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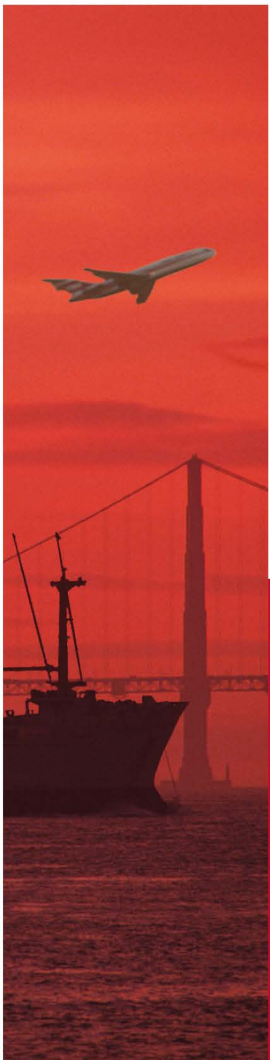

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Research for the TRAN Committee - Infrastructure funding challenges in the sharing economy

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TRANSPORT AND TOURISM

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STUDY

This document was requested by the European Parliament's Committee on Transport and Tourism.

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DIRECTORATE-GENERAL FOR INTERNAL POLICIES
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TRANSPORT AND TOURISM

Research for the TRAN Committee - Infrastructure funding challenges in the sharing economy

STUDY

Abstract

The study analyses the disruption created by shared mobility in the funding of transport infrastructure. While recognizing the benefits of shared mobility in terms of reduction of private car use, the study identifies that there might be short term negative effects on the revenues of long distance railway and coach operators. It also points out other potential risks, which include capturing the revenues through commissions charged by platforms mediating mass-transit services (Mobility as a Service), freeriding and lower tax contributions. The study makes recommendations to reduce these risks.

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LIST OF ABBREVIATIONS

ADEME	Agence de l'Environnement et de la Maîtrise de l'Énergie - French Environment and Energy Management Agency
ALSA	Automóviles Luarca, S.A.
APP	Application software
APTA	American Public Transportation Association
ATEMA	ATEMA Conseil
BCG	Boston Consulting Group
BCS	Bundesverband CarSharing (Germany)
CAPEX	Capital expense/expenditure
CEF	Connecting Europe Facility
CGDD	Commissariat Général au Développement Durable - French General Commission for Sustainable Development
CHUMS	Project Changing Habits for Urban Mobility Solutions
CNMC	Comisión Nacional de los Mercados y la Competencia - Spanish National Authority for Markets and Competition
CO_2	Carbon dioxide
COWI	COWI Consulting Group
ECMT	European Conference of Ministers of Transport (then ITF)
EFSI	European Fund for Strategic Investment
EIB	European Investment Bank
e-TEN	Trans-European Telecommunications Networks
ERDF	European Regional Development Fund
FTC	Federal Trade Commission (USA)
GART	Groupement des Autorités Responsables de Transport - French Association of Transport Authorities
GPS	Global Positioning System
ICT	Information and Communication Technology
IM	Infrastructure Manager
ITF	International Transport Forum (OECD)
MaaS	Mobility as a Service
MAIF	Société d'Assurance Mutuelle à cotisations variables (France)
NUTS	Nomenclature of Territorial Units for Statistics
OBIS	Project Optimising Bike Sharing in European Cities

OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics (UK)
OPEX	Operating expense/expenditure
OTT	Over-the-top (referred to providers)
PHV	Private Hire Vehicle
PIPAME	Pôle Interministériel de Prospective et d'Anticipation des Mutations Economiques (France)
PPP	Public-Private Partnership
PSO	Public Service Obligation
PwC	Price Waterhouse Cooper
RENFE	Red Nacional de Ferrocarriles Españoles
RFID	Radio-Frequency IDentification
SETA	Single European Transport Area
SNCF	Société Nationale des Chemins de fer Français
SUMC	Shared-Use Mobility Center
TCM	Transport Network Companies (USA)
TCRP	Transport Research Board (TRB)'s Transit Cooperative Research Program
TEN-E	Trans-European Energy Network
TEN-T	Trans-European Transport Network
TFEU	Treaty on the Functioning of the European Union
UIC	International Union of Railways
UITP	International Association of Public Transport
UTP	Union des Transports Publics et Ferroviaires - French Union for Public Transport
VAT	Value Added Tax

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EXECUTIVE SUMMARY

Background

The sharing economy is disrupting the transportation industry worldwide. A more complex mobility system is emerging. There are new actors, such as online platforms (BlaBlaCar, Uber and many others) and non-professional service providers (individuals who share their vehicles and rides). New transport services, such as ridesharing and ride-splitting are spreading. Thanks to price-comparison websites, booking apps, and others, a more fluid interaction among the different transport modes as well as among the different transportation players is emerging.

This new mobility ecosystem, however, will need to be sustainable. Transportation requires major investments in infrastructure. As this disruption of the transportation industry unfolds, it becomes necessary to understand how these changes affect investments. In the EU in particular, regulation can play a relevant role to set the right incentives for all players to participate in the funding of the infrastructures, both in terms of maintenance and the development of transportation infrastructures.

Aim

The purpose of this study is to identify the existing and the potential impact of the sharing economy on the funding of transportation infrastructures.

The study uses a broad definition of infrastructures, which includes the underlying physical infrastructures, such as roads, tracks, stations, airports, etc., as well as assets for the provision of transport services such as buses, railways, rolling stock, along with all the necessary support systems, including maintenance, staff, and more.

A new layer, the data layer, is emerging on top of the traditional physical infrastructure layer and the services layer. Online platforms are establishing themselves as managers of this new data layer (in transportation), yet their business models continue to rely on the existing infrastructure. Therefore it is necessary to ensure that the new players and new services enrich the transportation ecosystem without threatening the financial sustainability of the indispensable underlying infrastructure.

A wide definition is also used when it comes to the concept of "sharing economy", which can be understood as "a new socio-economic model that has taken off thanks to the technological revolution, with the internet connecting people through online platforms on which transactions involving goods and services can be conducted securely and transparently" (European Parliament, 2015c, para. 110).

Scope

Shared mobility: a rising challenge

The value of the sharing economy transaction in the transportation industry – the so-called "shared mobility" – in Europe in 2015 has been estimated at EUR 5.1 billion, growing at a rate of 77% from the previous year. This value is expected to reach more than EUR 100 billion in 2025. The revenue of transportation platforms in 2015 was estimated to be EUR 1.6 billion, up 97% from 2014 (PwC, 2016).

Europe is leading in shared mobility solutions, such as subscription-based bike- and car-sharing. The global leader in the carsharing industry is a European company, car2go, and Europe is the continent with the highest revenue for the provision of carsharing services, i.e., around EUR 230 million in 2015 (BCG, 2016).

However, when it comes to urban shared mobility solutions based on highly developed platforms, such as Uber and Lyft, the US and Asia are the global leaders. That is also where more sophisticated services, such as ride-splitting are currently emerging.

The situation is different when it comes to long-distance carpooling: here the world leader is the French platform BlaBlaCar. For example, the number of passenger–km mediated by BlaBlaCar in France in 2015 reached 12% of the passenger-km managed by SNCF, the French railway undertaking, in domestic long distance passenger services (DGDD, 2016). The value of BlaBlaCar transaction for France is estimated to be EUR 210 million in 2015.

Less revenue from passenger fares

The immediate challenge posed by shared mobility to transport infrastructure funding is the reduction in revenues from travellers' fares, as travellers migrate from traditional mass-transit services to new shared mobility services.

Among the different forms of shared mobility, carpooling has the greatest potential to affect traditional transportation. Carpooling empowers owners to make more efficient use of their private vehicles and it is substituting traditional long-distance transportation services (railway and coach), thereby reducing the revenue of existing operators. In France, 71% of long distance carpooling passengers would have used traditional transportation had carpooling not been available, and 64% of car-pooling users are travelling less by train. Carpooling has reduced the number of domestic long distance railway passengers in France by approximately 6% in 2015 (DGDD, 2016).

Shared mobility is not a substitute but rather a complement to urban transportation. Moreover, it is reducing private car usage and ownership, albeit, on a very small scale so far. Mobility as a Service (MaaS), the combined commercialisation of different transportation services by a single provider, may well be the future of urban transportation.

Revenue for traditional transportation is reduced as the substitution of traditional long-distance transportation services by carpooling takes place. Such a reduction is indirectly affecting the revenue of railway infrastructure managers, particularly in countries where railway infrastructure funding heavily relies on access-charges imposed on railway undertakings (France, Belgium and Germany in particular). No substantial effect is identified for road infrastructure funding, as it does not rely so significantly on tolls, and in any case, carpoolers also pay road tolls.

Revenue reduction might trigger a vicious cycle of reduction in frequencies and further reductions in passengers in long-distance railway and coach services. Furthermore, such substitution increases the cost of Public Service Obligations (PSO) and threatens the sustainability of PSO financing thanks to internal cross subsidies in an undertaking with exclusive rights for the provision of packages of both profitable and non-profitable services. Revenue of railway infrastructure managers is also reduced.

However, in the long run the situation could also reverse. As private vehicle ownership diminishes at the urban level due to the attractiveness of alternatives to the private vehicle (both new shared mobility and traditional public transportation), travellers will increasingly rely on alternatives to private vehicles for long distance trips. It is estimated that if 10% of private vehicle users stop using their cars, the number of passengers using alternative services, including traditional public transport and shared mobility solutions, would double.

Other challenges

Online platforms can reduce the funding available for transportation infrastructures by capturing a growing share of the value created in the entire mobility ecosystem. Online platforms charge commissions for their intermediation services. Such commissions are typically set around 20% and have even reached 30% of the total value of each transaction. Value capture does not seem to be an issue at the moment, as platforms have created new markets. Platform users, both drivers and passengers, keep growing despite commissions. However, as platforms might take a leading role in integrated mobility solutions, including traditional services (such as Mobility as a Service), commissions might capture part of the already tight revenue of traditional public transportation companies, both urban and long distance.

It is important to ensure that as shared mobility evolves, all players in the mobility ecosystem contribute to the funding of infrastructures without freeriding. The examples of media, telecommunications and electricity show that freeriding can reduce the available financing for infrastructures. While the same effect is not observable to a significant extent in transportation yet, this may well happen in the future as platforms start commercializing both traditional public transportation services and new shared mobility solutions under a single roof. The conditions (i.e. pricing) to be negotiated between platforms and traditional public transportation providers (often public authorities) will be of a key importance.

As public subsidies are a major source of infrastructure financing, it is important to ensure that new players such as platforms and non-professional providers contribute to the funding of infrastructures.

Finally, transportation platforms concentrate a great amount of interesting data that can be commercialised. However, new revenue derived from big data management might not be reinvested in infrastructure.

Recommendations

1. **More statistical information,** particularly in an EU-standardized format on shared mobility is necessary. National best practices should be monitored to produce a good set of data from surveys, web-crawling and traditional statistics at EU level.

2. **New shared mobility services should be integrated into the existing regulation**. This way, legal certainty will increase and coherent regulatory policies across all transport modes, both traditional and new, will be possible. Most of the competences on transport regulation are national but the EU has competences to ensure the free provision of information society services.

3. **Shared mobility should be promoted as a substitute for the use and ownership of the private vehicle.** Specific measures are proposed: (i) Promote each single shared mobility service, in particular ensuring legal certainty; (ii) Promote the complementarity of shared mobility to mass-transit services (first mile/last mile, etc.); (iii) Promote Mobility as a Service as the instrument to combine mass-transit and shared mobility services as a valid alternative to the private vehicle. Transport infrastructure will benefit from the increase of passengers and revenue in mass-transit systems.

4. In limited cases, shared mobility might compete with mass-transit services. A level playing field is necessary. It is recommended to **eliminate potential regulatory advantages that favour shared mobility over mass-transit services,** such as undue exemptions from charges for the use of the infrastructure, taxes, social contributions, or PSO financing, particularly when such advantages go against the commonly agreed policy objectives to reduce congestion, environmental damage and accidents.

5. **Shared mobility should be taken into consideration for the redefinition of some public service policies**. Competition from shared mobility is threatening cross-subsidies in mass-transit franchises of profitable service and non-profitable services. This is often the case when minimum frequencies are imposed and peak services finance off-peak services. At the same time, shared mobility provides new possibilities for a more efficient provision of public service.

6. As a new data layer emerges over the traditional physical infrastructure layer and transport service layer, it is recommended to **closely follow the evolution of platforms' activities in order to identify at an early stage arrangements that challenge the financing of infrastructure.** Challenges to financing can derive from value capture by platforms in the form of **commissions**. They can also derive from **freeriding** as in the case of telecommunications and energy infrastructure.

7. Online platforms are centralising a large amount of data on mobility. It should be ensured that **online platforms share big data** on itineraries, frequency, duration and other travel parameters. Similarly, online platforms are well positioned to share data with public authorities for the management of taxes and other legal obligations.

1. INTRODUCTION

1.1 Purpose

Digitalisation is disrupting the transportation industry just as it previously disrupted media, telecommunications and other industries. Thanks to digitalisation the "sharing economy" is on the rise also in transport. A series of new applications and digital platforms are essentially bringing down the transaction costs of sharing and thereby scaling up such well known activities as carpooling to a size that makes them a relevant competitor on the market for transport services. At the same time new services based on the concept of sharing either a ride or a vehicle are rapidly growing.

These new services and new service providers use traditional infrastructure, even if they access it in new and creative ways. The sharing economy does not change the fundamental fact that transportation requires physical infrastructures and the transportation ecosystem will only be viable as long as the necessary funding is available for the development and maintenance of this infrastructure. The failure to adequately invest in the transport infrastructure might eventually even limit the potential of the EU economic growth and prosperity.

The aim of this study is to evaluate how the sharing economy might disrupt the existing funding instruments for transport infrastructure. It analyses the impact of shared transport on traditional forms of infrastructure funding, particularly on revenue derived from traveller fares, as shared transport might substitute existing transport modes and capture a portion of such revenue. The study also examines how shared transport contributes to infrastructure funding in the form of tax payments.

Based on the results of the analysis, the study concludes with some policy recommendations. They mainly focus on three goals: to ensure transparency on how shared transport affects investment, to stimulate the right incentives for all players to participate in the funding of the infrastructure, and to guarantee the availability of the necessary investment to maintain and develop transport infrastructure in Europe.

1.2 Methodology

The analysis of the infrastructure funding challenges in the sharing economy faces some specific difficulties. There is no universally recognised definition of what the sharing economy is. Therefore, the study's point of departure is the analysis of the different definitions of the term, and the identification of the definition that will be used throughout the study.

Furthermore, data on the sharing economy in transportation is scarce. Shared mobility services are usually provided by small service providers, often non-professional ones. Such providers do not publish statistical information about their activity. Online platforms aggregate all the information about the services they intermediate, but this information is not published either. Public authorities are starting to elaborate statistics, but they are not common yet. Therefore, publicly available information is very limited.

For this study, we have identified the most relevant data on the magnitudes of shared mobility, as well as data on the profiles of both service providers and consumers. Large surveys made to shared mobility users provide interesting information. Particularly interesting data can be extracted from online platforms through web-crawling technologies. Web crawlers are software applications that automatically and repetitively derive information from the web. They allow for the systematic extraction of information publicly available in online platforms. This makes it possible to calculate the number of rides that are offered in the platform in a specific city or route, evolution over time, etc. For this study, however, no web crawling exercise was used, but we have used as sources specific web crawling exercises by different entities, in particular on carpooling platforms.

Finally, data on the sharing economy is fragmented. Rich data can be identified, for example from web crawling exercises. However, such data are limited to a city, a route or even a country, but it is not available under standard terms for a significant number of countries or over an extended period of time. As a result, standard data across countries and along a significant period does not exist.

In order to determine the impact of a shared economy on urban transportation and on long distance mass transit, two empirical analyses on the relevant transportation segments have been undertaken. Results confirm that the dynamics are different in these two transport segments. For long distance transport, the only shared mobility service of relevance is carpooling. Carsharing or ridesharing have very limited development on long distance. Therefore, the analysis is focused on carpooling, and results show that it is partially substituting mass-transit services. For urban transportation, there are several successful shared mobility services (bikesharing, carsharing, ridesharing and ride-splitting). Carpooling, on the contrary, has not caught up yet for short distances. At the moment, there is no evidence of substantial substitution of mass-transit by shared mobility services. On the contrary, analyses suggests that shared mobility complements urban mass-transit and, combined, creates an attractive substitute for the private vehicle.

In both cases, the studies have been limited to land transportation. Other transport modes, such as air transportation or maritime transportation, have not been included in the study, as it had been confirmed that the effect of the sharing economy on these two transport modes has been extremely limited for the moment. There are studies that demonstrate that the substitutability between carpooling and air transport is very small, due to the difference in prices and travel duration (UIC, 2016). Surveys also suggest that shared transport users do not consider air travel as an alternative to shared transport (ADEME/6T, 2015). The same reasoning applies to maritime transport.

The study has focussed on passenger transportation and it has not included freight transportation. Again, the impact of the sharing economy has been more relevant in passenger transportation up until now. The dynamics that evolve in this area are, however, relevant for the entire transport system and will affect the freight sector as well. There is room for shared transport of goods, particularly in short-distance transport, as providers are very fragmented, and efficiency is low (for instance, there are a lot of empty runs). In the US, Uber is already offering freight services possibly heralding a major disruption of the entire logistics sector (McDermott, 2017).

For this study, we have opted to focus attention on those cities or countries where shared mobility is more mature. Therefore, we looked at France for carpooling, Paris for bikesharing, Berlin for carsharing, and San Francisco and other US cities for ride sharing and ride-splitting. There is more information available for these locations. This information is also more representative of the trends in shared mobility, as services are more mature. We have complemented such in-depth analysis with references from other cities and countries, to confirm our assumption that the trends identified in the leading cases could be extended to other locations.

A further method used for the study is the analysis of the challenges faced in other network industries, particularly telecommunications and energy. These industries are facing parallel challenges. By extracting lessons from these parallel challenges, some potential threats to transport infrastructure have been identified. Analysis on this point is more theoretical. As shared transport is not as mature as parallel phenomena in the other industries, it is only possible to indicate how the industry might evolve, and the kind of challenges that might be faced, but no specific figures can be provided.

Finally, in-depth interviews have been conducted with the most relevant players: online platforms, traditional transport providers, infrastructure managers, transport authorities and leading academics active in the fields of transportation and technology. The interviews have put the existing data into perspective. They also confirm the extent of ongoing transformation of the industry and identify new trends.

1.3 Structure of the study

The study is structured as follows. Chapter 2 introduces the concept of "sharing economy", describes the most popular shared mobility options, and points out the correlation between the data layer and the transport infrastructure. Chapter 3 contains the analysis of the impact of the sharing economy on long distance transportation. Chapter 4 focuses on the determination of the effects of the sharing economy on urban transportation. Chapter 5 analyses the trends, opportunities and risks posed by the sharing economy to transportation, and specifically to the funding of infrastructure. Finally, Chapter 6 provides recommendations to be considered at the EU or national level.

2. SHARING ECONOMY AND TRANSPORT INFRASTRUCTURE

KEY FINDINGS

- The **concept of "sharing economy"** has been defined as "a new socio-economic model that has taken off thanks to the technological revolution, with the internet connecting people through online platforms on which transactions involving goods and services can be conducted securely and transparently" (European Parliament, 2015c, para. 110).
- Enabled by technology, new transport modes emerged that are neither traditional private transport (private car, motorbike or bicycle) nor mass-transit services (railways, coaches, urban buses, subway, etc.). These are referred to here as **shared mobility** services or shared modes.
- **Five forms of shared mobility** are identified: (i) Bikesharing; (ii) Carsharing; (iii) Carpooling; (iv) Ridesharing; and (v) Ride-splitting.
- **The value of transactions** in shared mobility in Europe **in 2015** has been estimated at **EUR 5.1 billion, and transport platforms' revenue reached EUR 1.6 billion** (PwC, 2016). The value of transactions **in 2025 could be above EUR 100 billion**.
- Online platforms are the managers of the new data layer in transport and rely on the existing infrastructure, but in new and creative ways. New players and new services **enrich the transport ecosystem,** but at the same time, they have to ensure the **financial sustainability of the indispensable underlying infrastructure**.

2.1 The concept of "sharing economy"

2.1.1 "Sharing" as a new socio-economic model

Sharing, defined as using an asset jointly, either at the same time or in turns, is as old as humanity. However, over the last decade, a new socio-economic model has emerged around the notion of sharing both assets and services. Different factors are fuelling the new model.

First, citizens, organisations and public authorities are increasingly aware of the negative environmental effects of life-styles in industrialised societies. The accelerated acquisition of goods is depleting natural resources, contaminating air, water and soil, and reinforcing climate change. Transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities (European Commission, 2016b p. 2).

Second, increasing economic hardship is generating a new demand for low-cost services. The financial crisis of 2008 has reinforced this trend. Air transportation is a good example but also the proliferation of low-cost coach services in Member States such as Germany and France (Steer Davies Gleave, 2016).

Third, there is a general trend towards choosing access over ownership. Individual ownership of assets is replaced with the possibility to use assets without owning them. For instance, consumers are increasingly aware of the individual cost of owning assets in terms of maintenance, repairs, insurance, storage, etc., as well as of the externalities in the form of congestion, environmental damage, etc. The reduction in the rate of private vehicle ownership in the most developed societies is a good example, as is the even more significant trend among young people to either not obtain a driver's licence or put off taking their licence exam (Beck, 2016).

There is a consensus on the identification of technology, in particular Information and Communication Technology (ICTs), as the new element that has made the emergence of the new socio-economic model possible. Internet ("interconnected networks") allows for seamless and inexpensive communication through previously isolated telecommunications networks. Smartphones allow universal communications as well as geo-localisation. Computers allow the automatisation of procedures through the execution of algorithms. All these elements together have dramatically reduced the transaction costs of sharing.

2.1.2 Terminology

Different terms are used for this new socio-economic model. "Sharing economy" is the most popular term in the English language, but there are alternative terms such as "collaborative consumption", "collaborative economy" or "on-demand economy". In other languages, terms such as the French "économie collaborative" or the Spanish "economía colaborativa" are popular.

Terminology reflects a debate on the concept. Authors and institutions that underline the peer-to-peer element prefer the term "collaborative consumption" (Botsman, Rogers, 2010).

Other stakeholders that underline the interaction through platforms and the flexibility to provide services on-demand seem to prefer the term "collaborative economy". The Commission, for instance, defines the "collaborative economy" as "a complex ecosystem of on-demand services and temporary use of assets based on exchanges via online platforms" (European Commission, 2015a, p. 3).

Finally, the most common English term both in Europe and in the US is "sharing economy". This is the term used by the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Even if the word "sharing" might evoke non-profit services, the most common understanding of the term does not exclude for-profit services, or services other than peer-to-peer, or renting assets specifically acquired for this purpose (and not only under-utilised assets) (Sundararajan, 2016).

All the key elements of the sharing economy are included in the definition used in resolutions of the European Parliament: "a new socio-economic model that has taken off thanks to the technological revolution, with the internet connecting people through online platforms on which transactions involving goods and services can be conducted securely and transparently" (European Parliament, 2015c, para. 110).

2.1.3 The leading role of online platforms

Online platforms are playing a leading role in the reduction of transaction costs (Parker, Van Alstyne, Choudary, 2016). Platforms have been defined as an "undertaking operating in two (or multi)-sided markets, which uses the internet to enable interactions between two or more distinct but interdependent groups of users so as to generate value for at least one of the groups." (European Commission, 2015b, p. 5).

Online platforms concentrate the technological innovations for the interaction of the parties interested in sharing goods and services. Parties interested in sharing identify themselves in the platform, and they choose the goods and services to be shared, their location, the conditions, etc. Platforms match owners of assets to be shared with users interested in making use of them. Algorithms automatise the matching process (Evans, Schmalensee, 2016), which takes place at a very low cost. The concentration in the platform of very large pools of providers and consumers creates the fundamental indirect network effect (Evans, 2011) that ignites a platform (Libert, Beck, Wind, 2016). Therefore, the cost of gathering information on the availability and location of an asset or a service is dramatically reduced. Individuals can inexpensively communicate to agree on the sharing terms. Trust is made possible thanks to the new cultural values facilitated by the social networks, as well as by specific instruments provided by the platform such as identification of the users, evaluations, “likes”, artificial intelligence tools that help to manage ratings and exclude fraudulent ratings, etc.

Lower transaction costs multiply the possibilities to share (Munger, 2015). Sharing is mostly possible when the transaction cost is lower than the value obtained by the individuals involved in a sharing transaction. Traditionally, sharing was limited to transactions with low transaction costs (sharing with relatives or friends), or to high value transactions. Now that transaction costs are very low, sharing is possible even when the value of the transaction is very low. It is possible to share just for a few hours an under-used asset such as a hand-drill, just as it is possible to share a bicycle, a car, a ride in a car, a yacht or even a jet (Goudin, 2016, p.10-11).

The reduction of transaction costs has fuelled sharing, as it has reinforced the pre-existing trends to diminish ownership of assets, lower the expense in services and decrease the environmental footprint of our day-to-day activities, including transportation.

All these trends crystallised by the end of 2008 and the beginning of 2009, when the leading platforms were established: Airbnb was created in San Francisco in November 2008, and Uber was created in San Francisco in March 2009. BlaBlaCar was set up in Paris in 2006, but it was only in 2009 when the app for mobile smartphones was launched. Transportation has been one of the leading areas of the sharing economy from its inception.

2.1.4 Other elements

Sharing often has a connotation of a non-profit activity. Some original sharing economy platforms did not foresee any payment among participants. This was the case of homeexchange.com. In other cases, payments were reduced and were supposed to cover expenses or share some common costs, but not to make a profit. This was the case of Couchsurfing or BlaBlaCar.

However, the sharing economy cannot be limited to non-profit activities if we want to fully include in our analysis the deep transformation that digitalisation is bringing to society. The sharing economy has to include for-profit platforms, as well as service providers that aim to have a profit.

Sharing economy platforms allow non-professionals to commercialise their assets and offer services. Before the sharing economy, professionalisation had often been the result of high transaction costs. Transaction costs explain the creation of the modern corporation (Coase, 1937). In the same line, standardisation of services, modern marketing, advertisement and complex contracting were all introduced to decrease transaction costs in the industrial society. All these activities require a minimum scale that goes beyond the reach of a non-professional individual.

As online platforms reduce transaction costs, they allow non-professional individuals to provide services and to commercialise services in competition with professionals and corporations. Peer-to-peer interaction is one of the main novelties brought by the sharing economy.

However, as the sharing economy matures, many non-professional individuals are becoming professional service providers. Furthermore, professional service providers are starting to make use of platforms for the commercialisation of their services. As a result, it is increasingly difficult to draw a borderline around the sharing economy. A very restrictive approach that limits the concept of sharing economy to peer-to-peer services would not allow taking into consideration a significant portion of services provided through such popular sharing economy platforms such as Uber or Airbnb. In this study, a wider interpretation of the term "sharing economy" is used, which includes not only peer-to-peer services, but also professional services provided using online platforms.

Sharing economy platforms allow sharing under-utilised assets. The reduction of transaction costs allows commercialising the temporary use of assets despite the low value of such a use. This possibility introduces a dramatic increase of efficiency, as a large percentage of goods produced in industrialised societies remain idle with no use most of the time. Transport is a prominent example of this: private cars remain idle 96% of the time (Bates, Leibling 2012, p. 23), creating a further cost for parking them when they are not being used.

However, the sharing economy allows the use of assets specifically acquired for the provision of these kinds of services, and not only of under-utilised assets. This is the case for most bicycle sharing systems, where local governments acquire and make bicycles available for use in turn by citizens. It is also the case of carsharing schemes such as car2go, where cars are specifically acquired and made available for use in turn by subscribers. In addition, Uber facilitates the contracting of transport services with professional drivers that acquire their vehicle specifically for the provision of the service. Consequently, for this study, the term "sharing economy" will not be limited to the use of under-utilised assets.

2.2 Forms of shared mobility

What does the sharing economy mean in transport? As we have discussed, transport has been one of the leading sectors in which this paradigm established itself. However, as with the sharing economy in general, different definitions and opinions exist as to which activities can be given this label. Excluding commercial activities does not seem productive as it would exclude some of the most prominent developments such as free-floating carsharing and station based bikesharing systems.

When using a broader definition of the sharing economy, two forms of sharing in transport can be distinguished (Goudin, 2016). Firstly, hiring an asset (car- and bike- sharing schemes) and secondly, hiring a transport service, meaning a car and someone to drive it (ridesharing applications such as Uber or carpooling such as BlaBlaCar). The important thing is that both phenomena (rental cars and carpooling communities) have existed well before the advent of the sharing economy. The defining element is the use of digital applications to facilitate the transaction. The availability of these technologies is the basis of the success of the most prominent players such as Uber, BlaBlaCar and car2go.

Enabled by technology, several new transport modes are currently emerging that are neither traditional private transport (private car, motorbike or bicycle) nor mass-transit services (railways, coaches, urban buses, subway, etc.). These are referred to here as shared mobility services or shared modes.

Naturally, the sector is in constant flux and apps are being developed that might call for an extension of existing definitions. In this study, we will distinguish between the following five forms of shared mobility services: (i) Bikesharing; (ii) Carsharing; (iii) Carpooling; (iv) Ridesharing; and (v) Ride-splitting.

2.2.1 Bikesharing

Short term bike rental systems, usually based on docking stations, have been set up in an increasing number of cities. They usually entail a registration and membership that is possible for short as well as for long term periods. Increasingly, smartphone apps are used to guide users to the next station. Furthermore, electric bikes are becoming more frequent. Different schemes exist in terms of installation and provision of the service, which is usually managed at city-level. A common characteristic is that membership allows the free use of the bikes for the first 30 minutes.

2.2.2 Carsharing

There are various forms that are referred to as carsharing. This study will focus on station based and free-floating carsharing systems (and, by analogy, scootersharing systems) based on memberships which can be found in an increasing number of cities. These systems provide members with access to a fleet of automobiles that can be found throughout the cities. They are rented for short periods, usually up to a day, and usually paid for per minute of use facilitated by an app. In free-floating systems, cars can be picked up and dropped off at any location in the area that the provider covers, whereas in station based systems cars are returned to designated areas. Providers include city administrations or private companies such as car2go, DriveNow or Enjoy.

2.2.3 Carpooling

Carpooling (also called ridesharing, particularly in the US) can be defined as the shared use of a vehicle by a driver (usually the owner of the vehicle) and one or more passengers in order to divide the cost of a trip made fully or partially together. Associated fees cover the price of gasoline or other costs directly related to the trip.

The biggest provider for this "traditional form" of shared mobility in Europe is the French company BlaBlaCar that links riders and drivers usually on medium to long distance trips.

2.2.4 Ridesharing

Platforms such as Uber have emerged as the most prominent facilitator of this service over the recent years. A smartphone application links riders with drivers that are registered with the community. Drivers and riders need to sign up for the service; however, drivers need to provide additional documentation. Drivers can be non-commercially licensed or licensed professionals (with Private Hire Vehicle – PHV - licenses). The driver's and the passenger's location is shared via Global Positioning System (GPS), and payment is facilitated via credit card or PayPal using the app. The app charges the customer a fare that is based on distance but also variable with a surcharge during peak hours.
This type of "sharing" differs significantly from traditional carpooling. The key difference between carpooling and ridesharing is that for ridesharing the driver would not usually have done the trip anyway (Rayle et al., 2015).

As applications evolve, the distinctions among ridesharing, carpooling and taxi services are starting to blur. Traditional taxis increasingly use their own apps as a dispatching service. Additionally, a new and upcoming service that can be referred to as "ride-splitting" or "dynamic carpooling" is offered by ridesharing providers. It essentially allows riders to "cab-pool" their Uber/Lyft ride, by matching riders on similar routes dynamically, significantly cutting costs (see below).

Ridesharing has characteristics of both systems. However, according to an empirical study in the US it can be concluded that ridesharing is overall more similar to taxi services than to carpooling[1] (Shaheen et al., 2014, p.3).

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1 Shaheen further suggests using the term "ride-sourcing" instead of "ridesharing" to differentiate commercial from non-commercial ridesharing. In our study, however, we will only use the term "ridesharing".

2.2.5 Ride-splitting

A rather recent service has emerged namely, "ride-splitting" (or "dynamic carpooling", as in SUMC, 2016). Ridesharing operators and other players are offering a service for passengers on similar routes to share rides with others, pairing them dynamically using the app (uberPOOL, LyftLine). This further reduces costs.

2.3 The rising numbers of shared mobility

The sharing mobility sector has been in a state of constant flux over the last decades, making it hard to find up-to-date and comparable data on its development. The available figures are only indicative of the type of change seen in some EU Member States. Nevertheless, this may help to identify the increasing trend in terms of both number of users and number of vehicles available.

For example, a recent study (University of Leeds - Institute for Transport Studies, 2016, p. 34) shows the growing numbers of carsharing customers and vehicles by selected European countries (Austria, Belgium, Germany, Ireland, Italy, the Netherlands, Switzerland) between 2009 and the most recent year available (2012, 2014 or 2015).

Furthermore, if we look at source websites that host self-reported initiatives, numbers are self-explanatory: none of them is exhaustive and they are mainly based on service registration, yet they reveal a very diverse and rapidly changing environment:

- In 2015, the directory www.collaborativeconsumption.com/directory/ listed about 245 unique initiatives within the sharing economy worldwide in the transport field (Weston et al., 2015). Less than two years later (March 2017) the directory lists 288 initiatives worldwide (+16%) (Collaborative consumption, 2017).
- More than 700 companies are listed on the source website Mesh under the category "mobility", and they cover the different types of sharing mobility worldwide (Mesh, 2017).
- The global Share Guide by "The People Who Share" (The People Who Share, 2017) lists about 800 different companies in the transport category. Thanks to their search engine and filters, it is possible to see that the sharing economy in the mobility field is a phenomenon that is present worldwide.

The value of transactions in shared mobility in Europe in 2015 was EUR 5.1 billion, and transport platforms' revenue was EUR 1.6 billion (PwC, 2016). For 2025, the same study has estimated that the value of transactions could be above EUR 100 billion and the annual revenue of the transport platforms might reach EUR 33 billion.[2]

2.4 Infrastructure and the new data layer

Different definitions of infrastructure exist. While some focus on "large, capital intensive natural monopolies" others differentiate between "economic" (transport, utilities, communication, energy) and "social" infrastructures (schools, healthcare, judicial infrastructure). This study will focus mainly on transport infrastructure but using a very broad definition: It includes the underlying physical infrastructure such as roads, tracks, stations, airports, etc., as well as assets for the provision of transport services such as cars, buses, railways rolling stock, and all the necessary support systems, staff, maintenance, etc.

With digitalisation, the role of infrastructures is evolving. The different infrastructures have always co-existed next to each other; there was a telecommunications infrastructure next to various transportation infrastructures (roads, tracks, airports, ports, etc.) which were parallel

[2] These figures include carsharing, carpooling, ridesharing, ride-splitting and shared parking services. They do not include bikesharing.

to an electricity and a water infrastructure. Of course, there were links among these infrastructures, inasmuch as the different users of the transportation infrastructures were communicating via the telecommunications infrastructure and that the water infrastructure was using electricity to function, for example.

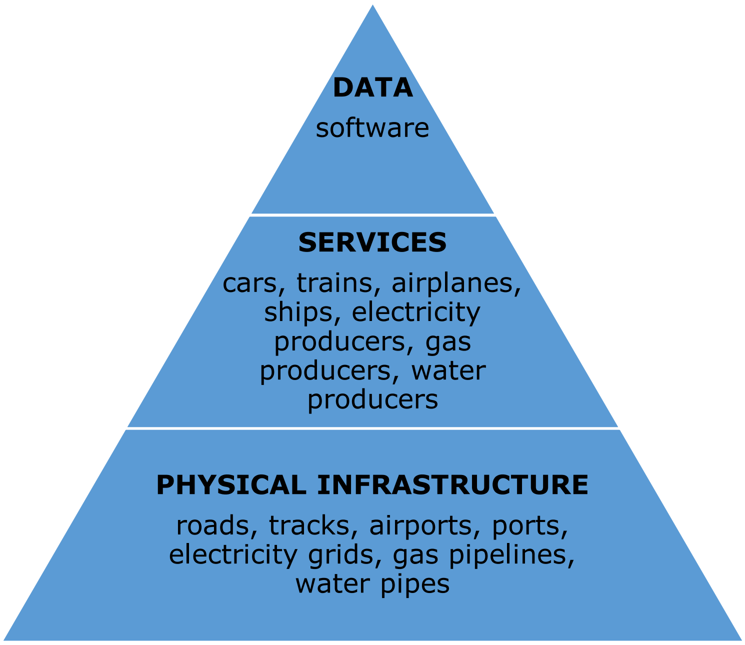
However, with digitalisation, the situation radically changes: while the various above-mentioned infrastructures continue to exist, and even exist next to each other, all these infrastructures have been duplicated, or rather "mirrored" by and in a data or digital layer. Indeed, information about both the state and the usage of the infrastructures is now being generated thanks to sensors, Radio-Frequency IDentification (RFIDs), GPS, satellites, cameras or smartphones, the latter by the users themselves. All this data has come to form a data layer, which contains information about the infrastructures, their state and their usage.

As discussed earlier in the study, online platforms are emerging as leading players in the data layer. In the mobility sector, entities such as BlaBlaCar or Uber operate solely in the data layer. They do not own or manage roads or tracks, as they do not own vehicles. They merely manage software (applications), data and algorithms. Airbnb, which does not own any buildings, functions the same way. However, platforms, as managers of the data layer, are proving to be the cornerstone of a new industrial organisation model.

Just as the internet allows the interconnection of telecommunications networks to provide seamless communication solutions, online platforms allow different transport or energy services providers to connect among themselves and with users, creating seamless mobility or energy solutions. This is the power of the data layer.

The interesting part of this data layer in regards to infrastructure lies precisely in the fact that this new data layer functions like an infrastructure. To recall, the traditional physical infrastructures (such as roads, tracks, electricity and gas grids, water pipes) served as a (physical) foundation on the basis of which services could be offered and developed. Now, there is a new data layer above the traditional physical infrastructure and the service layer. This data layer allows for new services and at the same time changes the nature of the traditional layers. Indeed, all information related to infrastructures is brought together in this new data layer. It is not really the data that are constitutive of the new infrastructure, but rather the algorithms in the software that are making the links between the data.

Figure 1: Layers in new industrial organisation model



Source: authors' own elaboration

This is particularly relevant in transportation, as we will see later in this study. Traditionally, each transport mode operated independently of each other. Fragmentation was the traditional structure in some transport modes. This is definitely the case in road transportation, as millions of independent vehicles use the infrastructure (private cars, taxis, urban buses, lorries, coaches, etc.). Fragmentation is growing even in transport modes traditionally operated as a centralised system: the operation of railway infrastructure, for example, was unbundled from railway undertakings. Liberalisation is bringing a growing number of transport service providers in railways, coaches, air transportation, etc. A similar trend can also be observed in electricity: producers and consumers are highly fragmented and only connected through intermediaries (retailers, traders). Thanks to digitalisation, information about production, consumption and electricity transport becomes openly available, providing opportunities for smart energy services.

We will come back to the consequences of digitalisation on transport later on. At this point, let us briefly mention some examples of the consequences of digitalisation on other infrastructures, namely electricity and telecommunications.

In the case of electricity, the newly emerging data layer contains information about production, consumption, the state of the transmission grid, congestion in the grid, and more. Such information, if properly analysed, does not only lead to more efficient use of the electricity infrastructure or production facilities, but it can also lead to a better consumption of electricity, something called demand-side management. The equivalent of a peer-to-peer service, in the case of electricity, consists of peer-to-peer electricity trading, i.e., exchange between (self-)producers and small consumers. Such peer-to-peer electricity exchanges create all kind of problems for grid operations, including financial problems when it comes to investment in grid development and maintenance. The sharing economy in the electricity sector therefore poses a challenge for the grid as it increases volatility and grid instability, which in turn must be handled by the grid operator at significant cost.

The most telling and most informative example of the implications for infrastructure funding of newly emerging digital services can be found in the traditional telecommunications sector: traditional telecommunications operators are providing connections to the internet, increasingly on a flat-rate basis. Once connected to the internet, individuals, households and firms are then exchanging messages (WhatsApp) and making voice and video conversations (Skype) over the internet, thus undermining the traditional business model of telecommunications operators, which then lack the financial resources necessary to invest in their telecommunications infrastructures. It is a typical example of when value-added moves either to the digital layer or where the usage of the infrastructure simply becomes free.

Digitalisation allows a usage of the infrastructure without covering the corresponding costs in the traditional way, simply because any value-added moves to the services offered thanks to the data/digital layer are not necessarily reinvested in infrastructure.

In the continuation of this study, we will show how this plays out in the case of transport and mobility and make some suggestions regarding how to develop a more sustainable system for infrastructure funding.

2.5 Challenges of transport infrastructure financing

2.5.1 The relevance of transport infrastructure

Infrastructure is crucial for a national and European economy and society to function. It is also crucial for the competitiveness of a national and European economy and all the firms operating therein. Globally there is a rising need for investment in new infrastructure and in the renewal of existing infrastructure in the years to come. In transport in particular, there is an urgent need to invest in infrastructures in a context of complex dichotomies (UITP, 2015):

- Growing demand vs. limited capacity;
- Ageing vehicles vs. climate-oriented commitments;
- Outdated systems vs. new technologies.

Furthermore, in transport as well as in all network industries, there is a growing need for integrating (and financing the integration of) technologies that take full advantage of the increasing amount of data available thanks to ICTs.

While historically the financing and build-up of infrastructure has involved both private and public funds, most infrastructures have eventually become state owned and public. However, the last half of the 20th century has seen a move towards privatisation and new regulatory approaches. Lastly, Public-Private Partnerships (PPPs) have emerged as a way to leverage more private funds for public infrastructure projects.

The supply of financing for infrastructure has been severely impacted by the financial crisis. Shrinking national budgets increase the need to mobilise private funds for infrastructure financing.

Countries across the EU and worldwide have adopted very different models for infrastructure finance and the ratio between public and private funds differs significantly across countries. A European Investment Bank (EIB) study found that in the EU the government sector finances about one third of all economic infrastructure investments, whereas the rest is made up of either corporate or project finance such as PPP (European Investment Bank, 2010, p. 27).

2.5.2 Transport infrastructure funding and transport policy in the EU

The EU has been supporting public infrastructure investments focussing especially on the cohesion regions to foster economic development in the least developed regions. In light of the recent financial and sovereign debt crisis, the EU has increased its efforts to counter the harmful effects of shrinking national budgets for infrastructure funding. Transport infrastructure takes on an especially important role in this regard, as it contributes to the larger goals of the EU.

Transport was included among the Community's common policies in 1957 to contribute to the removal of the barriers between Member States and to favour the achievement of the freedom of movement of goods, services, capital and peoples.

Today's EU transport policy follows the overarching goal of the creation of a Single European Transport Area (SETA) and the completion of the Internal Market for the transportation of goods and passengers by removing barriers to transport operations and by promoting safe, efficient and environmentally sound as well as user-friendly transportation services without curbing mobility.[3] The 2011 White Paper (art. 10) acknowledged that "infrastructure shapes mobility. No major change in transport will be possible without the support of an adequate network and more intelligence in using it. […] It has to be planned in a way that maximises positive impact on economic growth and minimises negative impact on the environment."

As a cross-border framework for the coherent development of infrastructures in Europe, the EU has set up Trans-European Networks in the areas of transport (TEN-T), energy (TEN-E) and telecommunications (e-TEN). The legally binding TEN-T guidelines (European Parliament and the Council of the European Union, 2013c) outline the network to be completed in two stages:

- by 2030 - the core TEN-T network, comprising strategically the most important transport connections from the point of view of the EU, and
- by 2050 - the comprehensive TEN-T network, ensuring connectivity to all the EU regions at NUTS2 level.

The European Commission, together with Member States, estimated the full cost of completion of the core TEN-T to be between EUR 700 billion and EUR 750 billion (Schade et al. 2015, p. 14).

The money to implement the TEN-T network comes partly from the EU, as well as from national budgets and in some cases from private funds. The EU 2014-2020 budget offers a possibility of a maximum of EUR 93.16 billion support for development of transport infrastructure through various instruments, such as Connecting Europe Facility, Cohesion Fund[4] and the European Regional Development Fund[5]. However, these funds together with limited national budgets may not be sufficient to reach the TEN-T policy goals within the desired time framework. The European Fund for Strategic Investments, established in 2015 as part of the Juncker Plan, intends to mobilise additional EUR 315 billion for infrastructure investment within three years. Nevertheless, the scale of necessary investments in transport infrastructure to keep European transport competitive is huge and it is essential to optimise the use of available financial resources. In this context, any possible risks of reduction of funds envisaged for transport infrastructures must be analysed.

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[3] 2011 White Paper (COM(2011)144), accompanying Staff Working Document (SEC(2011)391), in line with the Single Market Act II (COM(2012)573.

[4] For the 2014-2020 period, the Cohesion Fund concerns Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia (European Parliament and the Council of the European Union, 2013c) and several funding opportunities (European Structural and Investment Funds, Jaspers, Interreg, Urbact III, Innovative Actions in Sustainable Urban Development) especially for urban mobility are provided (European Commission, 2017c).

[5] The European Regional Development Fund focuses its investments on several key priority areas (thematic concentration on: a) Innovation and research; b) The digital agenda; c) Support for small and medium-sized enterprises (SMEs); d) The low-carbon economy. ERDF action is designed to reduce economic, environmental and social problems in urban areas, with a special focus on sustainable urban development. (European Parliament and the Council of the European Union, 2013b).

3. IMPLICATIONS OF THE SHARING ECONOMY ON LONG DISTANCE TRANSPORTATION

KEY FINDINGS

- **Carpooling,** as ignited by online platforms, empowers users to make a more efficient use of the private vehicle, but at the same time, it is **a substitute for the use of mass-transit services, in particular railway and coach services,** thereby reducing the revenue of existing long distance transport providers.
- In the most advanced market, **France**, in 2015 carpooling reached an estimate of **6 billion passenger-km.** This is more than 12% of the total passenger-km in long distance domestic railways. In the near future, it could reach 14 billion passenger-km.
- In France, it has been estimated that carpooling passengers paid **EUR 210 million to drivers in 2015**. This could increase to **EUR 1,366 million** in the near future.
- Substitution has reached significant volumes in the more advanced markets. It has been estimated that **SNCF lost 6% of the domestic long distance passengers** in 2015. Substitution is expected to grow further as carpooling matures and network effects multiply, also on medium and low density routes.
- The volume of passengers detracted from mass-transit systems varies across countries depending on several factors: (i) Maturity of the carpooling platforms and network effect; (ii) Competitiveness of the road network (congestion, quality, tolls, bad weather); (iii) Competitiveness of mass-transit services (price, trip duration, frequencies, etc.); and (iv) Legal restrictions.

3.1 Introduction

The sharing economy is having a significant impact on long distance transportation, and in particular on the funding of traditional mass-transit passenger transportation systems such as railways and coaches.

Carpooling via online platforms is the shared mobility service that is having the deepest impact on long distance transportation. Other shared mobility services such as carsharing or ridesharing have a very limited usage outside of dense urban areas.

Carpooling has a long history. Informal sharing of private vehicles probably started as soon as the first motor vehicles were available. Formal programmes to share trips were introduced in the US in 1942 (Chan, Shaheen, 2012), as part of the war effort, to reduce consumption of scarce resources (gasoline, rubber, etc.). Factories, churches or parent-teacher associations were asked to form "car sharing club exchanges". Similar initiatives spread around the US and Europe (ATEMA/ADEME, 2010) as a response to the energy crisis of the 1970's. As environmental awareness increased in the late 1990s, carpooling programmes became popular again. Carpooling was mostly restricted to specific communities (companies, universities, etc.) as members of a community have common transportation needs and the necessary trust amongst themselves. As a result, carpooling was mostly restricted to urban commutes. Carpooling for long distance transportation was almost non-existent.

The critical mass necessary to fully exploit network effects in carpooling (GART/UTP, 2014, p. 32) has been reached thanks to recent technological advances. Online platforms using smartphone apps benefit from the indirect network effects of multisided markets (markets where two or more distinct group interact through a third party). The more drivers and the more passengers that join the app, the easier it is to find a match for each ride.

Trust among users of online platforms is decisive.[6] Specific instruments have been introduced in the apps to generate trust (declarative information, verifications, ratings, comments, etc.). Carpooling platforms have achieved a high level of trust among users, often even higher than trust in work colleagues and neighbours.[7]

Carpooling through online platforms has been particularly popular in Europe and can be deemed a European success story. BlaBlaCar, a Paris based company, has 40 million members and more than 25 million users worldwide. It claims to match 12 million trips per quarter, and to provide access to 2 million trips at any given moment (BlaBlaCar, 2017). BlaBlaCar is the market leader for carpooling in all the large European countries, with market shares above 90% in France, Spain, Germany, Italy and Eastern Europe.[8]

Carpooling exists in the United States but is less popular than in Europe. Lower gasoline prices may contribute to the difference. In the US companies like Zimride and Rideshark help connect existing carpooling systems. Providing platforms for commuter ridesharing such as vRide have proven more popular. BlaBlaCar has launched operations in Brazil, Mexico and India but it is too early to determine the degree of success of these operations.

Carpooling brings evident benefits in terms of efficiency and cost-reduction to road transportation. In France, for instance, while the average occupation rate of a private vehicle is 2.2, occupation rates in carpooling are estimated at 3.4.[9]

Data on the impact of carpooling on collective transportation are scarce and fragmented. It is not possible to provide a systematic European-wide perspective on the reduction of passengers in collective transportation and on the impact on the funding of collective transportation at this time. However, abundant information exists in the more mature area of the carpooling market: France. Even if figures for France cannot be automatically extrapolated to the rest of Europe, the trends in the most mature carpooling market in the world pave the way for the evolution in the rest of Europe.

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6 Sundararajan (2016, p. 60) the digitalisation of trust is discussed, and the concept of "trust infrastructure" is presented.

7 In Mazzella, Sundararajan (2016), based on a survey of 18,289 BlaBlaCar users in 11 countries, it is stated that 88% of respondents had a very high or high trust in a member with a full profile in the platform. The same level of trust in colleagues was declared by only 58% of respondents, and in neighbours - by 42% of participants of the survey. Trust in family reached 94%.

8 BlaBlaCar grew in Germany through the acquisition in April 2015 of its local competitor, carpooling.com, which had 6 million registered users. BlaBlaCar grew in Eastern Europe through the acquisition in March 2015 of Budapest based AutoHop and in January 2016 of Jizdomat, active in the Czech Republic and Slovakia.

9 ADEME/6T (2015), based on a survey, identified the rate of 3.4 persons per vehicle, in line with a previous study by MAIF which defined a 3.3 rate. BlaBlaCar has published a lower occupation rate of 2.8 (BlaBlaCar, 2016a). CGDD has concluded that the occupation rate is even lower (1.4 passengers per car) but: (i) The driver is not included; (ii) It includes the "empty runs" or rides where the driver published a ride but no passenger was matched to it; and (iii) CGDD (and probably BlaBlaCar) does not take into consideration passengers traveling in the car who did not sign through an online platform (relatives or friends of the driver). Taking into consideration these three variables, occupation rates in all studies are similar.

Box 1: Analysis of carpooling by public authorities in France

French authorities have closely followed the evolution of carpooling in France. The French Environment and Energy Management Agency (ADEME - Agence de l'Environnement et de la Maîtrise de l'Énergie) commissioned a preliminary study in 2010 for the identification of the trends in carpooling (ATEMA/ADEME, 2010). The French Association of Transport Authorities (GART - Groupement des Autorités Responsables de Transport), together with the French Union for Public Transport (UTP - Union des Transports Publics et Ferroviaires) commissioned a study in 2014 on the impact of carpooling in collective transportation. One of the conclusions of the study was the need to identify the drivers behind the use of carpooling. An in-depth survey was then commissioned and published in 2015 (ADEME/6T, 2015). Building on this survey and using web-crawling techniques, the French General Commission for Sustainable Development (CGDD - Commissariat Général au Développement Durable) published a study in 2016 with quantitative data on the volumes of carpooling services and the potential for growth in the future (CGDD, 2016).

This public effort has been complemented with studies from private actors. Two studies are particularly interesting. An insurance company, MAIF, published an analysis of carpooling practices in 2009. A group of researchers (Shaheen et al., 2016) conducted a large survey among BlaBlaCar users with the support of the online platform.

This coordinated effort provides a rich amount of data for the analysis of the impact of shared mobility in the funding of mass-transit in France. This section of the study builds on the data published by French public authorities and private actors for the French market.

3.2 Description of carpooling

3.2.1 Profile of the carpooling users

In order to understand the dynamics of carpooling with relation to mass-transit transportation modes, it is important to understand the profile of carpooling users and the incentives driving the use of the service.

According to ADEME/6T (ADEME/6T, 2015), BlaBlaCar users in France are younger than the average population. Passengers tend to be younger (average 34) than drivers (average 37), when the average age in France is 40. In any case, the average age of the users is growing as the service matures.[10] Carpooling users tend to be better educated than the average (both drivers and passengers),[11] and they tend to be single and without children (ADEME/IPSOS, 2013).

Significant differences have been found in the profiles of passengers and drivers. Passengers are often students and employees with a low salary. Drivers tend to be young professionals with salaries below the average.[12] Passengers tend to concentrate in urban areas. Drivers, on the contrary, have a more diverse geographical background. Passengers have a higher use of collective transportation (including shared-bicycle schemes) than the average citizen. The majority of drivers own a vehicle whereas 52% of passengers do not own a car, particularly younger passengers.

[10] According to information made public by BlaBlaCar, the average age of newcomers to the platform in 2010 was 29, while in 2015 it was 34. The fastest growing group in 2015 was that of users above 60 (BlaBlaCar, 2016b).

[11] 47% of users have a college degree, against 13% of the total population. Similar results can be found in Shaheen et al. (2016).

[12] These figures are confirmed in Shaheen et al. (2016).

3.2.2 Reasons to use carpooling

Lower prices are the main driver for the growth of carpooling: 69% of carpooling users chose the service for its price, 12% for the flexibility in the schedule, 7% for the duration of the trip and 7% for the social experience (ADEME/6T, 2015). This finding is consistent across all surveys.[13]

Convenience is also important. According to ADEME/6T (2015), the time of departure is the main factor when choosing one driver over another (89%), even more than the price (79%) or the type of vehicle (22%). In Shaheen et al. (2016), saving time is identified as one of the main reasons passengers use the service. However, availability of the service diverges very significantly among routes. Dense routes across large cities ensure a wide range of options, often more options than mass-transit (night services, strikes, cross-border services).[14] Routes connecting rural areas, on the contrary, provide fewer options or even no option at all. The day of the week is also relevant. It has been confirmed in CGDD (2016) that carpooling services tend to be concentrated over Fridays and Sundays and in general on holiday periods.

As the number of users increases, carpooling becomes more attractive. On denser routes, the occupation rate of a car is higher than on other routes (CGDD, 2016, p. 6). The higher the occupation rate of a car, the lower the price of the service, as costs can be distributed among a larger pool of passengers. In parallel, as the number of drivers on a specific route increases, there are more departure time options. Since low prices and flexibility in departure times are the key parameters to use carpooling, as the number of users increases, the service improves, generating a further increase in the number of users. Such a virtuous cycle is the defining trait of the network effect (Libert et al., 2016).

3.2.3 How carpooling is used

Pricing is the key driver of carpooling success. Carpooling prices are clearly below railway prices (particularly high-speed services) and most of the times they are below coach service prices (see section 3.3).

The leading carpooling platform, BlaBlaCar, recommends a price by dividing the cost of petrol and tolls in three. Prices rarely diverge substantially from this reference. In France, it has been identified that the average price per passenger is EUR 0.06 per kilometre (CGDD, 2016, p. 5). This price will be different in other countries as the price of petrol and tolls are different. A commission of around 18% of the price is charged by BlaBlaCar to passengers.

There are several reasons for the low prices of carpooling services:

- Drivers tend to share only variable costs (petrol and tolls) with passengers, and fixed costs, which amount to 2/3 of the total cost,[15] are often ignored. This is possible because the driver is travelling to the destination, and not merely transporting third parties to the destination;
- National regulation on carpooling often introduces a limit on fees that can be charged, as the provision of the service for a profit is often prohibited (see section 3.4);
- In comparison to mass-transit services, carpooling has some regulatory advantages:
  - no taxes are paid by the driver when charging passengers,
  - no time-limitations are imposed on drivers,

[13] In MAIF (2009), 70% of users used the service for economic reasons, but more altruistic reasons were also considered: protection of the environment (12%) or providing a service (4%). In Shaheen et al. 2016, saving money is also identified as the main reason to use the service, particularly among drivers with a low income. In Fondazione per lo sviluppo sostenibile (2016) 65.8% of the answers to the survey refer to economic reasons; environmental reasons rank second (45.2%).

[14] GART/UTP (2014) identified carpooling as stronger when the railway service is weaker.

[15] See calculation in GART/UTP (2014, p. 42).

- in some countries, no tolls are imposed for the use of roads, while the main cost borne by railway undertakings is the access charge for the use of the railway infrastructure,
- no Public Service Obligations (PSO) are imposed, etc.

Therefore, even if private vehicles are not more efficient than railways or coaches, they can charge lower prices to transport passengers, thus affecting said passengers' choice of transport mode.

The low price of the carpooling service might explain some usage patterns. Drivers are not usually ready to significantly detour from their prearranged route to pick-up or drop-off passengers.[16] Stable meeting points are emerging as "hubs",[17] and passengers mostly rely on mass-transit transportation to reach the "hub".[18] As a consequence, carpooling is more successful in dense areas where passengers can easily reach the "hub" either on public transportation or on foot. This is a good example of the complementarity between carpooling and mass-transit transportation. This might be another reason why carpooling in the US is not as popular as in Europe.

Carpooling has started to influence decisions regarding car ownership. In ADEME/6T (2015), 3% of carpooling users declared that they had renounced owning a car, and 11% of users declare that they delayed acquiring a car either because they postponed the procurement of a driver's license (7%) or the acquisition of the car itself (4%). As passengers have more alternatives, they do not need to own a car.

On the contrary, 3% of users declared that carpooling had made them decide not to renounce their car (ADEME/6T, 2015, p. 65). Accordingly, CGDD (2016) has identified that carpooling does actually increase the number of private vehicle trips. For each carpooling trip, there is a 7% increase in the use of the private vehicle, which in 2015 in France amounted to 0.56 million new trips.[19]

3.2.4 Calculating the size and potential growth of carpooling in the most mature market: the case of France

Carpooling has reached a significant portion of the overall long distance transportation market in the more mature markets. French data are particularly relevant as it is the most mature carpooling market. According to CGDD (2016), a total of 8 million carpooling trips were made in 2015.[20]

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[16] According to the survey conducted in ADEME/6T (2015), 36% of drivers did not detour at all, 35% made a detour of less than 2km, 38% a detour of between 2km and 5 km and 27% a detour of more than 5 km.

[17] Carpooling "hubs" are emerging in European cities. In France, the most common locations for pick-up are train stations (36% of cases) and car parks in specific points such as commercial areas (29%). in only 6% of cases pick-up takes place at the driver's or passenger's location (ADEME/6T 2015, p. 64. See GART/UTP 2014, p. 57).

[18] 44% of passengers reach the meeting point in collective transportation modes, 22% have been transported by car by a third person, 20% have reached the meeting point on foot, 6% have driven their own car to the meeting point, and only 2% have been picked-up by the driver in their own location (ADEME/6T 2015, p. 64).

[19] For each carpooling trip, there is an increase of 0.34 vehicles on the road (the number of drivers that make the trip due to the cost reduction made possible by carpooling). At the same time, there is a parallel reduction of 0.16 x number of passengers in the car, assuming that such passengers would use their own car. As the number of passengers (other than the driver) is an average of 1.7, the reduction of vehicles is of 0.27 per trip. As a result, each carpooling trip generates an increase of 7% in the use of private vehicles.

[20] This figure is coherent with figures in other studies such as UIC (2016) and GART/UTP (2014). In UIC (2016) the number of carpooling trips in 2015 was estimated to be 7 million (p. 55). In GART/UTP (2014), based on public statements by BlaBlaCar, the number of passengers transported in 2013 was estimated to be around 1% of the total number of long distance passengers and 5% of the trips in public land transportation modes (train, coach and carpooling).

In economic terms, it can be estimated that the fees paid by carpooling passengers to drivers in France, in 2015, amounted to EUR 210 million.[21]

Table 1: Carpooling in France 2015

ITEM	ESTIMATE
Number of trips offered	8 million
Number of seats offered by trip (not including driver)	2.7
Number of seats offered	21.6 million
Occupancy rate	52%
Number of passengers transported	11 million
Average distance per trip	320 km
Number of passenger-km (not including driver)	3.5 billion
Number of passengers (including driver)	19 million
Number of passenger-km (including driver)	**6 billion**
Average price per km	EUR 0.06
Total fees paid by passengers to drivers	**EUR 210 million**

Source: CGDD (2016, p. 5), and extrapolation from CGDD data.

To put it into perspective, 6 billion passenger-km represent 2.72% of the total passenger-km in domestic long distance transportation in France in 2015, and more than 12% of the passenger-km of long distance railway transportation.

Table 2: Long distance passenger-km per mode in France

MODE	BILLION OF PASSENGER-KM	%
Private car:	158	71.98%
Of which total carpooling users	**6**	**2.72%**
Of which carpooling passengers	3.5	1.59%
Of which carpooling drivers	2.5	1.13%
Train	49	22.32%
Airplane	13	5.92%
All	219.5	100%

Source: CGDD (2016, p. 5)

[21] This is the result of multiplying the 3.5 billion passenger-km by the average price per km (EUR 0.06)

CGDD (2016) estimates state that carpooling has a significant potential for growth even in the most mature markets, i.e. France. Carpooling could grow from 3.5 billion passenger-km in 2015 to a range of between 5.9 and 8.2 billion passenger-km in the near future.[22] This would amount to annual payments of between EUR 354 million and EUR 1,366 million. These figures take into consideration only the number of passengers, not drivers. If drivers are included, the total number of passenger-km could reach 14 billion passenger-km.

There is evidence that carpooling creates new demand. In ADEME/6T (2016), 56% of users affirm that without carpooling, they would travel less (p. 66). This is particularly the case among passengers (62%), but also, even at a smaller magnitude, among drivers (21%). Carpooling users confirm that if carpooling were not available, they would not have made their last trip: 12% of passengers and 8% of drivers (p. 69).[23]

CGDD (2016) has estimated that the increase in the number of road trips due to carpooling in France in 2015 was of 0.4 billion vehicle-km. This is significant, but it represents only a small fraction of the total number of passengers using carpooling.

3.2.5 Trends and potential growth of carpooling in less mature markets

Carpooling is growing all around Europe. The increasing relevance of carpooling in terms of number of users, number of passenger-km and payments that we identified in France can serve as a lesson for the not-yet-mature (in terms of carpooling presence) markets in the rest of Europe.

In Europe, several start-ups entered the carpooling market in the past few years. In different cases, we can identify local initiatives that target commuter routes and specific groups and companies. For example, the five "champion cities" (Craiova - Romania, Edinburgh - United Kingdom, Leuven – Belgium, Perugia - Italy, Toulouse - France) that were part of the CHUMS project had existing carpooling systems, at various stages of maturity. The goal of the project was to "attract carpoolers, match them and retain them", to keep the numbers rising, and to develop and transfer this proven practice to generate a core sustainable market for carpooling across Europe (CHUMS, 2016). It is interesting to note that the frontrunner BlaBlaCar is constantly consolidating its leadership position by buying up competitors in different countries. In 2012, BlaBlaCar bought Superdojazd, and opened in Poland. In 2015, BlaBlaCar expanded further by teaming up with Mitfahrgelegenheit in Germany and Hungary-based AutoHop in Hungary, Croatia, Serbia and Romania. The following year, BlaBlaCar purchased Jizdomat and expanded to the Czech Republic and Slovakia (BlaBlaCar, 2017).

The success of carpooling depends on multiple factors, such as:

- the competitiveness of collective transportation in terms of price and duration of the journey,
- the competitiveness of road transportation due to the existence of tolls, congestion, etc.,
- cultural reasons that might limit the growth of the service in some countries (i.e. sharing a small closed environment with a stranger might put some travellers off, particularly in some countries). For instance, carpooling seems to have more limited success in the UK, where roads are congested, railways quite efficient and travellers seem to be more averse to sharing space with strangers.

[22] This estimation could be conservative, as it merely takes into consideration three parameters: (i) Demographic evolution, as current users tend to be younger than average; (ii) Geographic expansion of the service, as it is currently concentrated in dense routes; and (iii) Expected increase in train prices. It does not take into consideration the power of indirect network effects. As a matter of fact, CGDD (2016) study confirms that, as the number of active users on a specific route grows, the average number of "empty runs" diminishes and the occupation rate grows.

[23] Similar results in Shaheen et al (2016, p. 10).

3.3 Substitution of other transport modes

The large volume of passenger-km is, for the most part, not the result of new demand, or the shift from the use of private vehicles to carpooling. In fact, most carpooling passengers and even some carpooling drivers were previously traveling by train or coach.

Academic literature and some empirical research underline the strong competition between carpooling and mass-transit transportation, both for commuting and for long distance trips (Godillon, 2016, Minett, Pearce 2011, and TCRP, 2012).

Different studies demonstrate that carpooling is competitive with mass-transit transportation in terms of both price and duration of the trip. A recent study by UIC 2016 includes comparative tables on the substitutability of the different long distance transport modes, including carpooling (see below).

Table 3: Paris-Lille: modal chain, total time and cost

Paris - Lille

Starting location	Transfer to main means of transport			Main means of transport	Transfer to final destination			Final destination Total Time (hr)	Total Cost (€)	Summary	
0 min	5 min	25 min	25 min	1 h (train)	5 min	25 min	5 min	2 h 30	40 €	++	-
0 min	5 min	25 min	15 min	3 h (coach)	5 min	25 min	5 min	4 h 20	18 €	--	+
0 min	7.5 min	0 min	0 min	2 h (car)	0 min	0 min	7.5 min	2 h 15	40 €	++	-
0 min 0 min	7.5 min 5 min	0 min 25 min	15 min 10 min	2 h 2 h (carpooling)	15 min 5 min	0 min 25 min	7.5 min 5 min	2 h 45 3 h 15	12 € 14 €	+	++
0 min	5 min	50 min	45 min	3 h 15 *With connections* (plane)	30 min	50 min	5 min	5 h 20	200 €	--	--

Source: UIC (2016, p. 219)

Table 4: Barcelona-Alicante: modal chain, total time and cost

Barcelona - Alicante

Starting location		Transfer to main means of transport		Main means of transport	Transfer to final destination		Final destination Total Time (hr)		Total Cost (€)	Summary	
0 min	5 min	25 min	25 min	5 h 10	5 min	25 min	5 min	6 h 40	50 €	+	+
0 min	5 min	25 min	15 min	7 h 40	5 min	25 min	5 min	9 h 00	48 €	--	+
0 min	7.5 min	0 min	0 min	5 h 20	0 min	0 min	7.5 min	5 h 35	90 €	++	-
0 min	7.5 min	0 min	15 min	6 h	15 min	0 min	7.5 min	6 h 45	30 €	-	++
0 min	5 min	25 min	10 min	6 h	5 min	25 min	5 min	7 h 15	30 €		
0 min	5 min	50 min	45 min	1 h 10	30 min	50 min	5 min	4 h 15	100 €	++	--

Source: UIC (2016, p. 231)

Table 5: Paris-Frankfurt: modal chain, total time and cost

Paris - Frankfurt

Starting location		Transfer to main means of transport		Main means of transport	Transfer to final destination		Final destination Total Time (hr)		Total Cost (€)	Summary	
0 min	5 min	25 min	25 min	4 h	5 min	25 min	5 min	5 h 30	75 €	+	-
0 min	5 min	25 min	15 min	9 h	5 min	25 min	5 min	10 h 20	50 €	--	++
0 min	7.5 min	0 min	0 min	5 h 20	0 min	0 min	7.5 min	5 h 35	100 €	+	--
0 min	7.5 min	0 min	15 min	6 h 10	15 min	0 min	7.5 min	6 h 55	30 €	-	++
0 min	5 min	25 min	10 min	6 h 10	5 min	25 min	5 min	7 h 25	35 €		
0 min	5 min	50 min	45 min	1 h 15	30 min	50 min	5 min	4 h 20	90 €	++	-

Source: UIC (2016, p. 233)

In the UIC 2016 study, it is identified that railway transportation is the most convenient mode in terms of duration of the trip, particularly when a high speed service is available (with the exception of air transportation when a high speed railway service is not provided on long routes). However, both railways and air transportation are expensive (particularly when railway transportation is served with high-speed services). On the contrary, carpooling is the cheapest option and it is still convenient in terms of duration of the trip.

Thus, direct competition exists between carpooling and coach services, with a competitive advantage for carpooling in terms of both pricing and duration of the trip. Carpooling offers an attractive substitute to railway transportation when passengers want to reduce costs and are ready to compromise regarding the duration of the trip.[24]

Substitutability is also confirmed by surveys among carpooling users. They show that carpooling users would increase the use of collective transportation if carpooling were not available. According to the survey in ADEME/6T (2015), this is the case for both passengers (72%) and drivers (26%).[25] In ADEME/6T (2015), the type of collective transport mode that would be used is even distinguished.

Table 6: Transport mode that would have been used in the last trip if carpooling were not available

MODE	DRIVER	PASSENGER
Private vehicle	67%	16%
Train	14%	42%
High Speed Train	10%	27%
Coach	1%	2%
Airplane	1%	1%
No trip	8%	12%

Source: ADEME/6T (2015, p. 69)

Related, the survey in Shaheen et al. (2016) confirmed that for low-income users, the main alternative to carpooling is collective transportation.

There is even some quantitative analysis on the impact of carpooling services in mass-transit transportation in France. An estimate is provided in CGDD (2016). According to this study, the number of passenger-km travelled by train would have been 52.3 billion instead of 49.2 billion if carpooling had not been available. That is a reduction of 3.1 billion passenger-km, around 6% of the actual 49 billion train passenger-km in France in 2015.

In ADEME/6T (2015), it is advanced that each vehicle-km travelled by carpooling reduced the use of train by two passenger-km (ADEME/6T, 2015, p.74). If the total number of vehicle-km in carpooling is estimated to be 2.5 billion in 2015,[26] this means that the total number of passenger-km travelled by train would have been reduced by 5 billion, around 10% of the number of passenger-km in 2015.

[24] This seems to be the case in France, where coach services have traditionally been restricted to routes served by railway services and only recently, coach services have been launched. As the operation of a high-speed service often involved the reduction or elimination of parallel conventional services, at a lower price, on the same route, carpooling provides a much cheaper alternative to railway services. As a consequence, it has been identified (ADEME/6T, 2015) that carpooling services have a larger market share when the route is served by a high speed service.

[25] These figures are confirmed in the survey in Shaheen et al (2016, p. 12), as 65% of passengers would use collective transportation, while 88% of drivers would use a personal car.

[26] 2.5 billion vehicle-km is the result of multiplying 8 million annual trips by 320, the number of average km in carpooling trips.

However, the impact of carpooling on mass-transit depends on several factors, which are unevenly distributed across European countries.

First, carpooling reinforces the competitiveness of road transportation against railway transportation (which is a negative trend from the point of view of the EU transport policy goal to increase market share of more environmentally friendly modes of transport). Competitiveness depends on various parameters:

- Quality of the road network: the better the road network, the larger the impact on railways;
- Congestion: countries where roads are already congested will probably see a smaller growth of carpooling. This could be the case of the United Kingdom, where the sharing economy is overall more developed, but carpooling is not as popular as in other European countries; and
- Existence of tolls: roads are more competitive where no tolls are charged for the use of the road. However, where tolls are charged, carpooling allows distributing such fixed costs among the users, reducing individual cost and reinforcing the competitiveness of road transportation.

If roads face objective limitations (limited network, congestion, bad weather, etc.) the role of carpooling will be more limited, and the impact on railway funding will be smaller. On the contrary, in countries with a good road network, no significant congestion and no other objective limitation to the use of private cars, the impact on the funding of the railway system will be more significant.

The impact of carpooling on railways seems to diminish as distance increases in such a way that on very long distances (above 500 km) it is more limited than on medium distances (ADEME/6T, 2015, p. 61). The comfort of the railway services against private vehicles (more space, possibility to walk around the train, on-board services, etc.) seems to be the explanation. This fact also explains why carpooling has a limited effect on air transportation, as flights usually cover greater distances, particularly those above 500 km.

Second, carpooling reinforces the competitiveness of private vehicle transportation against coach transportation. Even if both transport modes use roads, carpooling is modifying the traditional equilibrium between private vehicles and coaches. As carpooling drivers merely require payments to cover variable costs (gasoline and tolls) but no fixed costs (acquisition of the vehicle, insurance, repair, taxes, etc.), the price for carpooling passengers is lower, and in some cases much lower, than coach services. As a consequence, the competitiveness of private vehicles against coaches is reinforced. The impact of carpooling on coach companies' revenues is expected to be particularly relevant. This impact is already felt in countries with a strong coach industry, such as Spain. In countries where coach services have been liberalised only recently (Germany and France) or where it has never really taken off (Italy), carpooling might just impede the growth of the industry to the levels that could be expected if carpooling had not existed.

Third, mass-transit services previously insulated from effective competition are more prone to suffer passenger reduction. This is the case of high-speed railway services in France. They had no mass-transit cheap alternative (coaches or traditional railway services), so the appearance of a cheaper alternative is having a strong impact on revenue. Spain is the counter-example. As high-speed railway services always had competition from coach services, carpooling is not perceived as competition for the service and no relevant impact on the revenue of the service has been identified.

The existing evidence shows that carpooling is substituting the use of mass-transit transportation. This substitution has reached significant volumes in more mature markets and can be expected to grow further as carpooling matures and network effects multiply, also on medium and low-density routes.

3.4 Legal restrictions to carpooling

The reduction of the number of passengers in mass-transportation has a direct financial consequence, as payment for the service by passengers is the main source of revenue for long distance mass-transportation service providers in Europe (see section 5.2).

This explains why some European countries prohibit the provision of transportation services to private citizens without a license. A distinction is often drawn between private and public transportation. Private transportation is allowed, while public transportation is prohibited. The key parameter to differentiate private and public transport tends to be whether the driver makes a profit or merely covers costs. Sometimes a further requirement is introduced, such as a limitation to provide the service to a closely related individual.
Many European countries have prohibited the provision of transportation services by individuals without a license, which is the basis for many shared transport applications.

- In France, carpooling is allowed as long as the driver makes the trip for himself and charges no fee, but merely divides the costs of the trip. (Article L. 3131-1 Loi de transition énergétique of 2015). The reference for costs is the annual publication by the tax authorities of the maximum deduction in the income tax for the use of the private vehicle. These figures take into consideration both fixed (acquisition of the car, insurance and repairs) and variable (petrol) costs with the exception of tolls and parking. They are different according to the power of the vehicle and the kilometres claimed by the taxpayer. As a reference, in 2015, for a car with a tax horsepower of six travelling 10,000 km per year, the cost per km was EUR 0.42, so the maximum payment for the average trip of 320 km would be EUR 134.4. This is clearly below the EUR 0.06 per km that are the average price charged by carpooling drivers to each passenger.
- In Spain, carpooling is only allowed if the passenger is closely related to the driver and only costs are shared. (Act 31/1987 on land transportation). Commercial Court nº2 in Madrid, ruled on February 3rd, 2017 that transport services mediated by BlaBlaCar are private services that can be provided with no license as the price is below EUR 0.19, the legal reference to reimburse expenses to civil servants when traveling with their own car.
- In Italy, the reform of the traffic law (Codice della Strada) is under discussion. The proposal that is now at the Senate (DDL 1638 Art. 2.12) calls for the introduction of the definition of carpooling, which is a transport service that:
  - does not generate profit;
  - is based on the principle of sharing the use of a vehicle by two or more persons that have to travel (part of) the same itinerary; and
  - puts travellers in contact thanks to public or private dedicated intermediaries, which may also be online instruments.
- Germany had once outlawed carpooling, long before online platforms came about. The law was passed to protect the business of traditional taxi companies. The ban was revoked by a constitutional court decision in 1964 clarifying that carpooling is legal when the costs charged do not exceed the costs of operation of the trip (BVerfG, 07.04.1964 - 1 BvL 12/63). Accordingly, Germany's Passenger Transport Act (Personenbeförderungsgesetz) does not apply to carsharing (§ 1 Abs. 2 Satz 1 Nr. 1 PBefG).

4. IMPLICATIONS OF THE SHARING ECONOMY ON URBAN TRANSPORTATION

KEY FINDINGS

- Urban transportation is becoming more **complex** as shared mobility emerges as a new category of services between the private car and mass-transit services.
- Europe is the world leader in bikesharing and carsharing. However, Europe is lagging behind the US and China in the penetration of more sophisticated, platform based, ridesharing and ride-splitting services.
- As a reference, **carsharing revenue in Europe was estimated to be around EUR 230 million in 2015**. There is no public information on total revenue in Europe regarding bikesharing, ridesharing and ride-splitting.
- As shared mobility grows, different studies show that it is **not substituting mass-transit.** Substitutability is rather low for carsharing and ridesharing services. It is more relevant for bikesharing and potentially for ride-splitting. Existing volumes for all shared mobility options are rather low and they are not in the position to substitute a substantial share of the services provided by mass-transit.
- Shared mobility solutions, particularly carsharing and ridesharing, seem to **substitute private car** usage and ownership.
- Overall, a more sophisticated understanding of the situation is emerging: **shared mobility might be a key complement to mass-transit**. Even if the volumes are not very large, shared mobility might reinforce the weak points of mass-transit (low-density areas, night services, specific needs) in a way that makes the combined provision of both mass-transit and shared mobility services a fully viable alternative to private car ownership.
- **Mobility as a Service** (the combined commercialisation of mass-transit and shared mobility solutions by a single entity, under a single price) might be the framework under which the substitution of the private vehicle becomes a reality.

4.1 Introduction

Urban transportation is a complex system with an increasing number of competing transport modes and with very different patterns across cities in the use of private vehicles, mass-transit, and new shared mobility solutions. However, common problems exist, at different degrees, in all urban areas. Transport creates external costs such as congestion, environmental problems (air quality, noise, CO_2, etc.) and generates accidents.

Table 7: Estimated annual external costs of current urban transport system in EU27

INDICATOR	ESTIMATED COST
Congestion	~ EUR 80 billion
Air Quality	~ EUR 20 billion
Accidents	~ EUR 80 billion
Noise	~ EUR 40 billion
CO_2	~ EUR 7 billion
Total external costs	**~ EUR 230 billion**

Source: European Commission/COWI (2013, p. 7)

Shared mobility is transforming urban transportation. New transport modes generate alternatives to traditional transport modes. Innovation is not limited to creating new transport modes. Technology and new business models driven by technology are transforming the way passengers use existing transport modes. Passengers can increasingly combine different transport modes. They are starting to perceive mobility like a service (see section 4.4).

Europe is leading in some of the shared mobility services at the urban level. Bikesharing started in Europe and Europe has the largest number of bikesharing systems in the world. Europe is also leading in carsharing. European car manufacturers have the largest number of vehicles under carsharing schemes.

However, Europe is lagging behind in the more sophisticated ridesharing and ride-splitting solutions. These solutions require more advanced technology and a leading role by an online platform with the financial resources to reach the critical mass necessary to reap the benefits of indirect network effects.

Uber, US based, is the leading ridesharing platform worldwide and in Europe. Ridesharing is less developed in Europe than in the US or China, due mostly to regulatory restrictions and the fragmentation of the European market.

The concept of Mobility as a Service also originated in Europe. Europe has the necessary tools to make it a success: powerful mass-transit systems, a rich ecosystem of shared mobility systems and leading companies investing in new mobility solutions.

4.2 Description of shared urban mobility

4.2.1 Bikesharing

The first bikesharing system was launched in Amsterdam in 1965, even though it failed shortly after. First generation systems merely provided free-to-use bicycles and were prone to vandalism, theft, etc. Second-generation systems started to be more stable as they introduced some controls (coin-operated systems). However, it was only the third-generation systems that became a success due to the use of IT-based solutions: personal smart cards, stations with terminals and customer information, and flexible charging systems. The bikesharing system launched in Lyon (France) in 2005 was the leader of this new generation (DeMaio, 2009).

Different models have evolved around the world. Bikesharing systems can be managed by:

- Local public authorities (i.e. in the Irish cities of Cork, Galway, Limerick, the National Transport Authority offers the service);
- Traditional transport organisations (i.e. DB Rent in Germany, OV-Fiets/NS in the Netherlands);
- Non-profit organisations; and
- Profit-oriented private companies (i.e. JCDecaux that started from France and expanded all over the world by partnering with local advertising operators). This is the most common alternative, and companies usually operate in several cities (i.e. Bicincittà operates in 115 Italian municipalities with a fleet of 6,241 bikes and 1,418 stations).

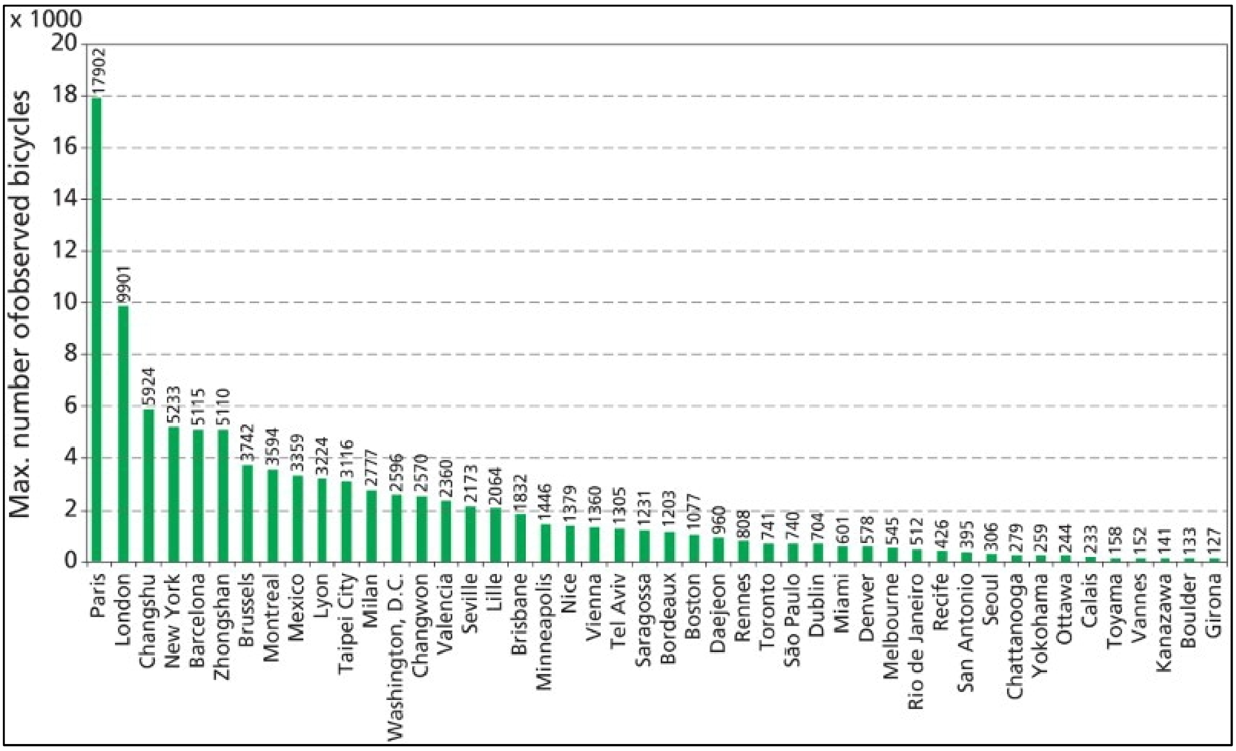
These models are constantly evolving, and recently different public-private partnerships have been established (i.e. BikeMi in the city of Milan, Bicing in Barcelona, and Stockholm City Bikes in Stockholm are all owned by the respective municipality and the service is operated by the private company ClearChannel).

Three direct sources of funding can be identified for bikesharing systems: (i) Public subsidies; (ii) Fares collected from users; and (iii) Revenue from advertisement. Advertising companies are managing a large number of systems: in Dublin (Ireland), JCDecaux is managing the system in exchange for the use of 72 advertising spaces for a period of fifteen years (valued at EUR 54 million) (Murphy, Usher, 2015).

The main advantages of bikesharing systems are flexibility in implementation, use and development, adaptability, increased physical activity (i.e. tackling the obesity challenge among urban societies), decreased congestion, emissions and noise, decreased fuel consumption and optimisation of individual spending.

Figures in 2016 show that Europe is leading in bikesharing (44% of existing bikesharing systems are in Europe, 42% in Asia and 10% in North America). China is the leading country with 37% of systems deployed there (Metrobike, 2017). Bikesharing systems have reached a significant size in many European cities in terms of registered users and bicycles available, the leader of which is Paris (Nair et al., 2013).

Figure 2: Size of bikesharing, selected cities



Source: Fishman (2016)

Bikesharing is mostly used by the young population, and more by males than by females. It is more popular among the highly educated population, independent of income level. It is used for commuting to educational and work centres, as well as for recreational purposes, particularly at night time, as mass-transit services are reduced. (Shaheen, Martin, 2015).

Bikesharing is a good tool to increase the use of the private bicycle. As more citizens see other people using the bicycle, they get more familiar with it and they give it a try. As they incorporate the shared bicycle into their daily routines, they often decide to acquire and use a bicycle to move around the city. This means that, at least during the initial period, bike sharing can serve as a promoter for urban bike use.

Moreover, the data collected on bikesharing users can be used by transport planners at a whole city scale. There are already interesting experiences in this regard in cities such as Minneapolis, Zurich, Madrid, etc. in terms of GPS tracking, creation of apps to share information, tracking of journey data, etc. (Romanillos et al., 2016).

Both bikesharing and the private bicycle face objective limitations in terms of volume of use. Geography (large distances, hills), weather and culture impose limits to the use of the bicycle as a transport mode. Some of these impediments, however, may be overcome by the switch to electric bikes/electric bikesharing systems, which are currently evolving. For instance, the city of Madrid has completely switched to electric bikes. In Italy, according to the data provided by Bicincittà (operator active in 98 locations in Italy), 16% of their systems provide e-bikes, 21% are mixed systems with both traditional and e-bikes and 62% provide only traditional bikes. The switch from traditional to electric bike sharing systems may have the downside of higher costs for maintenance and in cases of vandalism. Therefore, case-by-case evaluation on the possibility to offer electric bikesharing is taken by bikesharing suppliers, who tend to prefer to apply electric bikes mainly where it is necessary for geographical reasons.

Box 2: Bikesharing in Paris

Vélib, the bikesharing system in Paris, has a fleet of close to 20,000 bicycles spread around 1,606 stations, one every 300 meters, almost all of them inside the Boulevard périphérique (35 km freeway around the urban core of the city).

The system is operated under a concession of the city government granted to JCDecaux in 2007 for 10 years. The contract was prolonged for another year and will end by the end of 2017. After conclusion of the tendering procedure, in April 2017 it was announced that the service would be operated by the French start-up Smoove, as from 1 January 2018.

JCDecaux received exclusive control over 1,628 city-owned billboards, which were supposed to produce revenue of EUR 60 million per year (Nadal 2007). The city receives about half of that advertising space at no charge for public-interest advertising. A further local subsidy of around EUR 15 million per year has been necessary, mostly to compensate vandalism and theft.

According to data published by the city government for 2015 (Mairie de Paris, 2016), the user needs a subscription that can last from one day to one year. The use of a bicycle is free for the first 30 minutes. After that, it has a fee for any extra 30-minute period (from EUR 1 to EUR 4). Unlimited rentals can be made during a subscription period.

In 2015, the total number of annual subscriptions was 295,440. 60% of users were male. 57% of the users were between 14 and 35 years old.

In 2015, the total number of trips was 39.39 million (3% of the total number of trips in all mass-transit modes). During the same period, 1,520 million subway and 434 million bus trips were taken.

Peak use is between 8am and 10am and between 6pm and 8pm. 30% of trips are made for commuting. The service is evenly distributed among the days of the week, but significant variations exist throughout the year (4.3 million trips in June and 2.2 million in February).

4.2.2 Carsharing

Carsharing has evolved over time. Originally, carsharing systems were structured as "roundtrip systems" also called "station based systems". Vehicles were stored in a number of stations across town, and users had to start and terminate their trips in the same station. Vehicles were typically owned by the system managers.

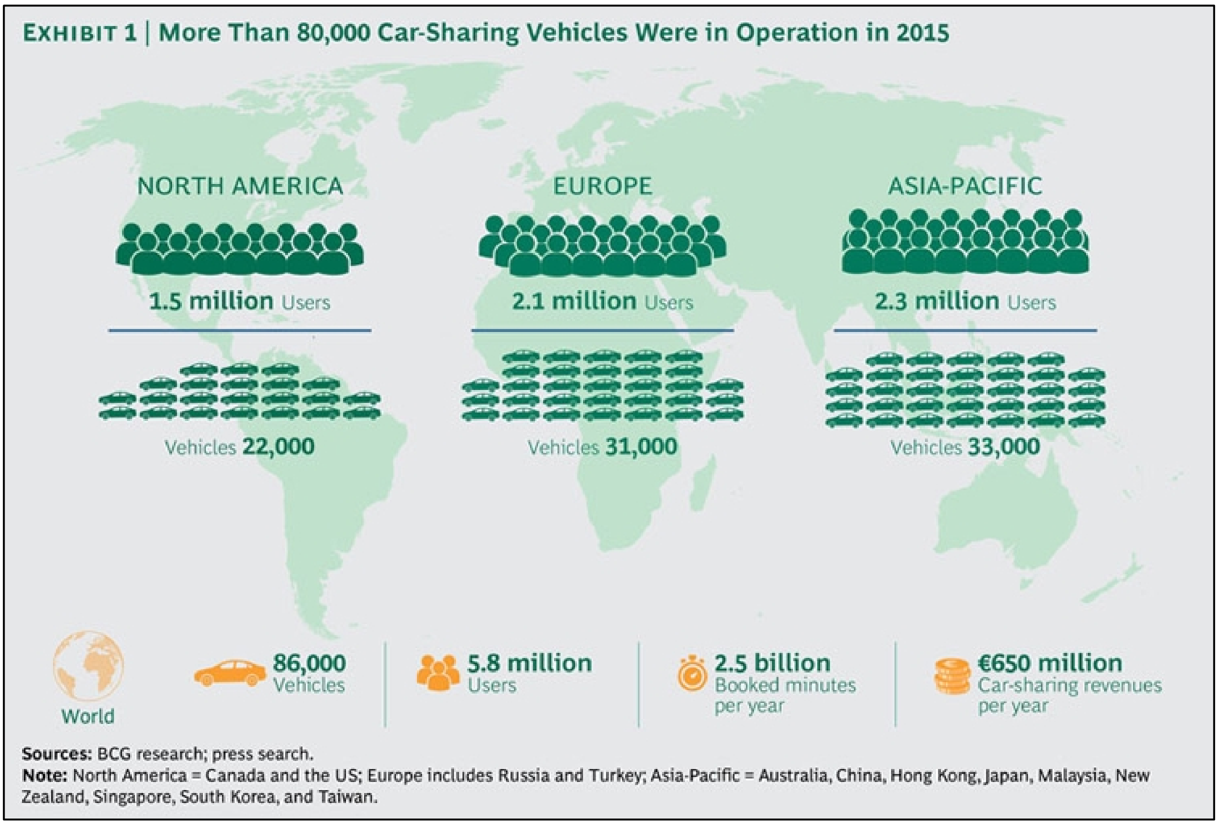
As with other shared mobility modes, carsharing is increasing in relevance as technology provides more flexibility and so called "one-way" or "free-float" systems are introduced. In one-way systems, trips do not have to begin and end at the same point, as users can leave the vehicle either at another station or in any parking space within a designated area (metropolitan area, city or part of the city). Vehicles are typically owned by the system managers, often a car manufacturer. There are also scootersharing systems, i.e. the systems managed in Italy by Enjoy and Zig Zag (Fondazione per lo sviluppo sostenibile, 2016, p. 58).

European car manufacturers have been very active in the provision of these systems. car2go, owned by Daimler AG, is the largest carsharing manager in the world. In October 2016, it operated systems in 25 cities, with 14,000 vehicles and a total of 2 million registered users.

A third generation of carsharing has emerged around peer-to-peer models. They work as a roundtrip service, but the vehicle is not owned by the system manager, but rather by a private individual who is not present in the car while driving around. The system is managed by an online platform (Martin, Shaheen, 2016). Some European start-ups active in this segment are Nobobil in Norway, Ridebite in Sweden, SocialCar in Spain or Tamyca in Germany. In December 2016, Daimler & Allianz launched a peer-to-peer system under the name Croove. Car owners seem reluctant to share their vehicles due to liability issues.[27] This is why active participation of insurance companies is common in these systems.

According to BCG (2016), there are more than 86,000 vehicles under all types of carsharing, and a total of 5.8 million registered users worldwide. In 2015, carsharing revenue reached EUR 650 million worldwide.[28] Based on the number of vehicles in Europe, it can be assumed that the annual revenue of carsharing in Europe was around EUR 230 million in 2015.

Figure 3: Number of carsharing vehicles and registered users in 2015



Source: BCG (2016)

However, existing carsharing systems tend to be geographically limited to very dense areas in major metropolitan areas. They are usually limited to cities with a population over 500,000 and are only operable in city centres.

Market development reports on carsharing systems in Europe focus mostly on EU-15 where several companies are already quite established in the urban mobility systems. However, development is picking up speed in central and eastern Europe. In October 2016, Traficar

[27] According to a study in San Francisco, half of car owners would not consider sharing their private car due to liability reasons (Ballús-Armet et al., 2014).

[28] In Frost & Sullivan (2011) it was forecasted that in 2020, and only in Europe, the number of vehicles would reach 200,000, the number of registered users would reach 14 million, and the revenue would be of EUR 7 billion. However, a substantial divergence is identified on the average revenue per vehicle. In BCG (2016), the average revenue per vehicle is EUR 7,558 per year. In Frost & Sullivan (2011), the average revenue is EUR 35,000, which seems to be exaggerated.

started Poland's first app-based car sharing service in Krakow and received over a thousand registrations in the first week, according to the provider (Eltis, 2016).

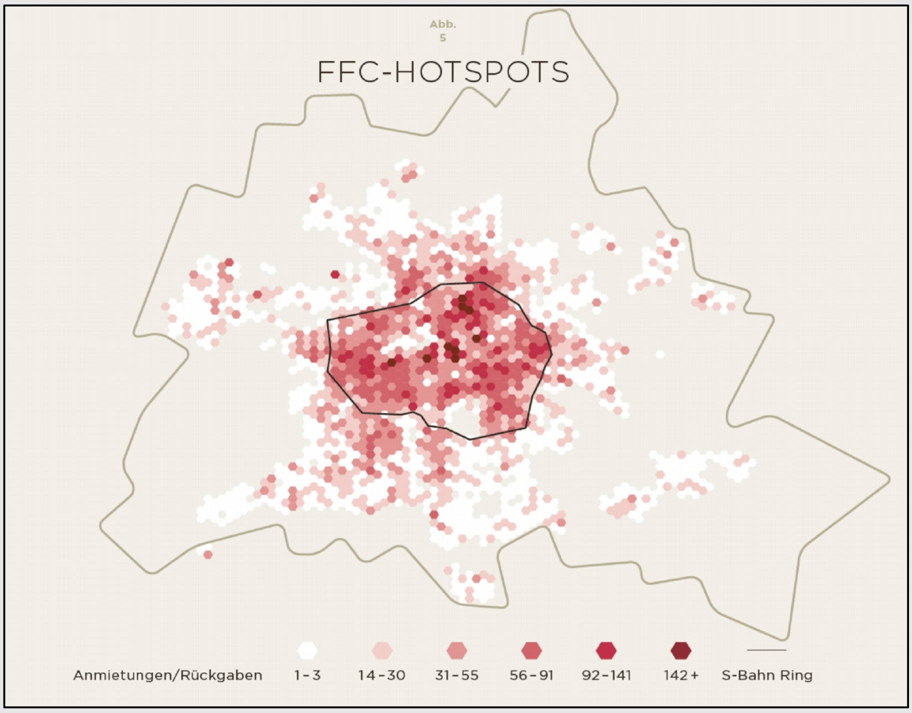
Box 3: Carsharing in Germany

The market for carsharing systems is relatively mature in Germany. Berlin is often referred to as the "carsharing capital of the world". There are three carsharing systems in competition and a large pool of vehicles (2,900 in 2015).

Research conducted for the city of Berlin determined that "at EUR 4.95, the cost of travelling 7.5 kilometres (the average distance of a carsharing trip) via a carsharing service is considerably less than the EUR 18.90 cost of a taxi for the same distance, but more than the EUR 3.45 cost of a private car and the EUR 2.70 fare on public transportation." (BCG, 2016).

However, even in Berlin, carsharing meets a very limited fraction of the total mobility needs, as it only represents 0.1% of all mobility options, compared with 29.5% of the private vehicle (BCG, 2016).

Figure 4: Concentration of free-floating carsharing* in the city centre of Berlin



Source: Civity (2014)

* Please see section 2.2.2 for definition of the free-floating carsharing

The service focuses on the most central, high-density areas. A study by Civity Management concluded that free-floating carsharing systems are more profitable the smaller their catchment areas are (Civity, 2014). Therefore, there is a limitation to the extent to which the service can be grown to reach more citizens. Apart from this economic aspect, there are also limitations to the extent to which free-floating systems can offer more efficient transport. In Berlin, a free-floating car is in use 62 minutes per day. That is significantly better than the 36 minutes an average private car is used each day but not good enough to be able to offer a solution to spatial problems e.g. lack of parking spaces in inner cities.

A study by a German carsharing association revealed that the availability of carsharing systems has an impact on household's decisions to abandon their cars (BCG, 2016). Carsharing users in Germany have a higher percentage of public transport subscriptions and a lower average car ownership as compared to other European countries. The substitution effect is however not as strong as sometimes claimed by carsharing associations, especially for the free-floating systems. Here, the substitution effect is only between 6.5% and 9.2%. There are even cases such as in the city of Munich, where free-floating carsharing users have a slightly higher average rate of car ownership and higher average rate of car usage. This might be explained by the high rent of the average user of these systems, particularly when limited to the central area in a city.

4.2.3 Ridesharing & ride-splitting

The most powerful transformation forces in the shared mobility environment are currently ridesharing services. Online platforms like Uber or Lyft facilitate the contracting of transport services between service providers and users. Technology allows the automatised matching of providers and users.

Ridesharing can bring massive efficiencies to urban transport. Traditional taxi services faced serious challenges to match offer and demand. Taxis would drive around the city looking for passengers while passengers would wait on the street for a taxi to drive near them. Taxi ranks and radio networks were alternative means for drivers and passengers to meet, but mostly unsatisfactory. Passengers would have to wait for the service, and drivers spent a very significant portion of their time driving with no passengers (ECMT, 2007).

Technology does not only allow simplifying communication with a radio network. Apps allow automatized, fast, reliable and inexpensive communications. Nevertheless, this is only a minor issue in ridesharing. The main innovation is efficiency in matching offer and demand, drivers and passengers. Thanks to algorithms that take into consideration variables such as the location both of drivers and potential passengers (geo-localisation is made possible by smartphones), transit patterns, previous transactions, etc., the platform automatically matches drivers and passengers. Waiting times are reduced for passengers, and drivers spend less time in empty-runs. Therefore, costs are reduced and prices can be lowered for passengers. As prices are reduced, new demand joins the market, triggering further efficiencies on the matching of drivers and passengers. This is the power behind ridesharing.

Ridesharing apps had been used by 15% of all US adults by December 2015 (Smith, 2016). They were more popular among younger individuals: 28% of individuals between 18 and 29 had used them, and only 4% of individuals above 65. They are more popular among college educated individuals (29%) and high earning individuals (26% among individuals earning more than USD 75,000) living in urban areas (21%).

US based Uber is the leading ridesharing platform worldwide, active in more than 500 cities, with 40 million active users monthly, spending an average of USD 50 per month (Lynley, 2016). In 2016, Uber had a worldwide revenue of USD 663 million, and the value of the mediated services was USD 20 billion (up from 10 billion in 2015) (Fortune, 2017). Uber is also the leading ridesharing platform in Europe. However, ridesharing is less developed in Europe than in the US, China (where the market leader, Didi Chuxing, is active in 400 Chinese cities) or India (where Ola is active in more than 100 cities), due mostly to regulatory restrictions and fragmentation of the market. There are some European competitors to Uber, such as Cabify in Spain, but they are operating at a much smaller scale.

Ridesharing can support different kinds of services. The most transformative has been the facilitation of services by non-professional individuals, on a peer-to-peer framework. Uber championed this model in the US. The introduction of the same service in Europe raised more opposition and some Member States even banned the provision of the service. European regulation often excludes the provision of services by individuals without a specific license for the provision of the service.

Ridesharing can support more traditional services. In Europe, Uber is facilitating transport services provided by licensed operators with Private Hire Vehicle (PHV) licenses. Mytaxi facilitates services provided by licensed taxis. Mytaxi, after the merger with Hailo, claims to have 70 million passengers and 100,000 registered taxis in 50 cities. Mytaxi is controlled by the German car manufacturer Daimler (Taylor, 2016).

Competition exists among all the services supported by online platforms, but prices are different. Licensed PHV services can be priced around 20% below regulated taxi services. Peer-to-peer services have been charged at a price around 35% below regulated taxi tariffs.

A further evolution of ridesharing is ride-splitting. Online platforms can match a driver with more than one passenger, so they can share the cost of the service. Ride-splitting was an abandoned practice in most of Europe, as it significantly delayed the duration of trips. Algorithms, however, allow the best matching of passengers as to avoid excessive waiting times or detours to accommodate the needs of the different passengers.

There are different forms of ride-splitting. The simplest form is just a fixed itinerary along a very dense route. The driver meets the passengers at a fixed location and drives them to a fixed location. Dynamic ride-sharing with passenger pick-ups and drops-off along automatically designed routes requires a mature software and a very dense volume of drivers and passengers. Ride-splitting can be provided by non-professional drivers in their private vehicles, but also by professional drivers with cars or larger vehicles.

Ride-splitting is already a reality. Both Uber and Lyft are providing the service in the US. Uber claims that more than 100 million uberPOOL services were provided in the first 18 months of operation, which began in 2014 (Manjo, 2016). Start-ups around Europe are developing new innovative business models. However, these services face significant regulatory restrictions. Exclusive rights are often granted to mass-transit operators to provide services along predefined routes. Some Member States, as Spain, prohibit selling independent seats in taxis and other transport services.

The combined effect of ride-splitting and self-driving vehicles could have a major impact on urban transportation in the future. Theoretical exercises suggest that such a combination, together with a mass-transit system, might remove 90% of cars in a medium-size European city such as Lisbon (ITF, 2015).

Box 4: Uber and the application of EU Law

There is a pending preliminary ruling by the Court of Justice of the European Union on the legal nature of Uber services, raised by Commercial Court no 3 of Barcelona (Case C-434/15), to be decided before the end of 2017.

Taxi associations claim that Uber provides transport services without a transport license, and therefore breaches national legislation on transportation and on unfair competition. They claim that national restrictions on transport do not breach EU law on freedom to provide services, as Article 58(1) of the Treaty on the Functioning of the European Union (TFEU) excludes "services in the field of transport" from the application of the general rules in the TFEU on freedom to provide services. In the same line, Directive 123/2006/EC (the Service Directive) is not applicable to such services.

Uber claims that it merely provides electronic intermediation services. Such services are information society services as defined in Directive 2000/31/EC (e-commerce Directive) and are protected by the freedom to provide services as defined in such Directive. Furthermore, intermediation services are not services "in the field of transport", as Directive 123/2006 explicitly states that intermediation services, i.e. those provided by travel agencies, are covered by the Directive. Consequently, national restrictions would have to comply with EU Law on freedom to provide services.

The European Commission made public a Communication on the nature of the service of collaborative economy platforms (European Commission, 2016c). The Commission tries to draw the borderline between intermediation and the provision of the underlying service. According to the Commission "when these three criteria are met, there are strong indications that the collaborative platform […] is also providing the underlying service": (i) The platform sets the price; (ii) The platform sets other contractual terms; (iii) The platform owns the key assets to provide the underlying service (vehicles, etc.).

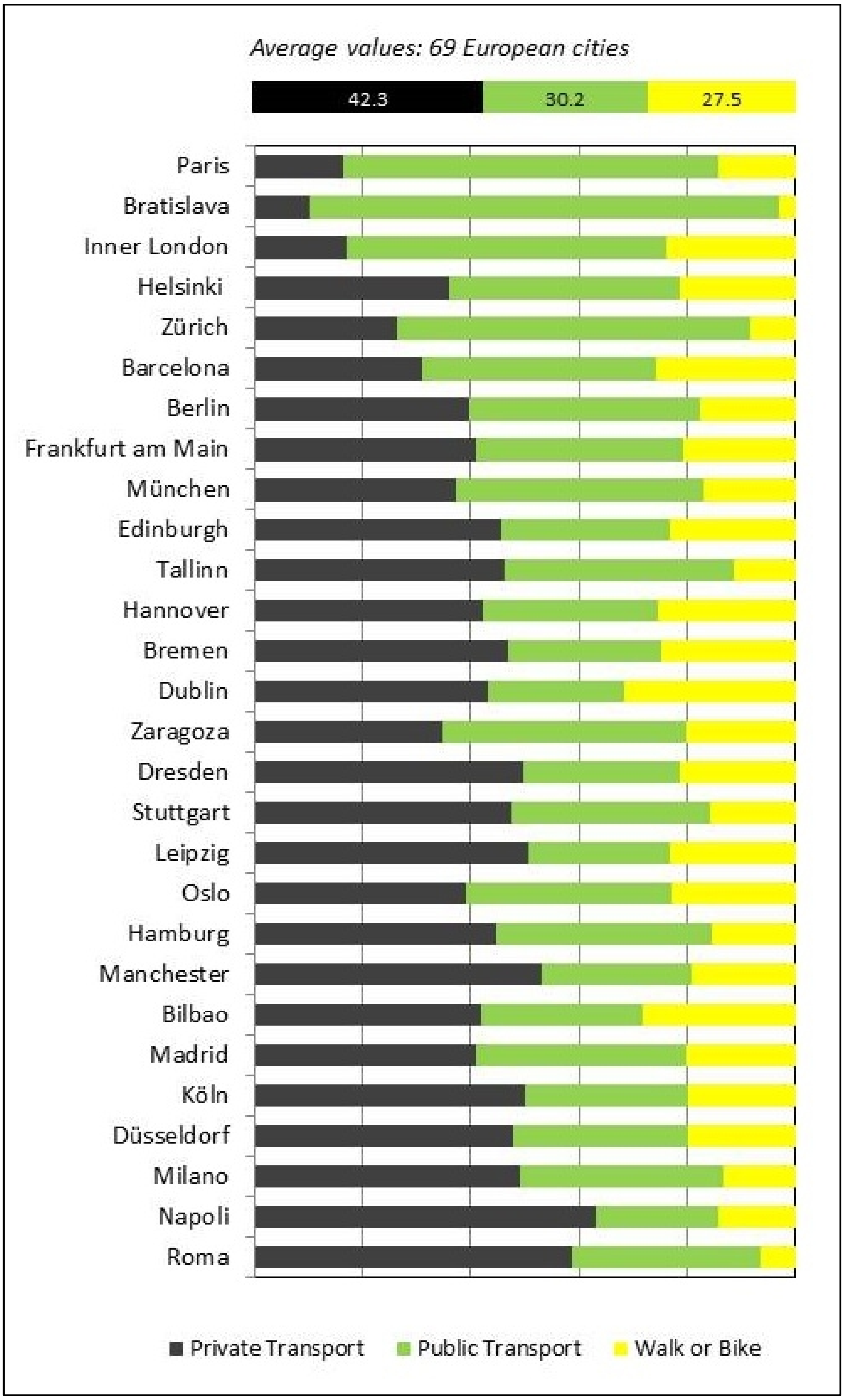
National restrictions have been common. Different Courts in the Member States (i.e. Belgium, Bulgaria, Germany, Portugal, Romania, Spain) have issued bans against the provision of the uberPOP service (a peer-to-peer service) based on different grounds (breach of transport regulation, unfair competition, etc.). Specific legislation has been adopted in Member States either as an obstacle to the provision of electronic intermediation services (i.e. France, Hungary) or, on the contrary, to expressly accommodate them in the local regulatory framework (Estonia). Currently, Uber provides services in most European Member States, but based on licensed transport services (mostly PHV licenses).

4.3 Substitution of other transport modes

It is interesting to advance what the impact of shared mobility will be in the existing transport mode split in European cities. Such an evolution will determine the challenges in infrastructure funding in the next decades.

Today, European cities present quite a heterogeneous mix of transport modes, which is reflected in Figure 5. In the large cities, as an average, the private car has a share of 42.3% of trips, mass-transit 30.2% and walking and bicycle 27.5%

Figure 5: Modal split on the home-work route in EU cities of more than 200,000 inhabitants (%)[29]

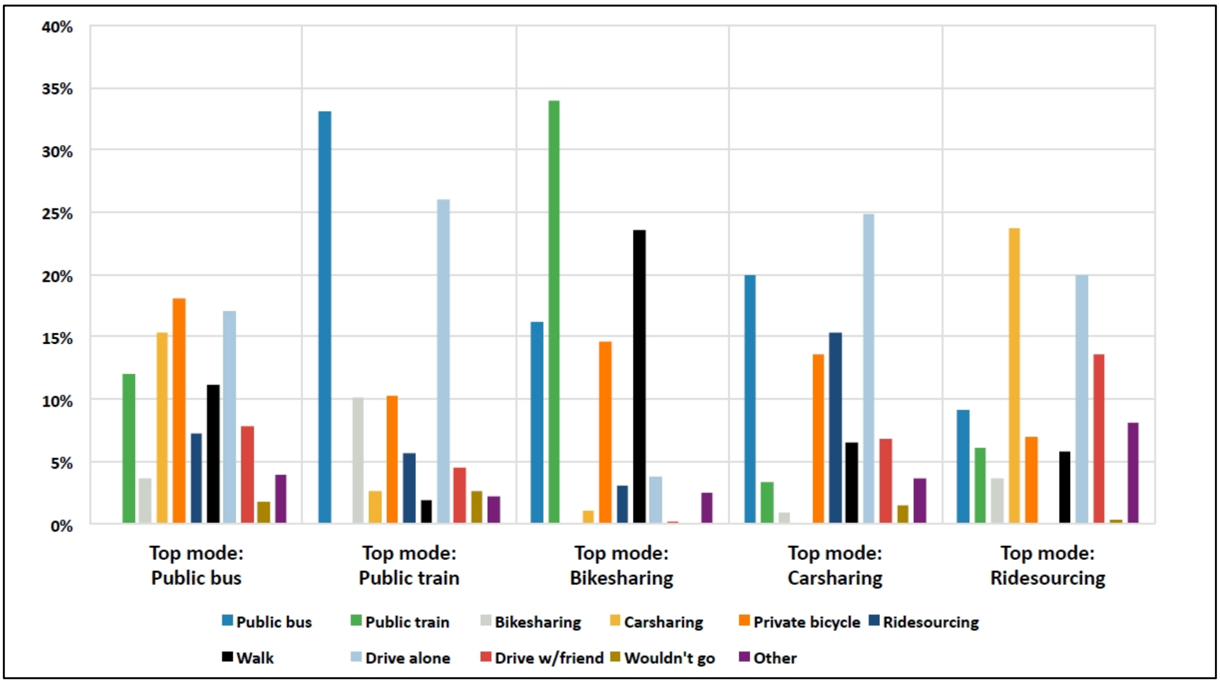


Source: Fondazione per lo Sviluppo Sostenibile (2016, p. 134)

[29] The average value is calculated out of 69 medium-large European cities. The chart represents the first 24 European cities. Values refer to the most updated year available (between 2006, less updated, and 2011, most recent).

As shared mobility matures, some substitution patterns have already been identified. They are described in Figure 6, with data from the US. There is no parallel study for Europe, but studies on specific cities and specific transport modes confirm the same trends identified in the US.

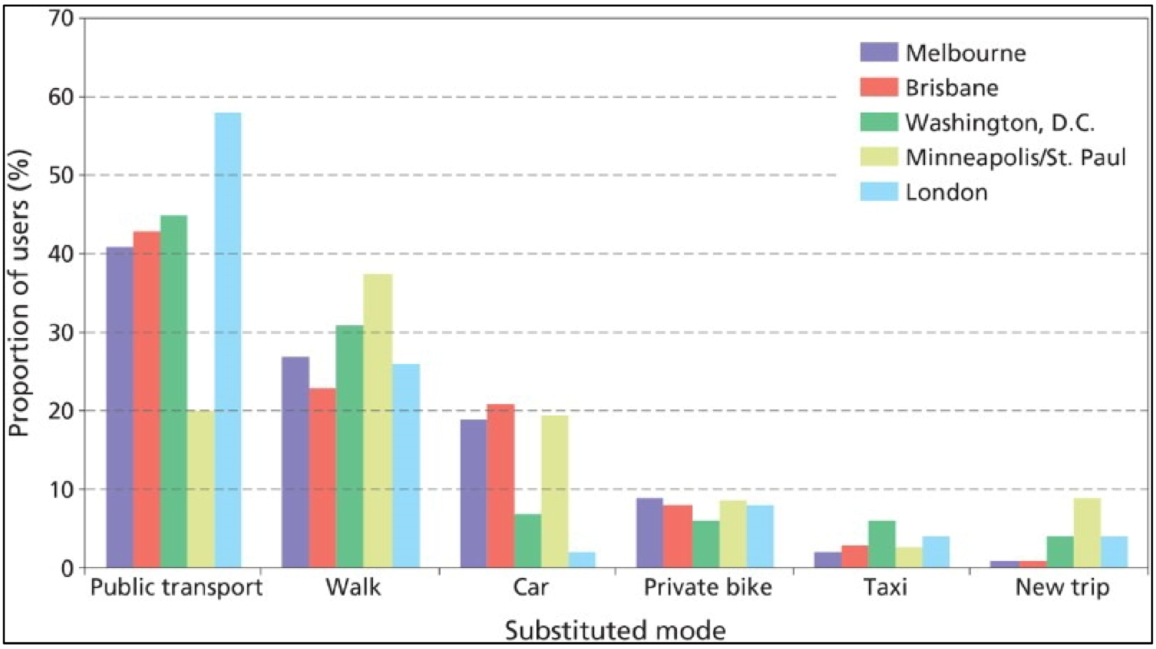
Figure 6: Alternative if a transport mode was not available



Source: SUMC (2016, p. 16)

In the US we observe that bikesharing has a limited (if relevant) impact on the use of private vehicles. Rather, it is substituting walking, the use of the private bicycle and, in particular, mass-transit services (see Figure 7). This trend is confirmed for cities outside the US (Ayuntamiento de Sevilla, 2010, Murphy, Usher, 2015).

Figure 7: Mode substitution by bikesharing in selected cities



Source: Fishman et al. (2014)

Carsharing and ridesharing have a limited substitution effect on mass-transit. Rather, they substitute the use and even the ownership of private cars.

Ridesharing might be less expensive than regulated taxi services (so it substitutes taxis[30]) but they are still significantly more expensive than mass-transit. As a consequence, little substitution among the two transport modes has been identified. In more developed markets in the US, ridesharing usage for commuting is very limited. Only 20% of ridesharing trips is for commuting. It is more common to use ridesharing for recreation/social purposes (above 55%) and shopping errands (18%) (SUMC, 2016 p. 11).

As UITP has stated, "on their own these new mobility services do not have the capability or capacity to meet citizens' mobility needs or solve traffic congestion. As an example, in San Francisco, the well-established home market of Uber and Lyft, they represent only 1-2% of all trips." (UITP, 2016) Likewise, carsharing in Berlin only represents 0.1% of the trips in the city.

An exception might be ride-splitting services. Ride-splitting services can significantly lower the cost of the provision of the service, particularly when larger vehicles are used. UberPOOL services can be even 65% cheaper than the regular Uber service in the US (Uber, 2017a). Consequently, ride-splitting prices can start to compete with mass-transit services.[31]

Ridesharing substitutes the use of the private vehicle. Frequent users of ridesharing services in the US are less prone to drive a car daily or weekly, 63% against 84% of non-users, and less likely to own a personal car, 64% against 78% (Smith, 2016). A study on Stockholm by Copenhagen Economics (2015), commissioned by Uber, concluded that the total number of active cars in the city would be reduced by 18,000 (5% of the total) if peer-to-peer ridesharing services were launched. A survey among Uber users, funded by Uber, reported that 22% of them were holding off on purchasing a car thanks to the ridesharing service (Deamicis, 2015). A number of studies also confirm this trend for carsharing services.[32]

A wider perspective helps to better evaluate the impact of shared mobility on urban transport. It is the combined effect of all shared mobility modes, together with mass-transit, that offers a reliable alternative to the usage and ownership of a private car. As has been repeatedly stated by UITP: "it is the offer of an integrated combination of sustainable urban mobility services that most effectively challenges the flexibility and convenience of the private car. A broader mix of mobility services is the answer to ever more complex and intense mobility needs. […] car-based services and especially car-sharing are the obvious services that complement public transport as they offer the benefits linked to car usage without the need to own the car." (UITP, 2016, p. 2).

Shared mobility complements mass-transit as it helps to overcome the three most relevant weak points of mass-transit: availability (it is not always available with a station near the origin and destination of a trip), reliability (it is not always open 24/7) and comfort (luggage, speed, etc.).

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30 The effect of the sharing economy on taxis, even if relevant, is not in the scope of this study.

31 A specific study on uberPOOL concludes that uberPOOL complements mass-transit rather than substituting it (Schwietermann, Michel, 2016).

32 In Martin, Shaheen (2016), it is stated that active members of the car2go system in five US cities sold a vehicle they had due to car2go (2% to 5%) or avoided a vehicle purchase (7% to 10%). As a result, car2go members sold between 1 to 3 vehicles per car2go vehicle (on average), suppressed the need for between 4 to 9 vehicles per car2go vehicle and overall, when considering both effects together, each car2go vehicle removed between 7 to 11 vehicles from the road of the five cities studied (on average).

First, shared mobility is used as "first mile/last mile" to complement mass-transit. As mass-transit can only serve high-density areas, shared mobility solutions allow passengers to move from their premises to mass-transit stations. Uber has often provided data on how a significant share of their services initiate or terminate at a subway or train station, both in Europe and in the US (Smith, A., Salzberg, A., 2016). Uber published evidence on how the launching of night tube services in London modified the service and reinforced service from and to the operating tube station (Rao, 2016). The same effect has been identified for bikesharing (Jäppinen, S., Toivonen, T., Salonen, M., 2013).

Second, shared mobility complements mass-transit when it is not active, particularly at night time. Ridesharing is particularly used 8pm-4am, when mass-transit systems reduce operations or even suspend them. On the contrary, ridesharing usage is at its lowest point between 5am-10am, in the morning rush hours (SUMC, 2016 p. 12). It has also been identified that bikesharing systems usually have a strong use at night (Shaheen, Martin, 2015).

Third, shared mobility, in particular car-based modes, provides the necessary flexibility to make specific trips for which mass-transit might not be suitable (trips with heavy luggage, trips when handicapped, trips that might require more speed, etc.).

The most relevant study on the subject so far, undertaken for the American Public Transportation Association (APTA) by the Shared-Use Mobility Center (SUMC) confirms this. The main conclusion of the study was that "people who take greater advantage of shared modes report lower household vehicle ownership and decreased spending on transportation" (SUMC, 2016, p. 7). In parallel, "the more people use shared modes, the more likely they are to use public transit" (SUMC, 2016, p. 3).

The key point is not the substitution of specific trips in private vehicles. Each mode, either shared mobility or mass-transit, might be in the position to substitute specific private car trips. However, no mode is a perfect substitute for car ownership. It is a usual trend that once an individual takes on the fixed cost of acquiring a private vehicle, they spontaneously tend to use the vehicle for every trip. Therefore it is important to provide a viable alternative to private vehicle ownership. Mass-transit has traditionally failed (with the exception of very dense areas in very large congested cities) in this regard. Mass-transit combined with shared transport provides a viable alternative to private car ownership.

Shared mobility, in its different modes, complementing mass-transit, creates a combined offer that is in the position to compete with the private car and substitute private car usage and ownership.

4.4 Mobility as a Service

The combined provision of mass-transit and shared mobility services has been identified as the next challenge in urban transportation. Mobility as a Service is emerging as the model for such a combined offer. Mobility as a Service is described as "a system, in which a comprehensive range of mobility services are provided to customers by a company which buys mobility services from service producers, combines them as a service supply and provides the services to consumers" (Heikkilä, 2014).

Pilot programs on Mobility as a Service have been undertaken in some northern European cities: Helsinki (Finland), Hannover (Germany) and Gothenburg (Sweden) (Kamargianni et al., 2016) and the West Midlands (UK).[33] A company acquires transport services from the operators of the transport services and then bundles them under a single brand, a single pricing scheme (either a flat rate or a "pay as you go" rate) and a single payment system. In this way, private car ownership can be substituted by the acquisition of Mobility as a Service.

Mobility as a Service would be the final stage of an already existing trend to combine various transport services into a single ticket or payment system. Mass-transit authorities have been coordinating different services (subway, tram, buses, etc.) under a single ticketing or payment system for decades. The next step is to include also transport services provided by private operators (shared mobility services, taxi, etc.), particularly to overcome the "first/last mile" challenge.

There is a high number of pilot programs to offer combined solutions with mass-transit and shared mobility services. Just to name a few: Uber is working with local transit systems in Atlanta (MARTA), Dallas (DART) and Portland (Uber, 2017b), among others, to combine services. Car2go has reached an agreement with the high-speed railway operator Italo, to sell combined tickets (Ferpress, 2014).

Mobility as a Service programs include traditional mass-transit services, plus private services such as taxi and shared mobility services, to meet fully the mobility needs of different passenger profiles. Different flat rates meet different needs of different profiles.

The key question is who will act as the leader of this model (Holmberg et al., 2016). Leadership could be taken by public authorities, as they are already managing mass-transit, which is perceived as the backbone of the system. Private online platforms might take the lead, integrating all different transport modes, and in particular mass-transit services, as they have proven the ability to manage multisided markets and create the necessary indirect network externalities. "Transport operators will benefit by creating a larger market via the integrated platform" (Kamargianni et al., 2015).

Differing political traditions are relevant to determine the leadership in the development of Mobility as a Service. In Europe, there is often a notion that it is the local public authorities' responsibility to ensure the availability of public transport to all citizens. In the US, mass-transit transport is more the pragmatic consequence of congestion in denser cities, and not so much a shared political goal in itself.

In any case, the financial implications of this model for the funding of transport infrastructure are of the utmost relevance. The debate will focus on the pricing conditions under which mass-transit services are provided through online platforms. Such pricing might determine the sustainability of urban transport infrastructure.

The inclusion of mass-transit services as underlying services mediated by an online platform together with other services raises questions about the definition of the prices of the mass-transit services, the commissions to be charged by online platforms and overall, whether in this new ecosystem, transport infrastructure funding will be ensured.

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[33] Helsinki-based MaaS Global offers their Service in Helsinki, Finland (Whimapp, 2017a) and the West Midlands, UK (Whimapp, 2017b).

5. CHALLENGES FOR CURRENT MECHANISMS OF INFRASTRUCTURE FUNDING

KEY FINDINGS

- **Carpooling services** are replacing long distance mass-transit services, thereby **reducing revenue from passenger fares**.
- A reduction in mass-transit passengers might trigger a vicious cycle of reduction in frequencies and further reductions in passengers of railway and coach services. Such a development would **challenge the existing PSOs** for land transport connections. As revenue from passengers is reduced, more public funding is necessary to sustain the same level of quality. This also threatens the current financial equilibrium of internal cross subsidies in an undertaking with exclusive rights for the provision of packages of both profitable and non-profitable services. Finally, **the revenue of railway infrastructure managers is also reduced**.
- In the long term, the situation could reverse. As **private vehicle ownership diminishes due to growing alternatives at an urban level**, travellers will increasingly rely on alternatives for long distance trips. If only 10% of travellers making use of cars migrate to mass-transit services, the number of passengers of publicly available transport services would double: **All alternatives would benefit, i.e. carpooling, car-rental and mass-transit services**.
- **Online platforms** pose further threats to transport infrastructure funding, as they can reduce the funding available for infrastructure either by **capturing a growing share of the value created by the whole ecosystem (through commissions)** or by eroding it. Value appropriation does not seem to be an issue at the moment, but the risk exists as platforms might take a leading role in integrated mobility solutions including mass-transit services. In this scenario, value erosion is also possible if pricing of access to mass-transit services for platforms is not properly defined.
- As **public subsidies** are a major source for infrastructure funding, it is important to ensure that new players, such as **platforms** and **peer-to-peer providers, contribute to the funding of the underlying infrastructures.** This can be through taxation or other forms of financial contribution to infrastructures.

5.1 Introduction

Over time, an unstable equilibrium has been reached in the different transport modes as to how to fund transport infrastructure. Transport infrastructure, including both physical infrastructure (roads and tracks) and assets for the provision of transport services (vehicles, rolling stock, etc.), requires massive investment to be built, maintained and operated. The delicate balance of public finance and payments by users of transport services, the two main sources of funding, is constantly under discussion.

The sharing economy, and in general digitalisation, poses a new challenge to the already complex funding of transport infrastructure. As the ICTs empower new interactions among the different players in the transport ecosystem, the existing equilibria are challenged.

The effect of digitalisation, platforms and peer-to-peer services on other industries, including other network industries, can provide valuable insights on the impact of the sharing economy on transport infrastructure funding.

The following challenges can be identified: (i) Challenges created by the substitution effect; (ii) Value appropriation by online platforms; (iii) Value erosion by new services; (iv) Data management.

5.2 Challenges created by the substitution effect

The sharing economy is creating new services that substitute traditional transport services. As users migrate to the new services, traditional providers experience a reduction in the revenue they receive as a payment for the provision of their services.

The leading example of the substitution effect from a non-transport sector is the postal industry. A new digital service such as electronic mail has substituted a significant portion of the services traditionally provided by postal operators. The subsequent reduction of revenue is forcing postal operators to adapt their infrastructure to the lower volumes of transported items and/or explore new services to diversify their revenue sources.

As discussed in chapter 3 of this study, shared mobility solutions are substituting long distance mass-transit services (both railways and coaches). In an urban context, such substitution is not taking place at a relevant scale. On the contrary, shared mobility at the urban level is reinforcing mass-transit systems as the use and ownership of the private vehicle is reduced. The situation might change overtime.

5.2.1 Revenue reduction for long distance mass-transit land services

It has been identified (see section 3.3) that long distance carpooling is detracting a substantial number of passengers from long distance passenger mass-transit land services (railways and coaches). As a direct consequence, the reduction in the number of passenger-km caused a reduction of revenue derived from passenger fares. This is already happening at a substantial scale in countries where carpooling is more mature, such as France and Spain. It can be expected in other European countries as well.

Revenue reduction, as a proportion, is more severe than passenger reduction. Several reasons explain this effect:

First, mass-transit services being substituted are those services provided in peak hours at full rate, while substitution is smaller at off-peak periods, often charged at a discount to attract travellers. There are several reasons justifying this substitution:

- Carpooling services are more frequent in peak times, particularly Friday and Sunday afternoon (GART/UTP, 2014, p. 110). In off-peak periods, matching drivers and passengers is more difficult (CGDD, 2016, p. 6), as offer is scarcer and does not always meet demand, particularly on routes with low and medium density. On the contrary, mass-transit services are ensured throughout the day, also in off-peak hours, often through legal or contractual obligations;
- Travellers are price-sensitive and they tend to switch to carpooling when the price of the railway service is more expensive. For example, this is the case during peak hours, when full price for railway tickets is charged and few discounts are available.

Second, carpooling is having a more substantial effect on high-price services, which previously had no direct substitute. This is the case of high-speed railway services in France.

Third, the revenue of mass-transit operators is further reduced as operators lower their prices to meet the new competition from carpooling. Therefore, the financial impact of substitution is larger than the percentage of passengers lost to carpooling. With the French example, as it has been estimated that passenger-km have been reduced in 6% in 2015.

Such revenue reduction will put more pressure on the already stressed finances of mass-transit operators and the growing funding gap expected for the future (Booz&co, 2012). Fares paid by passengers are, of course, one of the main sources of revenue for mass-transit operators. For instance, railways in the European Union are funded according to the following percentages: 40% passenger fares, 20% freight fares, 30% public subsidies and 10% other sources (figures correspond to 2012, Steer Davies Gleave 2016, p. 17). Long distance services receive significantly less public subsidies than suburban railway services.

Revenue reduction will affect investment in long distance mass-transit systems. Investment in new rolling stock and coaches might be deferred. Frequencies might have to be reduced. A deterioration of the service can be expected.

5.2.2 Vicious cycle

Reduction in frequencies is a major issue. Continuity of service is one of the fundamental traits of public passenger transport. It is even included in the definition of public passenger transport in Regulation (EC) No 1370/2007: "passenger transport services of general economic interest provided to the public on a non-discriminatory and continuous basis" (Art. 2(a)).

As revenue from passenger fares is reduced, mass-transit operators will face pressure to reduce costs. Cost reduction can derive from the reduction in the number of services, reducing frequencies in specific routes.

However, the reduction of frequencies triggers a vicious cycle in the mass-transit systems. As the frequency of service is reduced and waiting times get longer, mass-transit is not able to meet the needs of passengers and therefore triggers a further reduction of passengers and revenue, further reductions in frequencies, etc. This effect, known as the "Mohring effect", as in Mohring (1972), has been frequently identified (for instance in Bar-Yosef et al., 2013).

Carpooling could trigger such a vicious cycle in long distance mass transit services, particularly on non-dense routes.

5.2.3 Sustainability of PSO

The substitution effect identified in long distance land transport is a challenge to the provision of services under PSO. PSO is defined in Regulation (EC) No 1370/2007 as "a requirement defined or determined by a competent authority in order to ensure public passenger transport services in the general interest that an operator, if it were considering its own commercial interests, would not assume or would not assume to the same extent or under the same conditions without reward" (art. 2(e)).

Two models of public schemes to compensate mass-transit operators for the provision of PSO can be identified.

First, public subsidies can be granted for the provision of transportation services, particularly for low-density routes, usually connecting rural areas. Such subsidies can be granted both to railway and coach services. As a reference, the total amount of subsidies granted for the compensation of railways PSOs in the European Union in 2015 amounted to EUR 20 billion (Commission 2016a, p. 78).

Carpooling initially concentrated on high-density routes, but as the network effects get stronger, carpooling can be expected to expand to other routes. In France, routes connecting large cities (particularly Paris) with rural areas are already popular (ADEME/6T, 2015, p. 61). The next step is expansion to routes in between rural areas. As revenue from passenger fares is expected to diminish, an increase in public subsidies to maintain the same level of service (particularly frequencies) will be necessary. If such funds are not available, the quality of mass-transit services will have to diminish.

Second, compensation from public authorities may be seen in the form of granting exclusive rights to provide services on a profitable route, in such a way that profits for the provision of the service cross-subsidise other non-profitable services imposed on the service provider. This model is used both in railways (for instance in the United Kingdom) and in coaches (for instance in Spain). Such a model relies on the existence of a monopoly in the profitable service, and weak competition from other transport modes, as otherwise it would not be possible to extract the necessary rent from the profitable services to cross-subsidise the other services.

Carpooling is introducing new competition in the long distance market. It is a threat to this model of PSO funding. High prices due to artificial margins in the profitable services are possible if there is no good substitute for the monopolized service. However, if there is a good substitute, extraordinary high prices are a powerful incentive to migrate to the alternative transport mode ("cream-skimming"). It has already been shown that carpooling is a good substitute for railways and coaches. As monopolists loose revenue in the profitable services, they will face financial constraints to cover the cost of the non-profitable services. If there is no objective limitation to the competitiveness of carpooling, like road congestion, this model of public intervention becomes unviable.

For all these reasons, carpooling poses a fundamental challenge to the funding of long distance passenger transport under PSO.

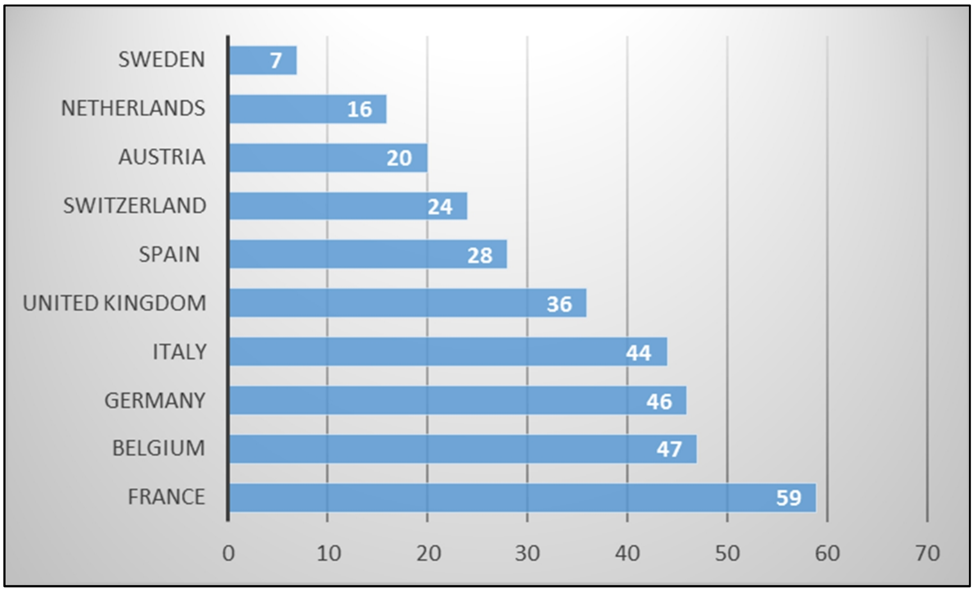
5.2.4 Impact on physical infrastructure funding

Substitution of long distance mass-transit services by carpooling also has an impact on physical infrastructure funding. It is necessary to differentiate among transport modes and national situations.

Railway infrastructure relies heavily on public funds in the form of subsidies to the railway infrastructure manager, but a significant share of infrastructure costs are covered with the access charges paid by railway undertakings for the use of the infrastructure. As railway undertakings lose passengers and revenue, a reduction in access charges paid by railway undertakings to infrastructure managers can also be expected.

The percentage of the total costs borne by railway undertakings is very different in the Member States. For instance, in 2012, it was 59% in France and 46% in Germany, but only 7% in Sweden, as shown in Figure 8.

Figure 8: Percentage of access charges from the total revenue of railway Infrastructure Managers' (IMs) in 2012



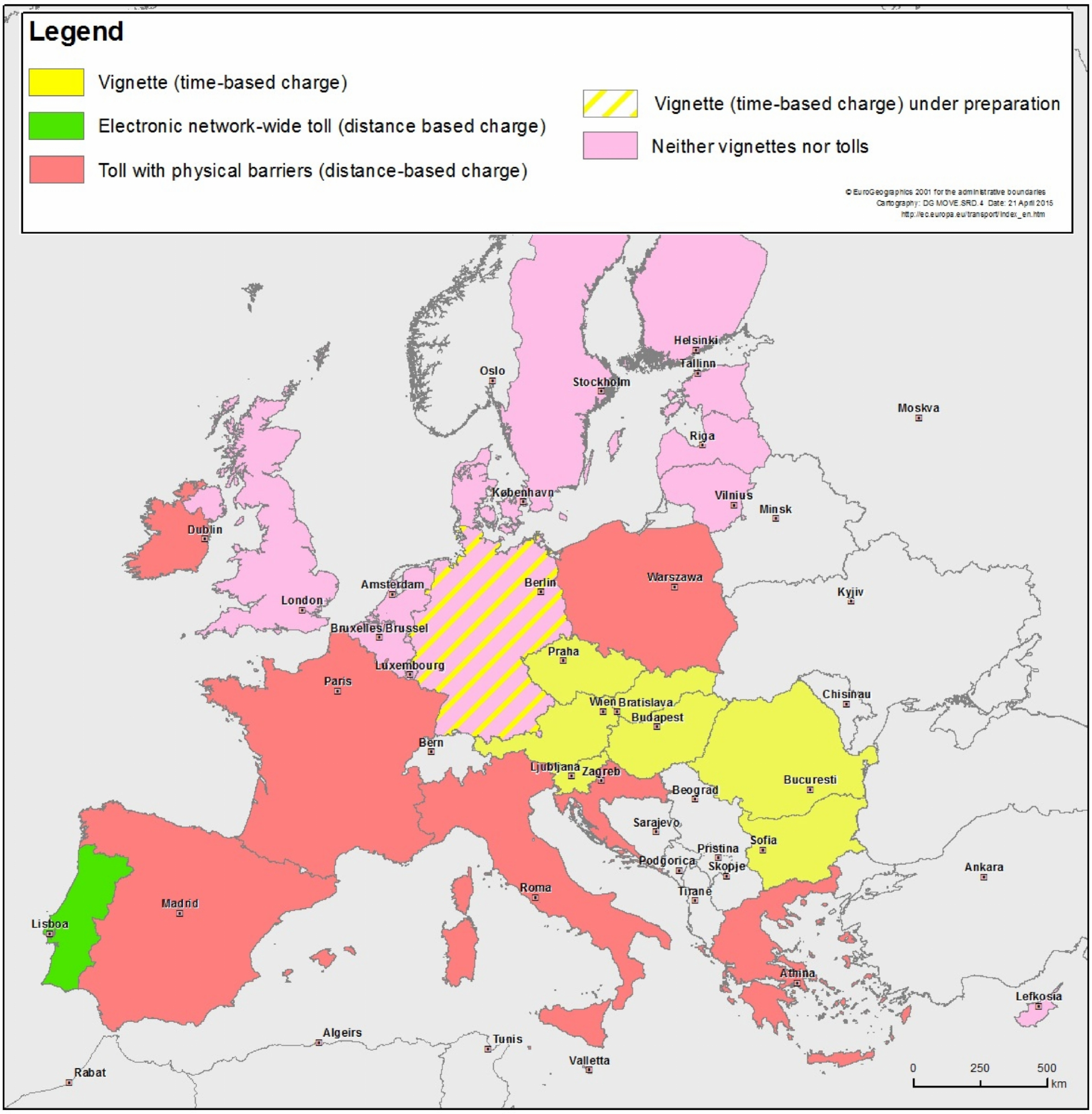
Source: elaboration of Finger, Putallaz, Van De Velde (2015, p. 24)

The structure of railways access charges is different in each Member State, but the principle in Article 31(3) of Directive 2012/34/EU is that "charges […] shall be set at the cost that is directly incurred as a result of operating the train service." It is common to pay a fee for each vehicle-km making use of the infrastructure, and even to take into consideration the number of passengers.

Consequently, the higher the reliance on access charges for the funding of the infrastructure manager (against reliance on public subsidies), the higher the impact of carpooling on the funding of railway infrastructure. As in certain Member States (i.e. France, Belgium and Germany) railway infrastructure is funded in a significant percentage through access charges, reduction in the number of passengers will cause a parallel reduction in funding for the railway infrastructure.

Road infrastructure relies more heavily on public funds than railway infrastructure. Only a minor percentage of costs are covered by users in the form of tolls, which are usually limited to high-capacity roads, and are not introduced in all Member States. As demonstrated in Figure 9, in line with the Directive 1999/62/EC, Member States have adopted various approaches in applying tolls on their road networks, ranging from the introduction of a country-wide toll (as in the case of Portugal) to a zero-charges scheme as in the case of 12 Member States, including Germany.

Figure 9: Road infrastructure charges for light private vehicles[34] in the EU



Source: elaboration of European Commission (2015c)

Furthermore, migration from coaches to private vehicles should not have a major impact on the revenue of those road infrastructures funded through tolls. When roads are funded with public funds, it is neutral whether there is a lower number of coaches and a higher number of cars. When there are tolls, private vehicles already fund the infrastructure with tolls. In this scenario, it would be simple to adapt toll-pricing structures to the new profile of vehicles making use of the road (less coaches, more private vehicles). Even more, as in some Member States such as Germany, coaches are exempt from paying tolls, so migration from coaches to private cars would increase revenue to fund roads in the form of tolls.

As a consequence, and contrary to the situation in railways, the reduction in the number of coach passengers should not have a substantial impact on the funding of roads.

[34] The light private vehicles category comprises passenger cars, motorcycles and other motor vehicles with total permissible mass of no more than 3.5 tonnes predominantly used for private purposes.

The divergent approaches to infrastructure charging in road and rail create the wrong incentives: rail access charges disincentivise the use of railways against road transport when no tolls are in place. This effect is reinforced by carpooling, as it benefits the regulatory competitive advantage of not having to contribute directly to the funding of the infrastructure it uses. The higher the toll, the smaller the price advantage of carpooling against railways. The same goes for coach services where coaches do not have to pay for highways at all (Germany).

Finally, uncertainty on future volumes of passengers will have an impact on investment. It is more challenging to decide on investment when it is more difficult to forecast the evolution of the number of passengers. This is particularly relevant, as investment in transport physical infrastructure requires decades to be recovered.

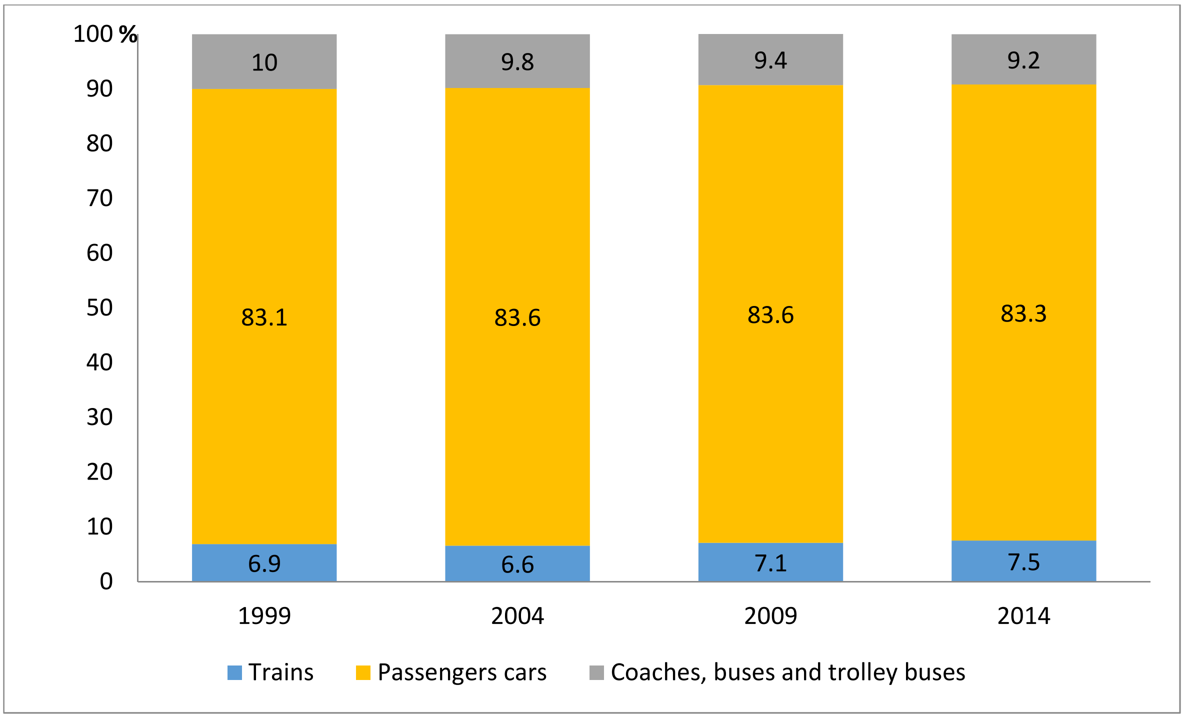
As a conclusion, substitution of long distance mass-transit services by carpooling has an impact on the funding of mass-transit services, PSO and transport infrastructure (particularly railway infrastructure).

5.2.5 Long term evolution

The scenario might substantially change in the long term. If changes at the urban level reduce the rate of car-ownership, this will have a major impact on long distance transportation. Travellers without a private vehicle will make more intense use both of mass-transit and shared mobility solutions when traveling long distance.

Private vehicle is the preferred transportation mode for long distance trips all around Europe, with a very high market share (see Figure 10 for details).

Figure 10: Passenger land transport modal split (EU average in % of passenger-km)



Source: European Commission (2016a, p. 19)

If only a fraction of car users switches to public transportation, the overall number of public transportation travellers will increase substantially. Based on the 2014 data shown in Figure 10, if only 10% of travellers making use of cars migrated to mass-transit services, the number of mass-transit passengers would double.

If the decline of private vehicle ownership at the urban level evolves fast enough, it could counterbalance the impact of the sharing economy on the funding of long distance traveling.

However, at the moment there is no evidence that such counterbalance is taking place. Carpooling for long distance travel is growing at a faster pace than the substitution of the private vehicle at an urban level. Regulatory obstacles to the development of shared mobility at a local level might be one explanation. In any case, it can be expected that such a structural transformation in urban transportation (reducing car ownership) will take place at a slower pace than the more punctual migration of travellers in long distance transportation from mass-transit to shared mobility.

In the long term and in the most optimistic scenarios, shared mobility might pose a new challenge to mass-transit. If private car ownership diminishes substantially, a very large surge in demand for long distance mass-transit might take place. The existing infrastructure would not be able to cope with such an increase in demand, and massive investment might be required to completely redefine long distance transportation.

5.3 Value appropriation by online platforms

Online platforms are the managers of the data layer. Platforms such as BlaBlaCar, Uber and others are providing intermediation services that allow transport service providers to interact with passengers for a more efficient provision of the underlying transport service.

Intermediation services are provided for remuneration. The remuneration takes the form of a commission, a percentage of the value of the intermediated transport service. Such a commission can be charged to the transport service provider (Uber), the passenger (BlaBlaCar) or even to both parties.

Platforms might provide the intermediation service without remuneration as a market entry strategy, in order to trigger the participation in the platform both of transport service providers and of passengers. This was the case, for instance, for BlaBlaCar.

As the platform attracts a significant number of users, indirect network effects grow and the benefits derived from such an externality can be distributed among all the parties. The platform itself can absorb a significant portion of the benefits in the form of commissions on the price of the underlying service.

Commissions can reach a significant portion of the price of the underlying transport service. Uber usually charges a 20% or 25% commission to drivers, but it has tested even a 30% commission in the mature markets of San Francisco and San Diego in the US (Macmillan, 2015). BlaBlaCar charges passengers a variable commission, smaller as the price of the trip increases, with an average of around 20% of the price of the service in the more mature markets.

Commissions by transport platforms in Europe have been estimated to be EUR 1.6 billion out of the total transaction value of EUR 5.1 billion in 2015. For 2025, it has been estimated that commissions will reach EUR 33 billion (PwC, 2016).

Platforms such as BlaBlaCar and Uber have created new services at very attractive prices by efficiently coordinating extremely fragmented service providers, including non-professional providers. Commissions do not seem to threaten the attractiveness of their services and, despite some complaints, both platforms continue to grow.

Successful platforms enjoy strong positions once they reach the necessary critical mass (Bundeskartellamt, 2016). However, the very same nature of this industrial organisation model poses a limit to potential abuses by platforms. If commissions pose too much of a burden on any of the sides active in the platform, they would leave the platform, reducing the benefits created by the indirect network effect and diminishing the value of the platform for all its participants and for the platform manager itself. Platforms are only successful if the right equilibrium is maintained for all participating entities. This effect has been graphically coined as "the second invisible hand" (Koopman et al., 2015), building on the invisible hand metaphor by Adam Smith.

Nevertheless, platforms might grow as to include traditional transport service providers. There is a trend to integrate a growing number of transport services under one platform enabling door-to-door solutions. A platform might integrate a ridesharing service from home to the train station, a high-speed railway service to another city, and a subway ride to the final destination of the trip. Mobility as a Service can be included in this trend.

Value appropriation by platforms might become a more relevant issue should aggregation platforms include traditional transport service providers, in particular mass-transit services. The finances of mass-transit service providers are already under stress. Intermediaries will interfere the yield-management systems of mass-transit operators, that is, variable pricing strategies based on the understanding, anticipating and influencing of consumer behaviour in order to maximise revenue. Mass-transit operators already perceive this evolution as a threat: "The challenge is that something from the outside world will act faster than us, and become the leader of the urban mobility market. This threat is very real" (Caroline Cerfontaine, UITP Combined Mobility Expert, in UITP, 2014).

If mass-transit service providers are included in aggregation platforms, the definition of prices for the underlying transport service and the commissions to be charged by the platform will become a central debate in the industry. This is already the case in telecommunications and the "net neutrality" debate (Leal, 2014).[35]

As a conclusion, one of the challenges for infrastructure funding is the appropriation of value by online platforms. This risk is smaller when platforms intermediate in new peer-to-peer services. The risk might become more relevant as online platforms might intermediate in the provision of traditional transport services, as traditional transport service providers are already under financial stress.

5.4 Value erosion by new services

Digitalisation, and in particular online platforms, has eroded value in many industries, providing services at no cost for the user or for a very low price, forcing traditional players to reinvent themselves or even to disappear. It is important to understand these processes in order to analyse if they could affect the transportation industry.

5.4.1 Advertising as an alternative source to fund services provided at no cost for the user

Advertising has become the source of funding for services previously funded by the price charged to the user of the service. Online platforms allow advertisers to interact in new forms with audiences, in such a way that the free provision of a service becomes a mere attraction so advertisers can display their content.

This was the case of the services provided by mapping and navigation companies, as their services started to be provided at no cost for the user by platforms such as Google, as a way

[35] The "net neutrality" debate refers to the need to regulate the conditions of the access to internet service, so no discrimination is introduced by infrastructure managers based on the kind of use of the service, or the type of content to be accessed, or the provider of the content service.

to attract an audience for the advertisers. User funding of the service was substituted by advertiser funding. Online platforms made this new model possible by structuring a new multisided market connecting advertisers and users through mapping and navigation services that platforms provide themselves.

Transportation offers interesting possibilities for the display of advertising. Mass-transit operators are already exploiting the possibility to display advertisements in their physical infrastructure, their vehicles, and their webs.

Advertising has an important role in the exploitation of bikesharing systems. As already described (section 4.2.1), such systems are often exploited by advertising companies such as JCDecaux in exchange for the right to exploit billboards in the city.

In any case, there are limited chances of this kind of substitution taking place in transportation. The existing players have already exploited many opportunities for the display of advertising. Furthermore, the potential revenue that advertising could generate does not seem to be enough to cover the high cost of transport infrastructure. Finally, this model would require the provision of the transportation service, and it is not viable to fully substitute existing transportation providers, as platforms have not shown the intention to build their own alternative services, as they did with mapping and navigation services.

5.4.2 Freeriding

Value can be eroded as new technologies allow traditional services to be provided at no cost for the user or at a very low price, as a provider can free ride on the investments previously made by other players.

The clearest example of freeriding is the illegal provision of audio-visual content. Content providers could hardly face the unfair competition of illegal copies of copyrighted audio-visual content, often through peer-to-peer exchange of such content.

Freeriding can also take place with infrastructures without infringing any law thanks to technology. Telecommunications offer very good examples. Platforms such as WhatsApp or Skype, so-called over-the-top (OTT) providers, make the exchange of written messages or even voice conversations without charging for the provision of such services possible. As a result, the revenue of traditional telecommunication operators for the provision of SMS and telephony services has been significantly eroded.

OTTs can provide their services for free as they are making use of the existing telecommunications infrastructure, installed and funded by the traditional operators, without paying for it. This is not illegal. OTTs just exploited a new loophole in the telecommunications ecosystem. Vertically integrated operators installed and ran the telecommunications infrastructure, funding it through charges to final users for each specific use of the infrastructure: each SMS, each minute of telephone call, etc. As internet access services were launched, users paid a flat fee that allowed them to convey any content through the infrastructure, including written messages and voice communications. Platforms such as WhatsApp and Skype just made it possible for users to make use of the internet access service to get messaging and voice services without having to pay the traditional telecommunications operator a specific fee.

Traditional telecommunications operators had to modify the way they finance their infrastructure, by relying more on flat rates for the connection to the network and less on charges for specific services, which can now be easily bypassed. This exemplifies the need for a long-lasting model to finance infrastructures due to the new sharing economy empowered by platforms.

Freeriding is an important challenge in transportation. There are massive public investments in transportation infrastructure, both physical infrastructure and transport services. Carpooling is a good example of freeriding, even if a voluntary one. Vehicle owners are ready to provide transportation services at a price that does not cover the full cost of the service. Drivers charge a price to cover the main variable costs (gasoline and tolls), but not the fixed costs of the acquisition of the vehicle, insurance, repairs, etc. This is a voluntary decision, and it is a rational one, as drivers would mostly be making the trip anyway, so they save part of the cost of the trip.

Freeriding can be extended to other segments of the transport ecosystem as the data layer increases its relevance and aggregation platforms intermediate mass-transit services. If access conditions to mass-transit services, in particular pricing, are not properly defined, it can create freeriding situations in the future.

As a conclusion, it is important to ensure that as shared mobility evolves and gets more complex, all players in the ecosystem contribute to the funding of the infrastructure and no freeriding exists. The examples of media, telecommunications and electricity show that freeriding can reduce the available financing for infrastructure. While the same effect has not been identified at a significant rate for transportation, it might happen in the future as transportation evolves to Mobility as a Service.

5.4.3 Taxes

Traditional players contribute to the system though the payment of taxes. Domestic transport services are subject to the Value Added Tax (VAT), even if mass-transit is often subject to a reduced rate. Corporations active in the transport industry pay corporate tax. Transport service providers and infrastructure managers pay social contributions for their employees. Just as a reference, there are more than 900,000 workers directly employed by rail operators and infrastructure managers in the EU (European Commission, 2016a, p. 11), and more than 500,000 workers directly employed by long distance coach operators (Steer Davies Gleave, 2016, p. 31).

Shared mobility presents some specificity in the payment of taxes and social contributions. On the one hand, transport service providers do not always pay taxes, particularly in peer-to-peer transactions. Non-professional providers often do not charge VAT with their fees, they do not pay corporate taxes nor personal income taxes, and they assume no social contribution. As these services are substituting transport services provided by traditional operators, a relevant decrease in taxes and social contributions from the traditional operators will take place, and such public revenue will not be compensated by new revenue from new transport service providers. Failure to pay taxes reduces finance available for transport infrastructure and, at the same time, reinforces the competitiveness of shared mobility against traditional transport.

Online platforms do pay taxes as a regular corporation. However, taxes are not always paid in the Member State where the underlying transport service is provided. Platforms often are established in one Member State from where they provide their information society services to the rest of the European Union. For instance, BlaBlaCar is established in France and Uber is established in the Netherlands. Taxes on the value appropriated by the online platforms are not always reinvested in the Member State where the transport service is provided.

As a conclusion, taxes are relevant in order to fund transport infrastructure as well as in order to have a competitive level playing field.

5.5 Data management

As stated above, in the sharing economy, a data layer is being created on top of the infrastructure layer (which includes the transport services). This data layer consists of the numerous data regarding what is going on in the infrastructure layer, such as passenger movements, their consumptions, their physical localisations and many other things. Data are indeed being collected from various sources, but often these data are not directly paid for. There is the situation where individuals and sometimes also public authorities give away their data for "free", often in exchange for various services (such as social media platforms or inscriptions to a car sharing community), at least in the case of individuals. This is much less the case of private companies, which much better appreciate the value of the data and ask for a remuneration for the data they so provide. This raises two questions, a purely financial and a regulatory one.

Financially, there is the question of the price of the data. If data is seen as a pure commodity, then this is simply a commercial transaction in which the price of the data is defined by the transaction. There may be some regulatory action involved in the case of market power and abuse of dominant position (Autorité De La Concurrence et al., 2016). For example, when an actor needs data from a dominant actor in order to do business, but is prevented from doing so because the dominant actor abuses its market power. Very concretely, with regards to public transport, there is the question of the value of the data that the public transport operator (for example a railway undertaking) provides to private operators (for example mobility services providers). As these data have been generated by systems funded, at least in part, by taxpayers and are now put to profit by private operators, it is fair that the public transport operator receives some money for its valuable data.

If, instead, data are considered an infrastructure, the question of regulating the data layer emerges. For example, if it is politically decided that the different transport operators – public and private – make some of their data available on an open platform, then the question arises as to the price of such data. Such a price would in any case have to be set by a regulator.

In section 2.4 of this study, we stated that the new data infrastructure is probably not so much the data itself, but rather the algorithms, which are capable of making sense and use of the data, generally for commercial purposes. However, these algorithms are the result of investment into software development and as such are proprietary. Yet, some of them have public economy implications, especially if not shared. This is the case for energy consumption or mobility behaviour. Yet, the way energy consumption or mobility behaviour will be represented, will very much depend upon the underlying algorithms that link the various data to each other. In this case, it is rather the algorithms that would have to be regulated, so that the respective way of linking the data together is of public rather than of purely private or commercial value.

In this line, some platforms have started to share data with local authorities. In January 2017, Uber announced the decision to share statistical data with local transport authorities and researchers in all cities where it has a significant presence (Uber, 2017c).

6. RECOMMENDATIONS

KEY FINDINGS

- **More statistical information, particularly in the EU-standardized format, on shared mobility is necessary**. It is recommended to follow best national practices to produce a good set of data from surveys, web-crawling and traditional statistics at EU level.
- **New shared mobility services should be integrated into the existing regulation**. This way, legal certainty will increase and coherent regulatory policies across all transport modes, both traditional and new, will be possible. Most of the competences on transport regulation are national but the EU has competences to ensure the free provision of information society services.
- It is recommended to **promote shared mobility as a substitute for the use and ownership of the private vehicle**. Specific measures are proposed: (i) Promote each single shared mobility service, in particular ensuring legal certainty; (ii) Promote the complementarity of shared mobility to mass-transit services (first mile/last mile, etc.); (iii) Promote Mobility as a Service as the instrument to combine mass-transit and shared mobility services as a valid alternative to the private vehicle. Transport infrastructure will benefit from the increase of passengers and revenue in mass-transit systems.
- In limited cases, it has been identified that shared mobility might compete with mass-transit services. **A level playing field is necessary**. It is recommended to eliminate potential regulatory advantages that favour **shared mobility** over **mass-transit services**, such as undue exemptions from charges for the use of the infrastructure, taxes, social contributions, or PSO financing, particularly when such advantages go against the commonly agreed policy objectives to reduce congestion, environmental damage and accidents.
- Shared mobility should be taken into consideration for the redefinition of some public service policies. Competition from shared mobility is threatening cross-subsidies in mass-transit franchises of profitable services and non-profitable services. This is often the case when minimum frequencies are imposed and peak services finance off-peak services. At the same time, **shared mobility provides new possibilities for a more efficient provision of public service**.
- As a new data layer emerges over the traditional physical infrastructure layer and transport service layer, it is recommended to closely follow the evolution of platforms active in the transport industry in order to **identify arrangements that challenge the financing of infrastructure at an early stage**. Challenges to financing can derive from value appropriation by platforms in the form of commissions. They can also derive from the freeriding of existing infrastructure, as has been identified in telecommunications and energy. It is important to identify and radically exclude potential free riders from benefiting from weaknesses of traditional business models or regulatory loopholes.
- Online platforms are centralising a large amount of data on mobility. It is recommended to ensure that **online platforms share big data on itineraries, frequency, duration and other travel parameters**. Online platforms are in a good position to share data with public authorities for the management of taxes and other legal obligations.

6.1 Improvement of information

Transportation is a heavily regulated industry and information is necessary to regulate the industry. Public authorities have information about the activity of traditional operators. Many players are publicly owned (road and rail infrastructure mangers, railway undertakings, public local transportation managers) and therefore public authorities have direct access to the information. Other players are under concession rights or licenses, and therefore under the obligation to provide information to public authorities (bus, coach and rail service providers). Good statistics have been developed to track the activity of traditional private players, particularly in road transportation.

Shared mobility is a new challenge. Public authorities have a very limited visibility about the activities of online platforms and the underlying transport services. There is little information on the number of users of the platforms, the number of rides that are contracted, pricing of the service, number of passenger-km, etc. There is little information on the usage patterns and the impact of shared mobility on other transport modes.

Eurostat has started to produce statistics about the sharing economy and the use of collaborative platforms (European Commission, 2016d). However, they are still at a very early stage.

There are interesting experiences at the national level. The most complete analysis has been made by the French public authorities on long distance carpooling. It includes customer surveys, web crawling exercises and projections (see Box 1). There are other national good practices, such as the Italian National Observatory on Sharing Mobility, and its National Report on Sharing Mobility (Fondazione per lo sviluppo sostenibile, 2016).

It is recommended to expand interesting national experiences to the EU level. Surveys, web crawling and traditional statistics can provide the necessary information to improve the regulation of the industry.

6.2 Integration of shared mobility in the regulatory ecosystem as new transport modes

It is recommended to integrate shared mobility solutions in the existing regulatory framework in order to provide legal certainty to all the parties and to adapt the existing regulatory framework to the new opportunities and the new challenges.

First, it is recommended to provide a regulatory classification for online platforms active in the transport industry. In the US, the legal category of "Transport Network Companies" (TCM) is being introduced in a growing number of jurisdictions (for instance California, Illinois, Massachusetts and many others). It recognises that the services provided by online platforms are different from the services provided by taxis. TCMs do not own vehicles. They do not provide transport services in their own name to final users. They intermediate between service providers and passengers. This is an exercise that could be undertaken at the EU level, mostly if such service is to be considered an information society service under the definition in Directive 2000/31/EC on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market (Directive on electronic commerce).[36]

Second, it is recommended to provide a regulatory classification to the different underlying transport services. Different services can be identified: bikesharing, carsharing, carpooling, etc.

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[36] The Court of Justice of the European Union has to decide on the nature of Uber as an information society service in a pending preliminary ruling submitted by the Juzgado de lo Mercantil nº 3 in Barcelona (See Box 4).

Regulation of transport services is the competence of Member States, and often of local authorities. In any case, it is important to make sure that these national regulations respect the freedom of establishment as defined in the TFEU. "Article 49 TFEU precludes restrictions on the freedom of establishment. That provision prohibits any national measure, which is liable to hinder or render less attractive the exercise by European Union nationals of the freedom of establishment guaranteed by the Treaty. The concept of restriction covers measures taken by a Member State which, although applicable without distinction, affect access to the market for undertakings from other Member States and thereby hinder intra-Community trade". [37] These regulations aim to provide legal certainty to service providers and passengers, and to ensure that no disproportionate obstacle to technical evolution is introduced.

It is necessary to reconsider whether existing restrictions in the national regulatory frameworks are still proportionate. For example, in some Member States it is forbidden to:

- sell individual services for the shared use of a vehicle (taxi, minivan, etc.);
- resell transportation services such as bus or subway rides. These restrictions are unnecessary and a limitation to new business models that bring efficiency and benefits for the users.

Third, regulation should take into account the effect of these new forms of transportation on the existing ecosystem. It is important to ascertain how shared mobility is integrated in the existing policy goals in transport policy: congestion, decarbonisation, safety, shift to rail, etc.

Moreover, the regulatory framework should overcome insular regulations for each transport mode. It should take into consideration the whole transport value chain, rather than each transport mode as an isolated service.

6.3 Provision of incentives to shared mobility as a substitute to private vehicle

It has been identified that shared mobility services have the potential to substitute the use and ownership of private vehicles. Each shared mobility service has potential to substitute the private car to some degree. Furthermore, the combined offer of shared mobility and mass-transit services is particularly attractive to substitute the private vehicle. Mobility as a Service might be the framework to foster this substitution. It is in the hands of public authorities to accelerate the substitution of the private vehicle.

Firstly, it is recommended to promote each shared mobility service, particularly those services with a higher potential to substitute the private vehicle, like carsharing and ridesharing. At this stage, legal certainty would be the most beneficial contribution.

Secondly, it is recommended to reinforce the complementary effects of shared mobility in mass-transit services. First mile/last mile complementarity can be reinforced by physically adapting the spaces to transfer from a shared mobility service to a mass-transit service (both urban and long distance). Integrated ticketing can also reinforce the combined use of these services.

Thirdly, it is recommended to promote Mobility as a Service, which would help to fully reap the benefits of the combined offer of mass-transit and shared mobility services. A transparent offer including all the alternatives to the private vehicle would accelerate substitution.

Substitution of the private vehicle will reinforce mass-transit systems and increase revenue in the form of fares paid by users, both to urban and long distance mass-transit operators. Such

[37] CJEU Case C-327/12, Ministero dello Sviluppo economico and Autorità per la vigilanza sui contratti pubblici di lavori, servizi e forniture v SOA Nazionale Costruttori - Organismo di Attestazione SpA, EU:C:2013:827; para. 45.

an increase should reinforce the financial situation of mass-transit operators and infrastructure managers when they benefit from access charges. However, increase in use might require further investment if there is already congestion.

6.4 Creation of a level playing field when shared mobility competes with mass-transit services

It has been identified earlier in the study that some types of shared mobility, in particular carpooling, compete with traditional mass-transit services such as long distance railway and coach services. Carpooling is a substitute to some of these services as prices, duration of the trip and general travelling conditions offered by carpooling are close substitutes to such services.

A level playing field was always important for competition among traditional transport modes. It is important to ensure that no transport mode is advantaged by unintended or unjustified regulatory factors. This is particularly the case when there is a policy to favour a specific transport mode, such as railways, for its beneficial effects on congestion and the environment, and yet still on another transport mode, such as road transport, which continues to benefit from the lack of tolls on the use of the infrastructure, etc.

Online platforms are increasing competition among different transport modes, both new and traditional, as technology allows effectively comparing traveling conditions. Competition is increasing not only inside each transport mode, but even more among different transport modes.

Furthermore, the traditional equilibrium among transport modes is being modified by shared mobility. Carpooling is increasing the competitiveness of road transportation. Technology helps to overcome fragmentation in the offer of road transport service in private vehicles. Private vehicles can now be used to transport passengers at a larger scale.

Therefore, it is important to ensure that private vehicle in road transportation that generates the worst externalities in terms of congestion, environmental damage and safety is not artificially privileged by loopholes in the regulation.

Some loopholes can be identified. As illustrated in section 5.2.4, many EU Member States do not charge tolls for the use of high capacity roads by private vehicles. On the contrary, all Member States charge access charges for the use of railway tracks, and these charges are particularly burdensome in long distance high-speed services. Other loopholes are related to the peer-to-peer business model. Non-professional transport service providers often do not charge taxes such as VAT and they do not pay income taxes for the fees charged to passengers. While this might be perfectly in line with local tax and social security legislation, it seems clear that an asymmetry with other transport modes exists.

The review of national tax and social security legislation in order to accommodate non-professional service providers seems urgent. Tax and social security legislations at a national level were defined for the industrial society, taking for granted that services would be provided by corporations or at least professional individuals. In many jurisdictions, it is not simple to accommodate non-professional individuals providing peer-to-peer service through different platforms. An individual can have a part-time job and obtain extra revenue sharing a room in his home, carpooling when traveling long distance with his car, or exchanging some services in his spare time. Non-professional service providers deserve legal certainty, and a regulatory framework without unnecessary barriers to meet all the legal requirements. At the same time, as peer-to-peer services grow in volume, often to the detriment of traditional providers, public authorities and society as a whole cannot renounce the fiscal revenue generated by these services. Simple and efficient procedures to meet tax obligations can be developed to facilitate the fulfilment of said obligations by non-professional service providers.

As a conclusion, it is recommended to ensure that new transport modes do not benefit from regulatory advantages that would go against policy objectives to reduce congestion, environmental damage and accidents.

6.5 Adaptation of PSO policies

Shared mobility requires a review of PSO policies in mass-transit, particularly in long distance transport.

Regulation (EC) No 1370/2007 defines public passenger transport as "passenger transport services of general economic interest provided to the public on a non-discriminatory and continuous basis." (Art. 2(2)(e)). The provision of such services is often subject to a "requirement defined or determined by a competent authority in order to ensure public passenger transport services in the general interest that an operator, if it were considering its own commercial interests, would not assume or would not assume to the same extent or under the same conditions without reward" (Art. 2(2)(e)). Such a requirement is termed as a PSO.

Public authorities devote significant public resources to compensate transport providers for the provision of PSO, both urban services and long distance services. Shared mobility challenges some of the instruments to ensure the provision of PSO (as discussed in section 5.2.3) and a review of some PSO policies might be necessary.

New competition makes the model of internal cross-subsidisation between profitable and unprofitable services unsustainable. When there is substitution, as in carpooling and long distance mass-transit services, passengers will make use of shared alternatives when mass-transit services are charged above cost to finance other unprofitable services. This seems to be the case in coach services in Spain, where profits from high-density routes finance the provision of unprofitable routes served under a single concession right.

The same effect might take place in a single route, as cross-subsidies take place among peak and off-peak services. There is evidence of this effect in France for railways.

Competition from shared mobility, when effective, might call for an end to the joint franchising of profitable and unprofitable services as a PSO compensation model.

Conversely, even when PSO are directly funded with public subsidies, migration of passengers from mass-transit to shared mobility might put extra pressure on the PSO sustainability. As a number of passengers migrate from mass-transit to shared mobility, it will be increasingly costly to guarantee the existing levels of quality, particularly of frequencies.

Furthermore, most PSO compensation schemes are defined for long periods of time. Regulation (EC) No 1370/2007 defines a public service contract maximum duration of 10 years for coaches and 15 years for railway (Art. 4(3)). The changing reality introduced by shared mobility might modify the economic equilibrium upon which public service contracts are built. A service quality condition review and the derived compensations might be necessary as a result of the new shared mobility services.

Finally, it is recommended to include shared mobility in the PSO policies on transport. Shared mobility might participate in some PSO compensation schemes. On the one hand, shared mobility might benefit from compensations for the provision of PSO to low-income users, as the cost of the provision of the service is lower than in other transport modes. In this line, shared mobility might be more cost-effective in the provision of services in very low-density routes. On the other hand, specific programs could be developed to ensure that shared mobility contributes to the funding of PSO. For instance, legislation in Massachusetts imposes the obligation to pay State authorities USD 0.20 for each ride on Transportation Network Companies. The revenue is then distributed among state and local authorities for the infrastructure funding (The 189th General Court of the Commonwealth of Massachusetts, 2016). USD 0.10 go to municipalities for transport infrastructure funding, USD 0.5 go to a state transportation fund, and USD 0.5 go to fund transition to competition for taxis. A similar scheme has been proposed in New York State.

As a conclusion, shared mobility has to be taken into consideration for the redefinition of public service policies. This seems to be particularly the case in long distance transport. Competition from shared mobility is threatening cross-subsidies in franchises of profitable service and non-profitable services. This is often the case when minimum frequencies are imposed and peak services finance off-peak services. In general, if passengers migrate from mass-transit to shared mobility, the funding of PSO will become more costly. Shared mobility has to be taken into consideration also for the provision of PSO and for financing them.

6.6 Ensuring the sustainability of investment in physical infrastructure

Online platforms create a data layer on top of the traditional transport activities organised around a physical infrastructure layer and a transport service layer. The unbundling of the data layer from the underling layers could distort the traditional mechanisms to finance physical infrastructure.

New players might appropriate or simply erode value from a value chain that is already under financial stress. Commissions charged by online platforms are an example of value appropriation. Existing commissions in peer-to-peer business models are an intrinsic element of the new business models and do not seem to challenge the sustainability of the underlying transport providers, nor the physical infrastructures they use. If online platforms get more active in traditional transport activities, either as intermediators of individual services or as aggregators of multimodal mobility services, commissions extracting further value from the traditional industry might become a challenge both for transport operators and for infrastructure managers.

New players can also freeride the existing infrastructure benefiting from weaknesses of traditional business models or regulatory loopholes, just as happened in the telecommunications or energy industry. Freeriding is not currently present in the transport industry at this stage but might arise in the future as new business models appear, particularly in the framework of Mobility as a Service schemes.

As the new data layer grows in relevance, it is recommended to closely monitor the evolution of platforms active in the transport industry in order to identify at an early stage arrangements that challenge the funding of infrastructure. Challenges to funding can derive from value appropriation by platforms in the form of commissions. They can also derive from the freeriding of existing infrastructure, as it has been identified in telecommunications and energy. It is important to identify and radically exclude potential freeriding benefiting from weaknesses of traditional business models or regulatory loopholes.

6.7 Big data sharing

The central role of online platforms in the sharing economy is creating a data hub that collects data of great value. Such a hub can be used to implement different public policies.

There is a role for public authorities to ensure that online platforms share some of the data they are gathering on the trips made by their users, such as itineraries, frequency, duration and other parameters of a massive amount of trips in urban and long distance environments.

It is not advisable to impose on platforms the obligation to share personal information about mobility patterns of specific passengers, particularly as this is sensitive personal data. Similarly, it is not necessary to force platforms to share data about their business interactions with service providers and passengers: matching algorithms, financial information, etc.

However, it is recommended to impose on platforms the obligation to share information at an aggregated level as to allow a better management of transportation systems both at an urban level and long distance. Some platforms have already started to share data. Uber announced a specific program to share such data.

Online platforms have accumulated relevant data on each service and financial transaction they intermediate. As a consequence, it is recommended to impose on platforms the obligation to collaborate with public authorities for the management of some micro-transactions in the name of their customers, such as payment of taxes.

There are experiences in other industries, such as accommodation, of management of a tax such as the tourist tax, by an online platform in the name of the platform’s customers. In this way, taxes can be effectively and efficiently executed on non-professional service providers.

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