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CHAPTER 2 “NEW MOBILITY SERVICES”

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INTRODUCTION

While the links between the development of ICT and individual travel behavior have been the focus of increasing research in recent years, the issue of the role of ICT in changing the mobility services landscape has so far received little scholarly attention in the literature. Whether the development of a new mobility service is enabled by, or even dependent on, ICT is usually an implicit assumption in most analyses of adoption behaviors or supporting policies.

Historically, this could be attributed to the fact that for a long time ICT brought only marginal improvements to existing mobility services, for instance enabling online journey planning for public transit users, phone booking for taxi customers, or online booking for car rental customers. Such improvements as ICT brought to mobility services did not change the concept, the operational model or the business model of those services, although they could to some extent change the user experience.

However, alongside the massive development of mobile ICT, and more specifically smartphones, the past decade has seen the arrival of new players, the emergence of new services in urban mobility, and the advent of new business and operational models.

This chapter examines the role of smartphones in changing the supply of urban mobility services, both from the perspective of *what* new services have emerged (looking at stakeholders, design features, relevant markets, etc.) and from the perspective of *how* said services interact with each other or with other, more traditional transport modes.

The first part of the chapter reviews the changes observed in the urban mobility services landscape that have been triggered or amplified by the spread of the smartphone. It discusses the emergence of new (or renewed) forms of services (e.g. shared modes, on-demand transport), and the arrival of new players (especially from the ICT world). The second part discusses the role smartphones play in such changes in the urban mobility services landscape and proposes an analytical framework for disentangling the effects of the threefold shift of mobility to the community-based economy, the access-based economy, and the platform economy. Finally, the third section discusses the outlook for competition between the (smartphone-enabled) mobility services with the strongest growth momentum as well as with more traditional modes.

1. CHANGES IN THE URBAN MOBILITY SERVICES LANDSCAPE

Recent changes in the urban mobility services landscapes take at least two obvious different forms: a) increasing diversity in the services offered; and b) new players attracting increasing attention.

1.1 New (or renewed forms of) mobility services: An accelerating trend of diversification

Many of the mobility services described as “new” or “innovative” in the literature (TRB/Committee for Review of Innovative Urban Mobility Services, 2015) have been around for decades, in one form or another. This is true for car-sharing services, which first appeared in Switzerland as early as 1948, and developed in Europe in the 1980s and in North America in the 1990s (Shaheen et al., 1998). It could be further argued

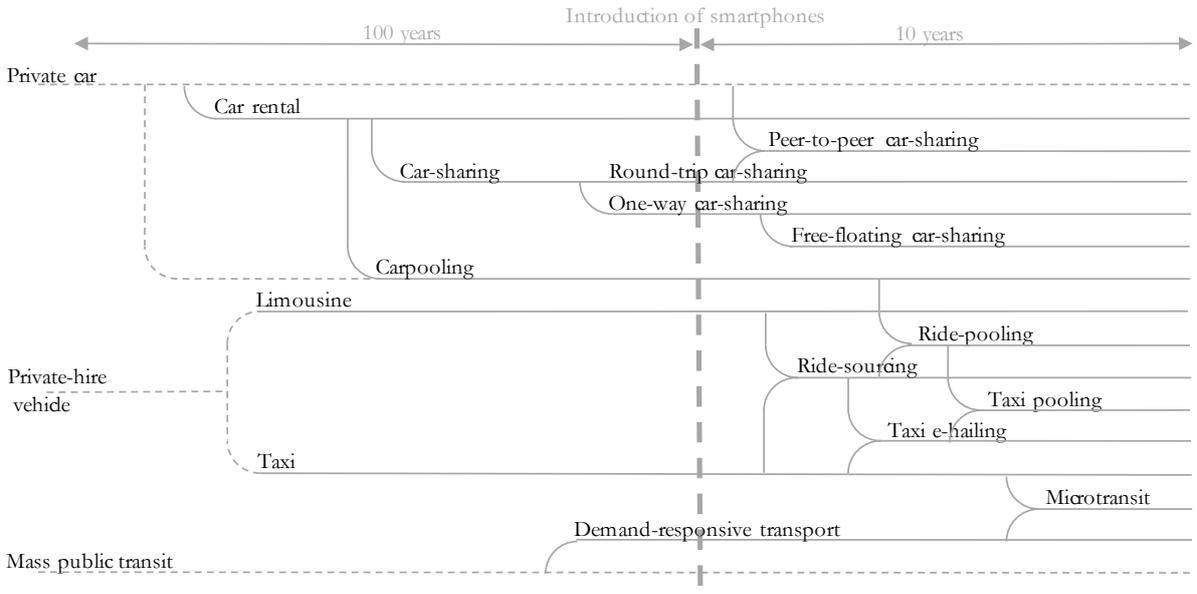
that car-sharing itself was a mutation from car rental, the existence of which can be dated back to the early 1910s (Automotive Fleet, 1962). The same observation holds for ride-sourcing services, which draw on a long history of service diversification in the private-hire vehicle industry (Gilbert et al., 2002; OECD/ITF, 2016).

Because of the ever-changing, increasingly diverse set of mobility service options on offer (overall and from each individual company), efforts to categorize new mobility services have generally met with only limited success, and most tentative typologies of new mobility services have been out of date by the time they were published. Considering new mobility services from the specific perspective of “technology-enabled transportation services”, the Transportation Research Board’s Committee for Review on Innovative Mobility Services (2015) recently established a taxonomy of these services dividing them into 11 categories, namely: a) traditional ride-sharing (carpooling/vanpooling), b) car-sharing, c) bike-sharing, d) micro-transit (examples: Bridj, Leap, Chariot), e) employee bus, f) transportation network companies (TNCs) – sequential sharing (examples: Uber, Lyft), g) transportation network companies (TNCs) – concurrent sharing (examples: UberPool, LyftLine), h) taxi apps (or e-hail), i) aggregator apps, j) parking/navigation apps, and k) mobile payment for an array of transportation services. Because of the confusing use of the term ride-sharing to refer to ride-sourcing (i.e. on-demand ride services arranged through mobile apps) in some of the academic literature, this chapter will opt for the term “carpooling” to refer to the sharing of a car journey – and possibly the associated costs – among two or more people. In addition, the term “ride-sourcing” will be preferred to that of “TNC”, so as to stick to a description of services (and their operational and business models) rather than the companies that supply them.

Figure 1 illustrates the recent acceleration in the diversification of mobility services, focusing on motorized transport (a similar diagram could be drawn for bike-related mobility services). The introduction of most new forms of mobility services has stemmed from the opportunity to upgrade and/or specialize a prior service. This is true for car-sharing, which from the start specialized in rentals for short time periods (with increments of one hour or less) and required self-access vehicles (using manual key lockers or, subsequently, universal keys or electronic unlocking devices) (Shaheen et al., 1998; Millard-Ball et al., 2005). This is also true for ride-sourcing, which upgraded traditional limousine services by making real-time reservation possible (through real-time vehicle tracking and real-time supply and demand matching algorithms) and by enhancing the customer experience with regard to reservation (convenience, reduced uncertainty over waiting time), billing (cashless payment, traceability), and trust (user feedback on service quality) (TRB/Committee for Review of Innovative Urban Mobility Services, 2016).

In recent years, however, an increasing number of new forms of mobility services have stemmed from the hybridization of two (or more) prior services. This is helping to accelerate the trend towards diversification in mobility services and to blur the lines established by tentative typologies of new mobility services. Ride-pooling is an example of such hybridization, whereby the concept of ride-sourcing (i.e. on-demand private ride services arranged through mobile apps) combines with the concept of carpooling (i.e. the concurrent sharing of a car journey – and possibly the associated costs – among two or more people) to offer a new service with hybrid features (lower individual cost compared with traditional ride-sourcing, set against the flexibility to share vehicle space and the possibility of longer rides in the event of detours).

Figure 1. The diversification in mobility services at a glance



Source: Author’s own construction based on data from Gilbert et al. (2002), Brake et al. (2004), Chan and Shaheen (2012), Furuhata et al. (2013), Millard-Ball et al. (2005), OECD/ITF (2016), Riley et al. (2014), Shaheen and Cohen (2012), Shaheen et al. (2015)

1.2 New players with strong momentum

Of all the signs of the profound changes that have been underway in the urban mobility services landscape over the past decade, the most obvious may be the appearance of new players that display strong growth momentum. Most of these fast-growing newcomers share the features described below.

Pioneer of pioneers, the US ride-sourcing company Uber was founded in 2009 and first officially launched in San Francisco in 2011. By early 2018 Uber was present in more than 700 cities around the world, operated a total of 10 million trips per day, had received total funding of \$16.4bn, and had achieved a market valuation of \$68bn.¹ Uber’s Chinese competitor Didi Chuxing was founded in 2012. By early 2018 Didi Chuxing was present in more than 450 cities in China, operated more than 20 million trips per day, had received total funding of \$18.1bn, and had achieved a market valuation of \$56bn. These two unicorn companies are the front-runners in a race that includes many other start-ups specializing in the supply of new mobility services. As illustrated in Table 1, the top 8 start-ups in mobility (those with over \$1bn in disclosed funding as of February 2018) have together received more than \$50bn in total funding over the past decade. The combined market valuation of these companies exceeded \$150bn as of March 2018.

Besides significant funding and the associated market valuation, the top 8 mobility start-ups also have in common the fact that they have received massive funding from corporate stakeholders in the ICT industry. These include a wide range of company profiles, from those highly specialized in Internet-related services (e.g. Baidu, Google, Tencent), to those specializing in electronics manufacturing (e.g. Foxconn, Qualcomm, Samsung, Xiaomi), including e-commerce platforms (e.g. Alibaba, Ctrip, JD.com, Rakuten) and social media platforms (e.g. Facebook, Sina Weibo). More “generalist” digital players Apple and Microsoft have also taken positions by investing in Didi Chuxing and Uber respectively. Interestingly, Didi Chuxing has become

¹ Financial information in this chapter was all retrieved from CBInsights’ website: <https://www.cbinsights.com/> Operational information (on cities, customer counts, etc.) was retrieved from the company websites, including <https://www.uber.com/>; <https://www.grab.com/>; <https://www.lyft.com/>; <https://www.olacabs.com/>; <https://www.ofo.com/>; <https://mobike.com/>; <https://www.go-jek.com/>.

a funding partner of the other five largest mobility start-ups, investing in Lyft and Ola in 2015, in Uber in 2016, in Grab in 2015 and again in 2017, and finally \$1.3bn in Ofo in 2016 and again in 2017.

Table 1. Disclosed funding of the top 8 mobility start-ups over the past decade

Company name	Headquarters	Founded	Total funding	Corporate investors from the ICT industry (from earliest to latest funding)
Didi Chuxing	Beijing, China	2012	\$18.1bn	Sina Weibo, Tencent Holdings, Alibaba Group, Apple, Uber , Foxconn Technology Company
Uber	San Francisco, USA	2009	\$16.4bn	Google Ventures, Baidu, Microsoft, Didi Chuxing
Grab	Singapore	2012	\$4.64bn	Qunar, Didi Chuxing , Uber
Lyft	San Francisco, USA	2012	\$3.96bn	Facebook fbFund, Tencent Holdings, Didi Chuxing , Alibaba Group, Rakuten
Ola	Bangalore, India	2010	\$3.8bn	Didi Chuxing , Tencent Holdings
Ofo	Beijing, China	2014	\$2.28bn	Xiaomi, Didi Chuxing , Alibaba Group
Mobike	Beijing, China	2015	\$2.01bn	Foxconn Technology Company, Ctrip, Qualcomm Ventures, Tencent Holdings
Go-Jek	Jakarta, Indonesia	2010	\$1.75bn	Rakuten Ventures, Tencent Holdings, Samsung Ventures, Meituan-Dianping, JD.com, Google
Total funding for 8 start-ups over 10 years			\$52.94bn	

Source: Author's own construction based on data from CBInsights as of March 2018

The strong momentum of these new players in the mobility services landscape is also reflected in their rapidly expanding international presence. As of February 2018, Uber was providing services to 717 cities around the world (312 in North America, 165 in Central and South America, 99 in Asia, 97 in Europe, 28 in Africa and the Middle East, and 16 in Australia and New Zealand). With a very international strategy, Ofo and Mobike have launched smartphone-enabled free-floating bike-sharing services in Asia, Australia, Europe, and the US, with respectively more than 250 cities (in 21 countries) and more than 200 cities (in 13 countries) as of February 2018. Although more regional, Grab was providing services to 161 cities in 8 different countries in Asia as of February 2018.

On the other hand, Lyft has remained mainly focused on the US market (with 640 cities as of February 2018), although it began operations in Canada in November 2017 (9 cities as of February 2018). Also mostly focused on its national market (102 cities in India as of February 2018), Ola launched operations in Australia in February 2018. As of early 2018, motorbike ride-sourcing provider Go-Jek too had remained focused on its national market (with services in 51 cities in Indonesia), but was preparing to launch operations in India.

Although ride-sourcing and free-floating bike-share companies appear to have been most attractive to investors in recent years, other major players can be found in other segments of the new mobility services market. Founded in 2006 and based in Paris, France, the carpooling service provider BlaBlaCar had raised total funding of \$0.34bn by early 2018, was valued at more than \$1bn, and had expanded its services to 22 countries, mostly in Europe, but also including Brazil, India, and Mexico. It is reported to be the largest carpooling service provider in terms of membership (in the region of 50 million). Free-floating car-sharing operator car2go, founded in 2008 as a Daimler AG subsidiary and based in Stuttgart, Germany, was reported to operate the largest car-sharing fleet by early 2018: 14,000 vehicles distributed across 26 cities in Europe, North America, and China, for a total member count of 3 million. Car-sharing pioneer and previous industry leader Zipcar (Shaheen and Cohen, 2012), founded in 2000 and based in Boston, USA, reported as of early 2018 a fleet of 12,000 vehicles and total membership of 950,000 in 382 cities in North America (358), Europe (22), Turkey (1), and Taiwan (1).

This overview of the fastest-growing actors should not mask the fact that a myriad other players are developing through a wide range of strategies and growth dynamics, with the potential to provide valuable services in the future.

Box 1. Car-sharing industry leaders in Europe and North America (1/2)

Car-sharing might seem a relatively mature industry in the new mobility services landscape, as in 2018 it celebrates its 70th birthday (Shaheen et al., 1998). Evidence of the industry's maturity can be found in the consolidation observed among traditional round-trip car-sharing services from 2007 onwards (Shaheen and Cohen, 2012), as illustrated in Figure 2. As a result of this consolidation, round-trip car-sharing leaders in Europe and North America have secured fleets of several thousand vehicles (up to 12,000 for the leading player Zipcar), and have expanded their operations internationally. Yet, no major new player has emerged in traditional round-trip car-sharing in Europe and North America in the last decade.

On the other hand, the free-floating car-sharing industry has seen several new, specialized players emerging from 2008 onwards, headed by the Daimler subsidiary car2go. The recent development of free-floating car-sharing services stems from their intrinsic reliance on smartphone apps. As vehicles in such services can be picked up and dropped off anywhere and at any time in the "home area" (i.e. designated operating area), real-time information on vehicle geolocation and availability – and hence smartphones (and mobile applications) – is necessary for users to access the service. Whereas most major round-trip car-sharing operators predated the introduction of smartphones, all one-way car-sharing services had an official app at launch, with the exception of car2go, which relied on an open API and third-party app development from its launch in 2008 until 2012.

Despite being relative newcomers, free-floating car-sharing operators have demonstrated their potential for rapid growth. The 5 industry leaders in free-floating car-sharing (namely car2go, DriveNow, Enjoy, Delimobil, and BelkaCar) have achieved in less than 10 years of operations a total vehicle count of approximately 26,000, a figure that took the 5 industry leaders of round-trip car-sharing (namely Zipcar, Flinkster, Mobility CarSharing, Cambio, and Stadtmobil) 20 years to reach.

Growth in free-floating car-sharing also appears to be more intensive (i.e. geographically concentrated) than in round-trip car-sharing. Indeed, the 14,000 vehicles in car2go's fleet are distributed across 25 cities (with an average of 500+ vehicles per city), whereas the 12,000 vehicles in Zipcar's fleet are distributed across 382 cities (with an average of 30+ vehicles per city). Apart from the industry leaders, which are aggressively pursuing their expansion agenda, including internationally, local free-floating car-sharing operators have launched with fleets in excess of 1,000 vehicles in a single city (e.g. BelkaCar in Moscow, Evo in Vancouver). The geographical concentration of free-floating fleets points to stronger network effects and/or economies of scale coming into play locally in free-floating car-sharing compared with round-trip car-sharing. Whether network effects or economies of scale could also have a significant impact at a larger level, so as to give international players a competitive advantage over local players in the free-floating industry, is still unclear at this early stage in the development of the services.

Consolidation among one-way car-sharing services might begin in 2018. Indeed, BMW became the sole owner of DriveNow after acquiring car rental company Sixt's 50% stake in the former joint venture in late January (BMW Group, 2018). Similarly, Daimler became the sole owner of car2go after acquiring car rental company Europcar's 25% stake in the former joint venture in early March (Daimler Financial Services, 2018). The two transactions could pave the way for a merger of the two services (among other options).

It should be noted that, besides specialized free-floating car-sharing operators, several traditional round-trip car-sharing operators have launched pilots or full-scale one-way car-sharing services, including the launch of Auto-Mobile by Communauto in Montreal (2012), Catch a Car, a subsidiary of Mobility CarSharing, in Basel (2014) and Geneva (2016), Zipcar in Brussels (2016), Zipcar Flex by Zipcar in London (2017).

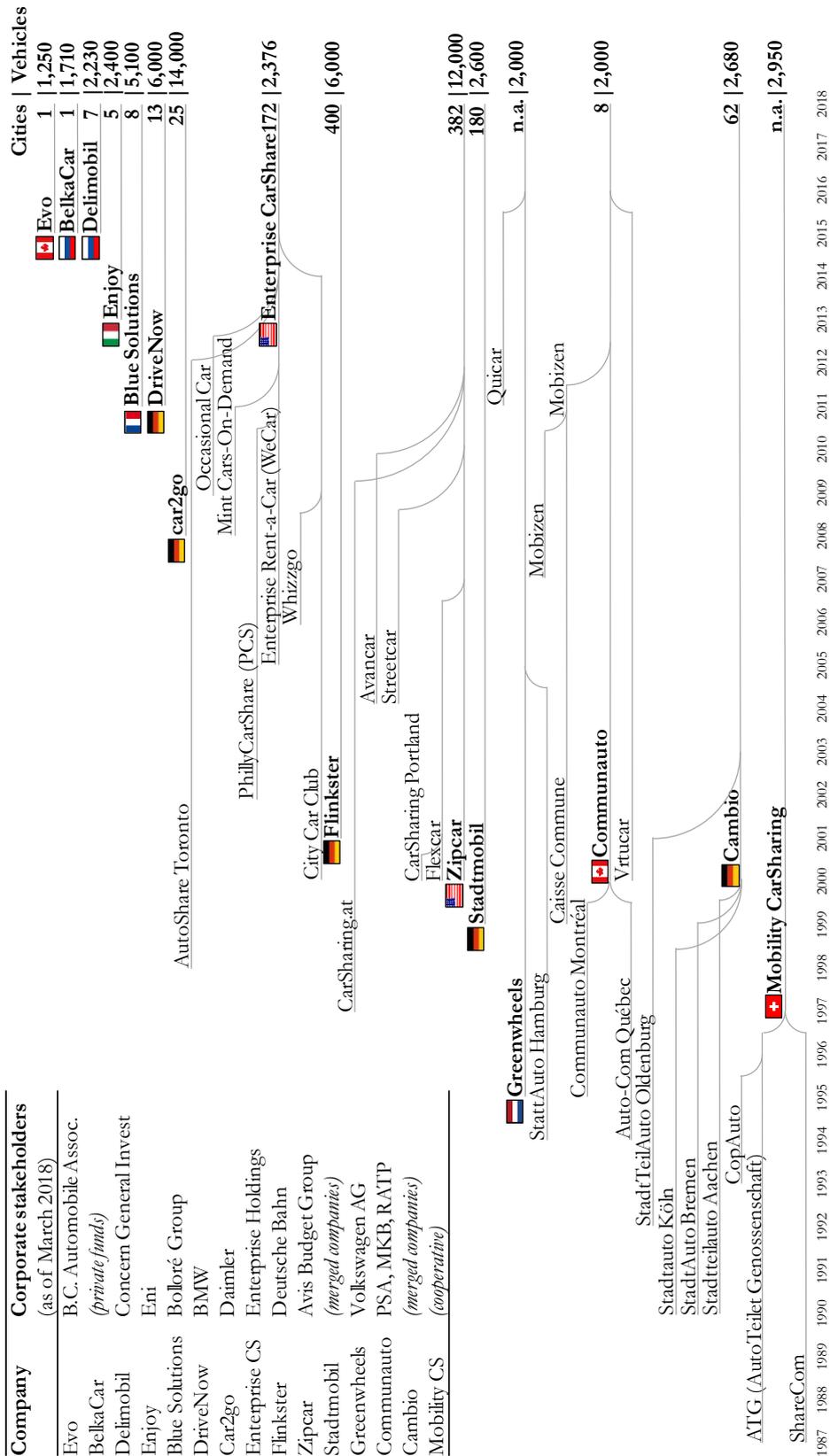
Only one operator specializing in station-based one-way car-sharing has so far gained recognition as an industry leader: as of early 2018 the French company Blue Solutions had deployed all-electric fleets in 5 cities in Europe, 2 cities in North America, and in Singapore, making a total fleet of 5,100 vehicles. Unlike most other car-sharing operators, Blue Solutions launches services under a different brand in each city (Autolib' in Paris, Blueindy in Indianapolis, etc.). The operations and business model of Blue Solutions' all-electric station-based one-way car-sharing services are infrastructure-heavy, because: a) one-way car-sharing services are known to require twice as many reserved parking spaces as vehicles in order to function optimally (Millard-Ball et al., 2005) (the ratio for Blue Solutions services is close to 2 in most cities, but closer to 1.5 for the largest system in Paris); b) an all-electric fleet requires stations for vehicle charging. As such, they usually operate through some form of public-private partnership.

Traditional car rental companies and car manufacturers have been major investors in the car-sharing industry (Shaheen and Cohen, 2012). There have also been recent signs of insurance companies showing an interest in financing the industry (e.g. British Columbia Automobile Association in Evo in Canada, Allianz in Catch a Car in Switzerland, MAIF in Koolicar in France).

Although not analyzed here for lack of reliable public data, peer-to-peer car-sharing platforms (also known as personal vehicle sharing) have also seen rapid growth in Europe and North America. As of May 2012, they were present in Canada, France, Germany, the Netherlands, the UK, and the US (as well as in Australia).

Box 1. Car-sharing industry leaders in Europe and North America (2/2)

Figure 2. Car-sharing leaders in the making: An overview of industry consolidation



Source: Boutueil V. and Voskoboinikova A., unpublished data; city/vehicle counts retrieved from company websites as of March 1, 2018 (only players with a fleet in excess of 2,000 vehicles or 1,000 per city are represented).

A picture is therefore emerging of a possible correlation between the growth momentum of new mobility service providers and their relative dependence on mobile ICT, whereby those companies with the greatest dependence on smartphones and mobile apps (e.g. ride-sourcing and free-floating vehicle-sharing services) are those attracting the most funds and developing the fastest.

2. DECODING THE CHANGES IN URBAN MOBILITY SERVICES: WHAT IS REALLY BEHIND THE “SHARED MOBILITY” CONCEPT?

In the context of European or North American cities, the private car (mostly in individual use) has been for decades, and is still to this day, the dominant mode in local mobility patterns (Kenworthy and Newman, 2015; Newman and Kenworthy, 1999). And for decades until recently, mass transit was virtually the only alternative to the private car for non-walkable trips in European and American cities – and a more credible alternative in the former than in the latter. The new mobility services that have developed over recent decades, e.g. ride-sourcing, car-sharing, etc., are seen as offering a new alternative, or else a complement, to the well-established duo of (individually used) private cars and mass transit. They offer the user a good compromise between the flexibility of the private car and the lower cost of mass transit.

This recent trend towards diversification in urban mobility services observed in developed cities has been analyzed as the outcome of mobility’s entry into the “sharing economy” in the late 1990s (Shaheen and Chan, 2016; Shaheen et al., 2016a; Le Vine and Polak, 2015). As no consensus has been reached among researchers about the exact definition of the “sharing economy” (Codagnone and Martens, 2016) or indeed about the boundaries of “shared mobility” (Le Vine and Polak, 2015), this section presents an overview of the concepts of the “sharing economy” and “shared mobility” and the academic debates to which they give rise. It subsequently goes on to map some of the business models of new mobility services onto the three dimensions of the sharing economy identified in the literature (Acquier et al., 2017): a) the community-based economy; b) the access economy; and c) the platform economy.

2.1 The “sharing economy” as it stands, in theory

2.1.1 The price of success

Although its origins can be traced back to the late 1990s (Shaheen et al., 2016a), it seems that the real hype around the term “sharing economy” began in the early 2010s (Gobble, 2017). Because of its fast-growing popularity, it has become an umbrella construct (Acquier et al., 2017) used to describe a wide range of concepts and corresponding trends in production and consumption patterns including, but not restricted to: “collaborative consumption”, “access-based consumption”, “the mesh”, “connected consumption” (Codagnone and Martens, 2016), or indeed “crowd-based capitalism” (Sundararajan, 2016). The term was added to the Oxford English Dictionary in 2015 (Gobble, 2017), which now offers the following definition: “*an economic system in which assets or services are shared between private individuals, either free or for a fee, typically by means of the Internet*” (Oxford English Dictionary, 2018).

Academic literature on the “sharing economy” concept, its history, its various forms, its impacts, etc., is expanding fast, as evidenced by the extensive literature reviews by Acquier et al. (2017), or Muñoz and Cohen (2017) from a business-modelling perspective, or Codagnone and Martens (2016) from a policy-making perspective, to cite just a few recent examples. Yet scholars concur that this growing body of literature remains ambiguous about the scope and definitions of the “sharing economy” and its associated concepts.

Among the advocates of a narrow definition, Frenken and Schor (2017) have proposed a definition of the “sharing economy” as “*consumers granting each other temporary access to under-utilized physical assets (‘idle capacity’)*,”

possibly for money.”² This definition allows the authors to distinguish the “sharing economy” from the “second-hand economy” (whereby consumers grant each other permanent access to their goods), from the “product-service economy” (whereby goods are rented from a company rather than from another consumer), and from the “on-demand economy” (whereby services rather than goods are shared between peers).

At the other end of the spectrum, the literature includes some very broad definitions of the “sharing economy” concept. More ostensive than connotative, i.e. often based on examples, such definitions are the most widespread and are very diverse. One example is provided by Elliott (2016): “*Sharing Economy*’ is a newly coined term for an ancient economic system embracing ‘community ownership’, efficient use of resources, scaled-back consumption, and ‘localized production’.”

Like many of the recent definitions found for the sharing economy, Calo and Rosenblat (2017) draws the reader’s attention to the role of the platform: “*The sharing economy* (...) refer[s] to a set of techniques and practices that facilitate trusted transactions between strangers on a digital platform.” Interestingly, such a definition would even exclude from the scope of the “sharing economy” familiar practices such as borrowing and lending goods or sharing a ride if such activities involved only family members, friends, neighbors, or co-workers (anything but “strangers”). There is however no consensus among researchers on the principle behind that exclusion (Acquier et al., 2017). Conversely, while it is unanimously acknowledged that large commercial platforms such as AirBnB or Uber have contributed significantly to the rapid spread of the concept of the “sharing economy”, there is also no consensus among researchers – or policy-makers for that matter – as to whether these platforms should be considered to be within or outside the scope of the sharing economy (Acquier et al., 2017).

2.1.2 From the “sharing economy” to “shared mobility”

Research that focuses on shared mobility is more limited and concentrated than research on the broader concept of the sharing economy. Yet, a number of research papers on the sharing economy have picked cases from the mobility industry, especially as Uber, the largest of the sharing economy firms by valuation, has been considered to epitomize the changes associated with the sharing economy, to the point that it has given its name to a new epithet: Uberization (Calo and Rosenblat, 2017). As might be expected, therefore, a similarly wide range of definitions and scope can be found in the literature focusing on shared mobility as in the literature on the sharing economy.

At the risk of stating the obvious, researchers in the field of mobility studies usually agree to place “shared mobility” in the broader context of the phenomenon of the “sharing economy”. This is attested, for instance, by the following two pairs of definitions found in recent literature:

“Advancements in social networking, location-based services, the Internet, and mobile technologies have contributed to a sharing economy (also referred to as peer-to-peer sharing, the mesh economy, and collaborative consumption). The sharing economy is a developing phenomenon based on renting and borrowing goods and services, rather than owning them. This sharing can occur among peers (e.g., community drivers, peer-to-peer carsharing, or bikesharing) or through businesses (e.g., a carsharing operator). The sharing economy can improve efficiency, provide cost savings, monetize underused resources, and offer social and environmental benefits. (...) Shared mobility, the shared use of a motor vehicle, bicycle, or other low-speed transportation mode, is one facet of the sharing economy. Shared mobility enables users to obtain short-term access to transportation as needed, rather than requiring ownership.” (Shaheen et al., 2016a)

² Codagnone and Martens (2016) would classify this definition in the “intensional” category. Intensional (i.e. ‘connotative’) definitions are “clear-cut in that they establish the necessary and sufficient conditions for a ‘thing’ being a member of a specific set.” On the other hand, ostensive definitions (i.e. ‘extensional’ definitions, definitions by exemplification or by pointing) “more pragmatically denote just a few key features and complement them with exemplifications.”

“Shared-mobility sits within the broader phenomenon that has been termed the ‘Sharing Economy’, in which widespread usage of emerging information and communications technology (ICT), particularly smartphones, enables new forms of market interactions that can enable both new services and improved efficiency in asset utilisation. Rather than individual physical items being purchased, owned, controlled, maintained and used solely by their owner, in shared-mobility systems the physical assets (bicycles, automobiles, small aircraft, etc.) are accessed sequentially by multiple users on a pay-per-use basis.” (Le Vine and Polak, 2015)

Despite being focused respectively on the user (“*shared use of a motor vehicle*”, “*enables users to obtain short-term access*”, etc.) and on the supplier (“*new services*”, “*improved efficiency of asset utilization*”), the two definitions display at least two common features. First, both clearly stress access (over ownership) as an important dimension of “shared mobility”. Second, both highlight the role of ICT in the development of the sharing economy.

2.2 Mapping new mobility services along three core dimensions of the sharing economy

Acknowledging the heterogeneity of definitions for the umbrella construct of the “sharing economy” as well as the need for a more constructive dialogue between the proponents of “narrow definitions” and of “broad definitions”, Acquier et al. (2017) developed an organizing framework that would allow the mapping of different perspectives on the sharing economy. The researchers posit that the sharing economy rests on three “functional cores”: a) the access economy (defined as “*a set of initiatives sharing underutilized assets (material resources or skills) to optimize their use*”); b) the platform economy (defined as “*a set of initiatives that intermediate decentralized exchanges among peers through digital platforms*”); and c) the community-based economy (defined as “*initiatives coordinating through non-contractual, nonhierarchical or non-monetized forms of interaction (to perform work, participate in a project, or form exchange relationships)*”).

The two definitions of shared mobility provided above explicitly refer to the first two functional cores on which Acquier et al. (2017) posit that the sharing economy rests, namely the access economy and the platform economy. The third core, the community-based economy, although less explicitly referenced in these definitions, might well be where shared mobility has its deepest roots.

2.2.1 The community-based economy: A fertile ground for service innovations?

The community-based economy is defined by Acquier et al. (2017) as “*initiatives coordinating through non-contractual, nonhierarchical or non-monetized forms of interaction (to perform work, participate in a project, or form exchange relationships)*”. Although many initiatives that meet this definition currently use digital platforms, the basic principle of community-based initiatives predates the appearance of such platforms. Starting with the extended family, and later expanding to broader communities (through the same process of extension of self documented in the case of “true sharing” (Belk, 1990; Belk 1994)), the community-based economy may actually be the most deeply rooted of all three dimensions of the sharing economy.

For example, “acquaintance-based carpooling”, typically taking place among family members and friends, as well as among coworkers, has a long history. Taking carpooling beyond the scope of the family, the first carpooling clubs in the US (at the time called “car-sharing clubs”) can be traced back to World War II, when the US government enacted a regulation that required carpooling arrangements for travel to workplaces to be made when no alternative means of transportation were available (Chan and Shaheen, 2012). Subsequently, “casual carpooling”, also known as “slugging” (i.e. a user-run, informal form of *ad hoc* carpooling), began in the US in the 1970s, fostered by the surge in fuel prices triggered by the Arab oil embargo and by the construction of the first high occupancy vehicle (HOV) lanes (Chan and Shaheen, 2012).

Sundararajan (2016) has argued that the rapid growth of the sharing economy could be partly attributable to people’s familiarity with the ancient practices (e.g. borrowing and lending underused goods, lending a helping hand for services, etc.) from which sharing economy business models are derived through a process

of digital reorganization. In light of the above, it could be further argued that the community-based economy is not just one of the three core dimensions of shared mobility, but that it has also provided fertile ground for all subsequent mobility service innovations.

2.2.2 The access-based economy: A tricky transition from ownership to “usership” and from products to product-service systems

The access-based economy is defined by Acquier et al. (2017) as “*initiatives sharing underutilized assets (material resources or skills) to optimize their use*”. From a consumer behavior perspective, the widespread development of the access-based economy suggests a shift in consumer preferences from the ownership of products (e.g. cars) to the use of services (e.g. car lease, car rental, or car-sharing, depending on intensity of use) (Mont, 2004). Twenty years ago, Prettenthaler and Steininger (1999) pointed out the pioneering role of car-sharing organizations in the broader shift to the access-based economy: “*Although substantial psychological forces support ownership of a car, the area of mobility by car is among the first where organizations have developed, that enable the shift from ownership to service use: car-sharing organizations (CSOs)*.” Cars indeed epitomize the underutilization of assets, as they are known to be “idle” most hours of the day when used privately. They have also been intimately connected with contemporary selves (Dowling et al., 2018).

The first known experience with car-sharing can be traced back to a Swiss cooperative in 1948, and many of the car-sharing initiatives launched in Canada and the US in the late 1990s still began with the same model of small-scale (one or a few vehicles), non-profit, self-organized entities, with a cooperative governance structure (Shaheen et al., 1998). Although a few of these cooperatives have achieved a larger scale (cf. Mobility CarSharing in Switzerland, with 2,950 as of early 2018, or Modo in Canada, with 600 vehicles as of early 2018), and some have converted to for-profit businesses (e.g. Auto-Com in Canada, in 1997, Shaheen et al. (1998)), it can be assumed that most community-based car-sharing initiatives have either failed or remained small-scale and perhaps, in some cases, under the radar of academic literature. Researchers have documented the difficulty in transforming small-scale car-sharing organizations into economically viable businesses (Shaheen et al., 1998). This points to the many organizational, contractual, and financial changes required to shift from a small-scale, user-led car-sharing initiative to a larger-scale organization.

Although other industries (e.g. hospitality) may have now surpassed mobility in terms of the dissemination of the access-based economy, the ever-growing member counts of major car-sharing actors such as car-sharing pioneer and historical leader Zipcar (founded in 2000, based in Boston, USA, and reporting 12,000 shared vehicles and 950,000 members in 382 cities as of early 2018), is a sign of the gradual shift in consumer preferences. The high fixed cost of owning and maintaining (and, in urban contexts, parking) automotive assets has undoubtedly been a driver of the consumer adoption of car-sharing (Shaheen et al., 1998; Prettenthaler and Steininger, 1999).

From a supplier perspective, the access economy can be embodied in the form of manufacturing companies transitioning to product-service suppliers, increasingly providers of services rather than products (Acquier et al., 2017; Mont, 2002). Car manufacturers developing their asset leasing activities to lease out cars instead of selling them is an example of such a transition. Alternatively, the access economy can also be manifested in companies other than the product manufacturer purchasing the product and in turn offering a service to the end-user. Major car rental companies and car-sharing operators meet this definition. In both cases, the centralization of the ownership and management of assets places a burden on the company’s balance sheet (because of higher fixed assets), and in both cases a dedicated organization and strategy is employed to deliver adequate service performance, quality. Of course, the flipside of the coin for the service provider who maintains direct contact with the end-user, is the opportunity to monitor user preferences and seize new market opportunities (Mont, 2002). This partly explains why car manufacturers and traditional car rental companies have become major stakeholders in the developing car-sharing industry (see Box 1 and Shaheen and Cohen (2012)).

If worldwide automotive fleets (in the range of 1bn cars) are compared with car-sharing fleets (not exceeding 100,000 for organization-based car-sharing), it is apparent that the shift from ownership to “usership” in the field of mobility, while gaining momentum, has not yet reached a tipping point. It could be argued that further progress is needed along this path for the sharing economy to reach full potential in the field of mobility, as persistent car ownership is an obstacle to many anticipated changes in mobility behaviors.

The access economy does not face exactly the same drivers and obstacles as far as bike mobility is concerned. Compared with cars, bicycles in developed cities experience less use (Kenworthy and Newman, 2015; Newman and Kenworthy, 1999) and are associated with lower positional value (i.e. prestige) (Litman, 2011). These two factors tend to make the transition to the access-based economy less problematic from the user perspective. Besides, bikes are also less costly fixed assets than cars for organizations to own, and less costly to manage (including from a physical dispatching perspective). This might explain the success of bike-sharing services, even in cities with little previous cycling activity (Castillo-Manzano et al., 2015; Shaheen et al., 2010). Parkes et al. (2013) documented the existence of 152 public bike-sharing schemes in Europe and 29 in North America as of mid-2012, compared with fewer than 10 in total in 2005.

2.2.3 The platform economy: The real tipping factor

The platform economy is defined by Acquier et al. (2017) as “*a set of initiatives that intermediate decentralized exchanges among peers through digital platforms.*” Platforms have penetrated almost all sectors of modern economies and have adopted very different forms and guiding motivations, but they usually share the following two characteristics: a) they create value by facilitating transactions rather than through their own production; b) they create strong network effects (i.e. their value rises with the number of users and suppliers joining) (Acquier et al., 2017). If the community-based economy is where the sharing economy has its deepest roots and the access-based economy is a necessary condition for the sharing economy to grow, the platform economy might be the boost that the sharing economy needed to scale up.

Platforms are a recent addition to mobility services. They are behind the success of most “unicorns” in the sector (see Table 1), powering a wide range of services, from carpooling with BlaBlaCar (founded in 2006) to ride-sourcing with Uber (founded in 2009) and Didi Chuxing (founded in 2012), including more recent additions in free-floating bike-sharing with Ofo (2015) and Mobike (2016). Some of these “transaction platforms” (Acquier et al., 2017) have even become emblematic of the “crowd-based capitalism” documented by Sundararajan (2016).

Platforms have helped to transform preexisting urban mobility services in three main directions. First, mobility platforms have enabled large-scale match-making between scattered demand and scattered supply through matching and pricing algorithms, and (real-time) information and geolocation (Acquier et al., 2017; TRB/Committee for Review of Innovative Urban Mobility Services, 2015), thereby broadening the scope and depth of opportunities offered by the access-based economy. Second, mobility platforms have improved safety and trust through remote tracking, rating, secure access, secure payment and insurance mechanisms (Acquier et al., 2017; TRB/Committee for Review of Innovative Urban Mobility Services, 2015), thereby broadening the scope of innovations stemming from the community-based economy. Third, they have lowered the costs of supplying mobility services by leveraging economies of scale and the low costs of self-contracted labor (Drahokoupil and Jepsen, 2017).

While it is difficult to disentangle the respective effects of these three transformations on the effective success of platform-based mobility services, it is usually considered that the platform structure of shared mobility services (with the network effects and economies of scale it entails) is where the greatest potential for growth in new mobility services is located. Acquier et al. (2017) refer to the “scaling power” of platforms.

2.3 What do smartphones and applications really do for shared mobility?

Smartphones and apps are a prerequisite for neither the community-based economy, nor the access-based economy, nor even the platform economy (as evidenced, for instance, by the launch of BlaBlaCar before the spread of smartphones). Yet, mobility apps (i.e. “apps with a primary function to assist users in planning or understanding their transportation choices [which] may enhance access to alternative modes” (Shaheen et al., 2016b)) have become endemic in most urban contexts and have played a role in the recent acceleration in the supply of new mobility services, and the success thereof.

Smartphones are acknowledged to contribute to the reduction in “transaction costs” (i.e. non-monetary costs, in time, negotiation, etc., of arriving at an agreement between the supply and demand of a good or a service) associated with accessing mobility-for-hire services (Shaheen et al., 2016a). In practical terms, what smartphones and mobile apps have brought to shared mobility that earlier generation ICT had not, or only partially, could be summarized as follows: a) the power of right-here-right-now; and b) the ease of all-in-one; and c) the safety of total tracking.

2.3.1 The power of right-here-right-now

Mobile apps have brought shared mobility services to a new level of immediacy of information (e.g. on the availability and price of a service, on the location, quality, and reliability of a particular service unit), reservation, access, payment, and rating. Together, this has improved the efficiency of existing services (e.g. round-trip car-sharing), and allowed for the creation of new (forms of) on-demand mobility services (e.g. ride-sourcing, free-floating bike- or car-sharing, dynamic carpooling).

Chan and Shaheen (2012) identified five stages in the development of carpooling (or ride-sharing) in North America since the 1940s (phase 1, World War II “car-sharing” clubs; phase 2, major responses to 1970s energy crises; phase 3, early organized ride-sharing schemes; phase 4, reliable ride-sharing systems; and phase 5 technology-enabled ride-matching), with phase 5 being characterized by “the incorporation of the Internet, mobile phones, and social networking into ride-sharing services”. Six years on, it could be contended that real-time (or dynamic) ride-sharing accessed through smartphones and powered by automated ride-matching technology in fact marks the beginning of a sixth phase in the development of these services. Indeed, subject to such services reaching a critical mass of subscribers – which might entail greater integration between ride-sharing platforms and with other transportation modes (Furuhata et al., 2013; Chan and Shaheen, 2012) – these latest technologies could both unlock a whole new level of possible real-time ride-sharing matches and present relevant ride-sharing opportunities in a more attractive light, as both safe and easy (and let’s not forget economically attractive).

Similarly, Shaheen et al. (2010) listed four generations of bike-sharing services since the 1960s (generation 1 starting with the free White Bikes in the Netherlands in 1965; generation 2 starting with the first large-scale coin-deposit bike-sharing system in 1995; generation 3, ICT-based bike-sharing with locks and smartcards, starting in 1998; generation 4, demand-responsive, multimodal bike-sharing, emerging as of 2010), with generation 4 being characterized by “flexible, clean docking stations, bicycle redistribution innovations, smartcard integration with other transportation modes, and technological advances including GPS tracking, touch-screen kiosks, and electric bikes.” In this case too, eight years on, it could be contended that free-floating (i.e. station-less) bike-sharing where bikes are located by smartphone and accessed through smart locks using QR (Quick Response) codes, actually marks the advent of a fifth generation of bike-sharing services, with a significant potential for a) scaling up already successful bike-sharing services; b) solving unsolved problems of rebalancing through dynamic value pricing mechanisms; and c) reducing risks of theft and deterioration through GPS tracking (including possible “geo-fencing”) and real-time traceability of asset condition (Parkes et al., 2013). The same kind of argument could again be made for free-floating car-sharing, where smartphones are a clear enabler of the service in the first place, and then of its upscaling.

Finally, smartphones have also played an instrumental role in the creation and development of ride-sourcing services, although some research would put the emphasis not so much on the role of the smartphone as on that of match-making algorithms (see, for instance, Dubal (2017) describing ride-sourcing companies as “*second generation, algorithmically-enabled chauffeur companies*”; but also, Calo and Rosenblat (2017), Rosenblat and Stark (2016)). It could be argued that ride-sourcing companies were only able to harness the power of algorithms through the immediacy of geolocation and interaction that smartphones allow (Shaheen et al., 2016a).

2.3.2 The ease of all-in-one

Smartphone and mobility apps are in a sense competing with smartcards for dominance in the access to new mobility services. Over recent decades, smartcards have gained a strong foothold in the public transit sector and in mobility-related access. They have also been used in car-sharing and bike-sharing since 1998 (Shaheen et al., 2010; Shaheen et al., 1998). They fulfil a wide range of functions, from personal identification to cashless payment, including data storage (e.g. time and duration of vehicle usage). Although fully-integrated smartcards providing access to public transport and new mobility services alike have been trialed in several cities (Shaheen et al., 2010; Shaheen et al., 1998), full integration across all urban mobility services remains an exception, thereby obliging multimodal users to hold and carry several smartcards.

According to a survey of 31 car-sharing experts in 2013 by Shaheen et al. (2015), “*operators noted public transit, smartcard, and electric vehicle integration as key to [one-way car-sharing’s] expansion.*” Yet when the survey results are examined in greater detail, it emerges that only 4 of the 26 round-trip car-sharing operators and 2 of the 5 one-way car-sharing operators in the survey mentioned smartcard usage among key technological innovations needed to capture potential growth opportunities as of late 2013. Although both smartcard (also called “Member Card”) and smartphone access (through car2go app) still coexisted in car2go’s free-floating car-sharing services as of October 2017, car2go’s Trip Process Agreements for the United States and for Canada explicitly mentioned that “*car2go intends to phase out vehicles using Member Cards*” (car2go, 2017a). With no mention of the Member Card at all, car2go’s General Terms and Conditions documents for all other countries (i.e. Austria, China, Germany, Italy, Netherlands, Spain) valid as of September 2017, stated that “*the means of access for car2go vehicles is the car2go app*” (car2go, 2017b). As of early 2018, DriveNow had maintained a dual access system in their fleets, whereby a dedicated smartcard (also called “customer card” or “DriveNow ID”) could be used to access the vehicle as an alternative to the smartphone app (see, for instance: <https://www.drive-now.com/de/en/how-it-works>; accessed March 1, 2018).

Smartphones can both remedy the problem of multiple smartcards, and help to streamline the process of joining a new service. While some services offer instant, all-electronic registration processes that give first-time users immediate access to the service (e.g. Uber, Ofo), others require applications to be validated (e.g. validation of ID documents or driver’s licenses). In the latter case, several options apply: a) the registration/application can be an all-electronic process (e.g. DriveNow, through Internet or smartphone app), or require some documents to be mailed, or an in-person visit to a physical validation point (e.g. car2go); b) applications can be validated instantaneously or there can be a delay for processing; c) access to the service can immediately follow validation (e.g. through a smartphone app) or there can be a delay while a method of physical access (e.g. a smartcard) is sent by mail.

Smartphones also streamline the process of joining a service by making it possible a) to use pre-registered debit/credit cards, bank account numbers, digital wallet accounts, etc., and b) to confirm identity through existing web accounts or social media avatars.

2.3.3 The safety of total tracking

From a user perspective, smartphones and mobility apps create perceived consumer value by allowing the real-time geolocation (and tracking) of (moving) vehicles, from before a reservation has even begun to after

the vehicle is dropped off in the case of car-sharing and bike-sharing services, and from booking the ride to checking out of the ride in the case of ride-sourcing services (including vehicle tracking right from reservation through to pick-up) (Shaheen et al., 2016b). They can also enable real-time reporting on vehicle condition (e.g. prior to a car-sharing trip), incidents, and customer satisfaction (e.g. driver rating) (Shaheen et al., 2016b). The ability to track the history of trips/bookings and the associated billing can be another source of additional value for users, e.g. for accounting purposes.

In services where trust and safety are a concern, e.g. ride-sourcing or carpooling, the rating of drivers by the community of passengers builds user trust by a) providing information for future passengers, and b) weeding out underperforming or problem drivers (Shaheen et al., 2016b). The reverse process, the rating of passengers by drivers in ride-sourcing and carpooling schemes, works in a similar way. In addition, some ride-sourcing apps also offer users the possibility of sharing their location, trip status, and estimated time of arrival with designated relatives (e.g. Uber's "Share my Trip" feature in some cities), thereby increasing the sense of security of users (and their relatives). Some ride-sourcing apps (e.g. Grab) even include an "alert button" so that users can instantly call their relatives or the police in case of trouble (Eskenazi and Boutueil, 2016).

The downside of this kind of total tracking from a user perspective is, of course, the risk of a breach of privacy, as studies indicate that people may not know or not fully understand what private information they consent to share (Shaheen et al., 2016b).

From a provider perspective, on the other hand, besides the obvious benefits of total tracking in terms of service performance (e.g. real-time supply and demand matching, improved quality of service), it appears that new mobility service providers are collecting large masses of data on mobility patterns and user preferences (regarding Uber's big-data analysis of customers' willingness-to-pay, see Calo and Rosenblat (2017)). The possession of such masses of data may well be the key to surviving (and perhaps thriving) in a rapidly-changing and highly competitive landscape of urban mobility services.

3. WHERE IS THE COMPETITION GOING?

3.1 Spoiler alert: Predicting the future is difficult

In dynamic, competitive markets, researchers (and policy-makers as well) can rarely get access to first-hand information on the strategies of private stakeholders, and have often endeavored to infer future market developments from observing past developments. Such attempts include the work of Shaheen et al. (2010), who provided a 45-year overview of past developments in bike-sharing services in Europe, the Americas, and Asia, and predicted the emergence of a fourth generation of services that would be demand-responsive and multimodal and that would include: a) flexible, clean docking stations; b) innovations in bicycle redistribution; c) smartcard integration with other transportation modes, such as public transit and car-sharing; d) technological advances including GPS tracking, touch-screen kiosks, and electric bikes. Another example is the work of Chan and Shaheen (2012), which provided an in-depth, 70-year analysis of ride-sharing (i.e. carpooling and similar services) in North America and reached conclusions on the likelihood of a shift towards greater interoperability among services, technological integration (the Internet, mobile phones, social networking), and policy support over the forthcoming decade.

More elaborate methods for exploring possible future developments of new mobility services include stakeholder (or expert) surveys. Shaheen and Cohen (2012) analyzed worldwide market developments and emerging trends in car-sharing through a survey of 25 experts in 2010, which led them to anticipate the following developments over the period 2010-2015: a) renewed emphasis on electric vehicles; b) continued multi-nationalization and commercial mainstreaming of car-sharing (with the emergence of new multinational operators accounting for the majority of members and fleets deployed); c) expansion of traditional car rental providers and automakers into car-sharing; d) advances in one-way rentals; e)

introduction and growth of personal vehicle sharing; f) linkages between mobility options, such as car-sharing and bike-sharing; and g) continued worldwide growth and expansion of car-sharing into new nations and regions (with the support of new technologies). An online survey of 31 car-sharing operators was conducted in 2013 (Shaheen et al., 2015), reaching conclusions regarding: a) expected growth trends in one-way car-sharing services through governmental backing, supportive policies, use of mobile technologies, and their unique cost structure and flexibility/convenience; and b) possible development of one-way car-sharing into an appropriate addition to round-trip car-sharing, public transit, and other shared-use modes.

However insightful (and largely correct) such research has been, it is vulnerable to three kinds of retrospective criticism. First, by overlooking the strategies of stakeholders and the complex interplay between them, it may have overestimated the propensity of private stakeholders to act in favor of intermodal and intramodal integration and interoperability (or the capacity of policy-makers to influence private stakeholders to that end). Second, because of a lack of distance in relation to a fairly recent technology, it may have underestimated the transformative power of smartphones and associated data-driven business strategies. Third, by looking at each category of service somewhat independently from the others, it may have overlooked similarities or even convergences between different types of services.

The context in 2018 is one of a rapidly-changing market for new mobility services (where new technologies and new or hybrid services appear virtually every day) led by multi-billion-dollar private companies (with disruptive tools and approaches, fast-expanding international coverage, and only a few years of history). In such a context, to take a compartmentalized approach to the examination of mobility services would put the analysis at risk of not seeing the forest for the trees.

The sections that follow will first present an overview of recent developments in, and concerns about, the competition between new mobility services and traditional mobility services (taxis and public transit), and second, take a step back and discuss emerging similarities and convergences among new mobility services in an effort to unveil hidden trends.

3.2 Acknowledging current concerns about the competition between old and new...

3.2.1 Ride-sourcing vs. taxis: The combat hogging the spotlight

In many developed countries, ride-sourcing companies have emerged as disruptive competitors to the well-established, highly-regulated taxi industry. In London, for instance, it was estimated as of August 2016 that 110,000 cars were licensed to operate as private hire vehicles, including 30,000 Uber vehicles, as compared with 22,500 registered black cabs (Dudley et al., 2017). It is generally acknowledged that ride-sourcing services have unlocked new demand potential in mobility-for-hire by reducing the transaction costs of getting a ride in someone else's vehicle (Jin et al., 2018; Dubal, 2017; Dudley et al., 2017; Shaheen et al., 2016a; Gabel, 2016; OECD/ITF, 2016) and by reaching neighborhoods with insufficient taxi and public transit services (Jin et al., 2018). However, it is also acknowledged that in doing so they have benefitted from a lighter regulatory framework compared with the incumbent players, in terms of capacity (medallions), fares, driver licenses, vehicle safety inspection, geographical scope, etc. (Dubal, 2017; Dudley et al., 2017; Shaheen et al., 2016a; Gabel, 2016; OECD/ITF, 2016; Ross, 2015).

The development model of Uber and similar companies has come under increasing pressure from the regulators and incumbent operators in many developed countries (Lesteven and Godillon, 2018). Depending on local context and regulations, and on the source of legal complaint, the following claims have been brought to court: a) ride-sourcing companies should be registered as ordinary transport companies or else taxi companies rather than Internet service providers (or a "technology company") (Dubal, 2017; Elliott, 2016); b) Uber app should be classified as a taximeter and be subject to fare regulation (Dudley et al., 2017); and c) Uber "registered driver partners" are not in fact "independent contractors" (Calo and Rosenblat, 2017; Dubal, 2017; Dudley et al., 2017; Elliott, 2016).

While there is a risk that Uber and their like may see their business models destabilized by unfavorable rulings on these claims, it seems likely that regulators will also respond to the rapid growth of ride-sourcing by enacting new regulations directed at the private hire industry, including, depending on local context, increased requirements for driver training (topographical tests) and language proficiency, or additional requirements for call center services or permanent commercial insurance (Dudley et al., 2017).

Shedding light on a less-discussed aspect of the competition debate, Gabel (2016) employed a microeconomic approach to show that the taxi monopoly was still in place in the US as of 2015, revealing the not insignificant market power advantage retained by taxis over ride-sourcing companies as a result of: a) the prohibition on ride-sourcing companies accepting street hails; b) the inability of such companies to serve the section of the community that does not own a smartphone (or is unable to use its Internet capabilities). What medium-term impact these issues will have on the competition also remains to be seen.

3.2.2 Ride-sourcing vs. public transit: A war brewing?

Increasing attention has been paid in recent research to the possible competition (or synergies) between new mobility services and public transit. Drawing on an extensive review of literature, Jin et al. (2018) have revealed how ride-sourcing services are seen as a complement to public transit at night and at weekends (improved time accessibility) and as feeders for public transit (improved spatial accessibility). On the other hand, Shaheen and Chan (2016) contend that the effects of ride-sourcing services on public transit use remain unclear and that more research is clearly needed in that regard.

Meanwhile, new forms of competition have emerged between new mobility services and public transit, whereby the distinctions between the two categories of services are becoming increasingly blurred. Indeed, very much in line with Uber's "simple mission" of providing "*transportation as reliable as running water, everywhere for everyone*" (<https://www.uber.com/newsroom/2055524/>; accessed March 1, 2018), recent developments in the company's strategy have included the establishment of partnerships with a range of municipalities in the U.S. to offer privately run (yet in some cases subsidized) services. Such agreements can include the provision of feeder services to and from commuter rail stations (Shaheen and Chan, 2016) or else the replacement of former public sector operations, e.g. the statutory functions of transport for the disabled (Dudley et al., 2017).

3.3 ... and looking beyond

3.3.1 Convergences in the business models

The rapid development of new mobility services has been supported by several innovations in business models by comparison with previous services. In some cases, e.g. major ride-sourcing services, the service provider's core business has been divested of both physical assets (vehicles, infrastructure) and productive workforce (drivers). In other cases, e.g. car-sharing, the service provider has retained massive stocks of physical assets (large vehicle fleets) and developed new jobs and skills, as well as new intangible assets.

Building on the RCOV framework (resources-competences; organization, both internal and external; value propositions) for business model analysis (see, for instance: Demil and Lecocq, 2010), it could be argued that, although very different at first sight, most business models in new mobility services are similar from at least three points of view: a) in terms of value proposition, they focus on a pay-per-use principle; b) in terms of organization, they rely on drivers outside the company to provide the service; c) in terms of resources and competences, they place the greatest emphasis on intangible assets, including apps (or other interfaces), algorithms, and data.

Ride-sourcing, car-sharing, bike-sharing, and carpooling services are all founded on the principle of short-term access to a vehicle. Car-sharing services have lowered the increment step of vehicle rental down to just one minute, in some cases. The pay-per-use principle (also called pay-as-you-go, or pay-as-you-use) is common to all new mobility services, which attests to their solid rooting in the access-based economy (see *supra*). It may however take different forms from one service to another, depending on: a) whether or not a membership fee is applied (the fee can be recurrent – usually annual or monthly – or one-shot, e.g. in the case of some car-sharing cooperatives); b) whether or not a minimum fee applies for each use; c) whether pricing is based on time or distance or a combination of both; and d) whether pricing calculations use small or large increments (minute vs. hour, kilometer vs. distance packages). The principle of pay-per-use in itself, together with the specific conditions for its implementation, are part of the value proposition to the user of the service.

From an organizational perspective, it is interesting to note that a common feature of all the new mobility services considered so far is the reliance on a driver who is not an employee of the service provider. Indeed, the driver can be: a) the user (e.g. in the case of car-sharing and bike-sharing services); b) a fellow user (e.g. in the case of carpooling platforms); or c) an “independent contractor” (e.g. in the case of major ride-sourcing platforms) (for a discussion of the evolution of this notion in the context of the U.S. transportation industry, see: Dubal (2017)). Although the services try to maintain some control over the contribution of third-party drivers to the overall quality of service perceived by the users/passengers (through guiding principles, codes of conduct, and rating systems), it seems to be a clear-cut choice among all the most dynamic new mobility services that their respective organizations should not incorporate drivers, but rather serve as an intermediary between users and drivers.

Last, from the perspective of resources and competences, there is no ambiguity about the fact that the core know-how and assets of all front-runners in the new mobility services revolve around apps (or other interfaces), algorithms, and data. Smartphone apps are how new mobility services become known to the public, how new users (both passengers and drivers) are recruited, and how services are usually accessed on a day-to-day basis. They are as much part of the user experience as the journey *per se*. All new mobility services have their own app – though some may also be accessible through other interfaces (e.g. web portals). And, as attested by regular updates (e.g. 17 updates to Uber’s app on iTunes over the last 6 months of 2017; 15 for car2go; 12 for BlaBlaCar; 10 for Ofo; 4 for Zipcar; source: <https://itunes.apple.com>; accessed March 1, 2018), apps are living assets that new mobility services are careful to maintain, upgrade, and adapt. On the other hand, new mobility services are also increasingly recognized (whether positively or negatively) for their powerful algorithms, which may or may not include features such as dynamic supply-demand matching (for ride-sourcing and some carpooling services), dynamic vehicle dispatching (e.g. for some car-sharing and bike-sharing services), or else dynamic pricing (e.g. on Uber’s patented “surge pricing” mechanism, see Rosenblat and Stark (2016) and Shaheen et al. (2016a)). Finally, the strong focus on (massive volumes of) data in new mobility services is increasingly upfront and public. As reported by Calo and Rosenblat (2017), Uber’s top management have openly acknowledged the “existential” importance of data to the company, as the collection and analysis of such data is key to the future ambition of developing innovative logistics services, mapping services, and ultimately self-driving ride-sourcing services. Docherty et al. (2017) bring an interesting perspective to the role of data in the broader transition to smart mobility systems: “*data is the most valuable commodity in the smart system, because it structures the matching of mobility to demand, and therefore both the price of mobility to the end user but also the size of the surplus generated by the mobility service transaction. In the smart future, data is the knowledge upon which the power to control the marketplace is built.*”

3.3.2 Convergences in the operational models of the more flexible mobility services

New mobility services have developed through an increasingly diversified range of operational models, from carpooling (casual, organized, and dynamic) to car-sharing (round-trip, one-way and free-floating, commercial and peer-to-peer), including ride-sourcing (and ride-pooling), micro-transit, etc.

Focusing on car mobility, the two categories of services with the greatest growth momentum as of early 2018 are ride-sourcing and free-floating car-sharing. Although they are operationally different in many respects (driver vs. no driver; waiting time vs. walking time, however short, to access the service; etc.), these services also present striking similarities and convergences.

First, these two categories of service are the ones that offer their users the greatest flexibility. Indeed, subject to sufficient supply, both categories are based on the following operational principles: a) real-time on-demand ride/vehicle booking (app-enabled, no requirement for prior reservation); b) pick-up/access and drop-off/egress wherever the user wants (no distant meeting point and no designated station); and c) travel along the fastest itinerary (smartphone-enabled navigation, no unwanted detour). Ride-sourcing services may be seen as one step ahead of free-floating car-sharing services in terms of geographical flexibility, because: a) their operating area, i.e. where pick-up is possible, is usually larger than the home zone where free-floating car-sharing vehicles can be accessed (as of early 2018, the operating range for ride-sourcing is the metropolitan scale, as compared with the city or neighborhood scale for free-floating car-sharing); b) they allow drop-offs outside their operating area (subject to driver approval), whereas free-floating car-sharing vehicles cannot be dropped off outside their home zone; and c) they save the user the effort (and time) of searching for a parking spot at their destination. On the other hand, free-floating car-sharing is likely to be more flexible in accommodating en-route changes in destination or itinerary at the user's convenience (ride-sourcing services might allow such changes, but only subject to driver approval).

Second, convergences in the operational models of these two categories of services can be observed in terms of spatial organization (choice of an operational area, based on the type of urban area, local population density, etc.), fleet sizing (density of supply), and pricing. Such convergences can only be observed at the local level (of a city or a metropolitan area), as many parameters in the operational models of services are context-dependent. Box 2 illustrates the type of insights that can be drawn from comparing the operational models of different services at a local level. Based on the comparison of a set of indicators describing the operational models of ride-sourcing services and free-floating car-sharing services in two different cities, the analysis points to the possible convergence of these categories of services in terms of density of supply (e.g. number of vehicles available per square kilometer). Although preliminary, such results open interesting perspectives for further research:

Box 2. Free-floating car-sharing vs. ride-sourcing in London and Seattle (1/2)

Analyzing new mobility services at city level can bring a better understanding of their respective operational models, including such factors as the operator's choices regarding the designated operating area (overall size, population density in the area, etc.), fleet size, fleet density in the operating area, fleet-to-population ratio in the operating area, etc.

The cities of London and Seattle offer two contrasting cases for a comparison of the operational models of ride-sourcing services and free-floating car-sharing services at the local level. Both cities host at least one major ride-sourcing service (Uber, with respectively 25,000 and 14,000 vehicles) and two major free-floating car-sharing services (respectively, DriveNow and ZipcarFlex, and car2go and ReachNow). However, with a population of 8.7 million, the Greater London metropolitan area is much more spatially concentrated (1,570 sq. km.) and much more densely populated (5,500 inhabitants/sq. km.) than Seattle metropolitan area, with a population of close to 3.8 million spread over a territory of 15,200 sq. km. (i.e. 250 inhabitants/sq. km.).

In both cities, the activities of free-floating car-sharing services are concentrated in much smaller operating areas than those of ride-sourcing services (an area size ratio of about 7-to-1 in London, and about 70-to-1 in Seattle, as illustrated in Table 3). In addition, the activities of free-floating car-sharing services are concentrated in much more densely populated areas than those of ride-sourcing services (a population density ratio of about 2-to-1 in London, and about 12-to-1 in Seattle). As of early 2018 at least, free-floating ride-sourcing is best described as a service for central urban areas, whereas ride-sourcing could be described as a metropolitan service. As might be anticipated, ride-sourcing services appear less "sensitive" to the characteristics of the area (cf. the very different size and population density of Uber's operating areas in London and Seattle), pointing to the fact that the company in a sense externalizes the commercial risk of scarce demand to: a) the driver partners (who are proposed – and rather strongly nudged into accepting – passenger pick-ups in remote, sparsely populated areas, with little prior information on whether the associated expense will be covered); and b) the users (who pay the cost of their remote-pick-up request through the surge pricing mechanism, based on their algorithmically calculated willingness-to-pay for the service) (Calo and Rosenblat, 2017). Free-floating car-sharing services, on the other hand, might seem to internalize the commercial risk related to local density of demand, as their overall operating areas are confined within fairly strict limits and their fleet sizes are kept in adequate proportion to those areas (between 3.3 and 3.8 vehicles per sq. km. for all 4 services in the two cities). Fleet density indicators (whether related to area size or to population) are difficult to compare across services, because ride-sourcing vehicles are not actually active 24/7 whereas free-floating car-sharing services virtually are (if downtime for maintenance and refueling is ignored). Nonetheless, assuming that ride-sourcing services are active an average of 8 hours per day, it appears that free-floating car-sharing in London and Seattle has already reached comparable levels of density of supply to those of ride-sourcing over their respective operating areas.

Table 2. Indicators for comparing ride-sourcing and free-floating car-sharing at the local level

Services (Feb. 2018)	Launch date (locally)	Fleet (veh.)	Operating area (O.A.) (sq. km.)	Pop. density in O.A. (inh./sq. km.)	Fleet density in O.A. (veh./sq. km.)	Fleet-to-pop. ratio in O.A. (veh./000inh.)	Pricing simulation for short trip* (GBP)
LONDON							
Ride-sourcing							
Uber	2011	25,000	1,572	5,500	15.9	2.9	9.1
Free-floating (FF) car-sharing							
DriveNow	2014	310	84	11,000	3.7	0.4	7.6
ZipcarFlex	2017	700	183	10,100	3.8	0.4	5.8
<i>Total FF</i>	-	<i>1,010</i>	<i>212</i>	<i>9,950</i>	<i>4.8</i>	<i>0.8</i>	-
SEATTLE							(USD)
Ride-sourcing							
Uber	2011	14,000	15,208	250	0.9	3.7	11.8
Free-floating (FF) car-sharing							
Car2go	2011	740	211	3,150	3.5	1.1	10.0
ReachNow	2016	700	211	3,150	3.3	1.1	10.8
<i>Total FF</i>	-	<i>1,440</i>	<i>211</i>	<i>3,150</i>	<i>6.8</i>	<i>2.2</i>	-

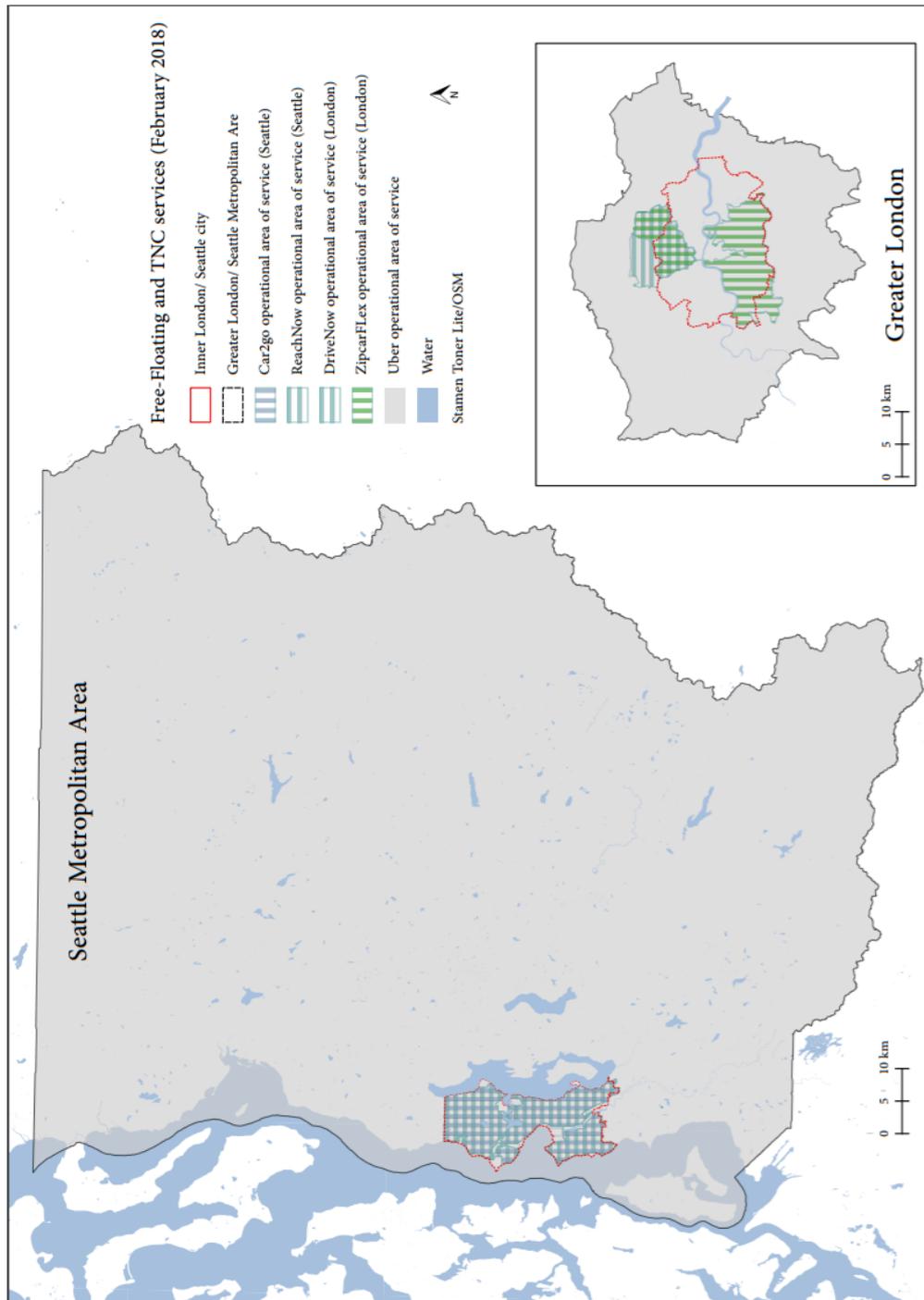
* Pricing simulations use unit fares (per minute and/or km) released on the service websites as of March 1, 2018. When several vehicle models were available at different prices (cf. DriveNow in London, ReachNow in Seattle), unit prices for the cheapest vehicles were used, assuming higher availability of smaller vehicles in dense city centers. A 5km trip is used as a common reference for pricing comparisons across services in a dense urban context. Driving speed is assumed to be 17kmh in both London and Seattle, which brings driving time for short trips to 18 minutes. A 2-minute penalty (10%) is added for free-floating car-sharing trips to account for the need to park on arrival (search for a spot + actual parking).

Source: Boutueil V. and Tanikawa K., unpublished; based on data retrieved from company websites as of February 2018 and local census data.

Box 2. Free-floating car-sharing vs. ride-sourcing in London and Seattle (2/2)

In addition, free-floating car-sharing services appear to have adopted much more aggressive pricing strategies (compared with ride-sourcing services) in London than in Seattle, with discounts relative to ride-sourcing prices in the range of 16 to 36%, and 8 to 16% respectively. Such aggressive pricing may point to the service being in an early phase of development in London, as growth in car-sharing fleets is quite recent, whereas Uber already has a strong hold on the market. It may also (or alternatively) point to the competition from public transit being fiercer in London than in Seattle. Finally, it may also (or alternatively) point to stronger network effects being at play in London than in Seattle (higher member-to-vehicle ratios could allow for higher utilization rates, and therefore lower marginal pricing). Although member counts at city level are not public information, the latter hypothesis finds some support in the fact that ZipcarFlex can leverage its common membership with Zipcar (operating an additional 1,550 vehicles in London as of early 2018) to reinforce the network effects.

Figure 3. Comparing the operating areas of services



Source: Boutueil V. and Tanikawa K., unpublished data; operating areas retrieved from company web-sites as of March 1, 2018.

4. LOOKING FURTHER DOWN THE ROAD... WHAT QUESTIONS REMAIN FOR THE FUTURE?

4.1. Outstanding issues

As highlighted by the numerous references in this chapter, the academic literature focusing on new mobility services has been steadily growing over recent decades. The acceleration in service diversification has been paralleled by an acceleration in the research effort. In particular, most recent forms of new mobility services (e.g. ride-sourcing, one-way or free-floating bike- or car-sharing, dynamic carpooling) have given rise to a wide range of research in such diverse fields as microeconomics, econometrics, transport modeling, operations research, travel behavior analysis, innovation management, political science, urban planning, etc. Research questions specific to these modes that have received special attention so far include: optimal size and spatial distribution of shared fleets; optimal strategies for dynamic repositioning of fleet vehicles; dynamic pricing; optimal matching of itineraries (Raviv and Tzur, 2016; Shaheen et al., 2015; Furuhata et al., 2013).

Further development is needed, however, in some areas of research concerning on-demand mobility services, where data could already be collected (using existing or *ad hoc* surveys, operator data, or official statistics) and analyzed by researchers, given how widespread these services have become and the possibility of hindsight offered by a decade-long history. These areas of study might include, for instance, behavioral research on response to incentives (to join or co-produce the service, e.g. for vehicle repositioning), trust building among service users, the medium-term impact of new mobility services on individual car ownership and travel behavior (longitudinal surveys), and user sharing preferences (see, for instance: Dowling et al., 2018; Lan et al., 2017; Shaheen et al., 2015; Furuhata et al., 2013). Another area with great potential for further research is the growing momentum of peer-to-peer car-sharing services enabled by mobile technologies (Shaheen et al., 2016a; Shaheen and Cohen, 2012). Car-sharing services that leveraged the massive fleet of “idle” personal vehicles that could be made available for rental at a very low transaction cost in exchange for perhaps significant revenues to their owners, may have an equally strong disruptive potential for mobility systems in urban, suburban, and rural areas as the impact ride-sourcing has had in urban areas over the past six years.

Other strands of research also need to be pursued in order to gather useful insights for public policy-makers facing the challenge of planning for future mobility systems in a context of strong asymmetry of information and high uncertainty. These would include:

- land use and transportation research on the effects of on-demand mobility services on urban form, accessibility and equity, and on the aggregated medium-term environmental impacts (e.g. at city level) of said services (Shaheen et al., 2015; Parkes et al., 2013);
- economic research on the role of infrastructure in regulating the development of new mobility services (Shaheen et al., 2015; Chan and Shaheen, 2012) and or optimal pricing of infrastructure (Parkes et al., 2013);
- behavioral research on optimal incentives for the integration of mobility services, both intramodal (e.g. among dynamic carpooling platforms) and intermodal (e.g. between vehicle-sharing systems and public transit) (Chan and Shaheen, 2012);
- research on the potential of, and optimal public support for: a) mobility aggregator platforms (also known as MaaS, mobility-as-a-service) (Docherty et al., 2017; Willing et al., 2017; Transport Systems Catapult, 2016; Chan and Shaheen, 2012), or b) new mobility services that would not be smartphone-enabled (e.g. formalized flexible carpooling along major commuter routes) (Chan and Shaheen, 2012).

Emerging issues in the field of new mobility services that need further investigation also include the interactions between these services and other technologies, including electric vehicles and automated vehicles.

Beyond such issues, which usually fall within the scope of mobility and transport studies, the rapid growth of on-demand services also raises important research questions as to their effects on labor, consumer protection, data privacy protection, insurance policies, and value capture (Acquier et al., 2017; Calo and Rosenblat, 2017; Dubal, 2017; Rosenblat and Stark, 2016; OECD/ITF, 2016).

Finally, while this chapter has focused on new mobility services in developed countries, further investigation is direly needed on whether or not the development of new mobility services in developing economies is similar to that observed in developed economies, and on the specific kind of effects new mobility services are anticipated to have on mobility systems in developing economies (Shaheen and Cohen, 2011).

4.2 Is the fight for data really the end game?

The strategic priority placed on data by new mobility service providers, especially on-demand services such as ride-sourcing and free-floating car-sharing, has only recently been uncovered and openly discussed (see, for instance: Docherty et al., 2017). As already mentioned, the opportunity to collect and analyze mass first-hand data on daily mobility patterns in a context of supply diversification and behavioral change is crucial to the survival and development of these services. However, looking beyond the usual focus on mobility data for the sole purpose of short-term adaptation to a rapidly-changing, highly-competitive market, one can find a growing body of consistent evidence that the endgame is about something more.

Dudley et al. (2017) point to the development of autonomous vehicles as being “the most ambitious element” in company strategies. After opening a driverless car research center in Pittsburgh, United States, in 2015, Uber launched a self-driving fleet in the city in September 2016 (followed by another in San Francisco in December of the same year), together with the development of a proprietary, highly-granular, global mapping system. While the regulations relating to self-driving vehicle pilots still require the presence of a standby driver in the vehicle, Uber appears to be sharpening its (digital) weapons to fight the next war, which will arise from the massive revolution that automated vehicles will bring to urban mobility services. It is interesting to note that this is the first time in Uber’s history that the so-called “information service provider” is planning to purchase massive quantities of physical assets, as it has entered an agreement with Volvo Cars for the provision of “*tens of thousands of autonomous drive compatible base vehicles between 2019 and 2021*” (Volvo Car Group, 2017).

Interestingly, the hypothesis of a convergence between the ride-sourcing model and the free-floating car-sharing model finds further support here. Indeed, upon acquiring their 25% stake in car2go from car rental company Europcar in early March 2018, Daimler released a public statement that: “*car2go has laid the ground work for Daimler’s CASE strategy as the company shifts to a fully connected, autonomous, shared and electric vehicle portfolio. Today, car2go has algorithms which predict mobility demand and the fleets are strategically moved to optimize maximum usage and meet demand. The goal is to develop the required expertise and resources so that we are a leader in the future business with self-driving cars.*” (Daimler Financial Services, 2018)

And if this prospect of fully-converged automated ride-sourcing and free-floating car-sharing services were not enough to give researchers and public policy-makers a headache as to what new issues and challenges lie ahead for urban mobility systems, the growing buzz around the “Tesla Network” project might just do the trick. Tesla’s CEO could indeed have a plan for a car-sharing platform that will enable all willing owners of a fully-automated, all-electric Tesla vehicle (expected to reach market in a couple of years) to make their vehicles available for on-demand (autonomous) car-sharing to anyone on the platform.

The prospect of hundreds of thousands of brand new, fully-automated vehicles, just an app click away, ready to take anyone from anywhere, to anywhere, at a cost that might compete with that of mass transit, provides enough food for thought for several decades worth of research on (yet more) new mobility services.

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