Exploring the opportunities offered by a niche market such as that of urban mobility would drive the established technological trajectory towards different patterns, where marginal changes in technology lead to high changes in performance with improvements steeper than demanded. Introducing and developing technologically straightforward products with components that are already existent and commercially available, would give industry leaders the ability to gain advantages in innovations and then the leadership in new emerging markets avoiding leapfrogging by new entrants.

The urban mobility market would be characterized by increasing returns generated by the processes of adoption of the new urban vehicles. In this field, timing is always an important factor. The analysis conducted underlines that some first movers are already exploring the market (i.e. Renault and

Estrima) and developed products that, with different degrees of precision, are meeting customers' needs.

Many studies suggest that first movers benefit of higher returns and survival rates, other endorse the idea that early followers can outperform first movers' performance. In this case, it seems that the early followers' advantages might be higher than those of first movers.

While first movers such as Renault unveiled a demand that was hidden and unexpressed, the analysis suggests that the trends in passenger cars use and ownership, together with the peak car phenomenon implications and the future European Union Agenda in the field of sustainable urban mobility, confirmed the size of the potential demand for alternative modes of transportation. The automotive industry player that will be able to enter the urban mobility market as an early follower, would benefit from the ability of exploiting the demand that has already been created while adopting superior technologies for both products and production processes. Superior products (in both design and technology) together with firm's reputation could ensure a profitable market entrance and strong advantages over other competitors.

This project contributed in determining and understanding the differences between urban and non-urban mobility and differs from others in the field because it avoids considering duality in mobility supply (passenger car vs public transport), considering instead different modes of transportation that support multimodality. It also underlined that most leading carmakers are not expressing clear interests in a market that, if the assumptions hold and the projections and trends are accurate, will grow exponentially in the future. Car manufacturers should play an active role in reshaping the urban mobility, collaborating with public institutions to implement, develop and support a sustainable mobility model.

Creating awareness of alternative modes of transportation and of the difference between urban mobility and non-urban mobility among public opinion is a challenging task.

The required switch from single-mode mobility to multimodality will encounter the resistance to change of many individuals and of several car manufacturers. However, isolating the commuting/urban mobility form leisure related travel would give the possibility to commuters and urban travellers to drastically reduce transportation costs. Producing vehicles properly designed for the urban environment could help car manufacturers to increase the value offered to their customers: combining the flexibility and agility of a motorcycle with the comfort and protection of a passenger car would solve several mobility problems in city centres. Furthermore, the introduction of short-term rental offers that compensate for the inability of urban electric vehicles in enabling non-urban mobility would ensure higher returns and increased market share while reducing the scepticism about electric vehicles.

Finally, the benefits for urban life and, more generally, the community as a whole would be countless. Reduced pollution, less traffic, less noise, easiness of parking are just few of the many advantages that urban electric vehicles provide.

The road to reshaping the urban mobility is obviously fraught with obstacles, however, sustainability in transportation is a choice and, as such, it creates opportunities that depend on the joint commitment of individuals, car manufacturers and public institutions.

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