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Crossing the Urban Data Layer: Mobility as a Data Generating Activity

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Summary of the Report

We analyze mobility within cities from the perspective of data acquisition and how location-based-services enable companies to set demand and preferences in a geographic context. A key aspect is that movement creates context-based-intelligence when it becomes possible to adjust advertisement and offers based on location, activity and social-context.

In terms of impact on on business modeling, we find that a primary impact is that on value proposition and marketing. Smart-devices enables a constant connection and a two-way dialog between company and customer. It will be increasingly important for retailers to effectively reach customers with offers that are contionously updated to maximize the likelihood of a purchase through behavioural-based pricing.

Data driven business models are transforming the insurance industry as data from wearable devices and social-media activity determine life-insurance premiums, and car insurance is set by where and when a car is driven. Similarly, credit-risks are now determined through an understanding of purchasing patterns and account-flows, rather than credit-scores.

Another category of business impact is that created by the ability to measure device performance and usage. This impacts the entire corporate value chain – notably thorugh outcome-based contracts and servitization when large data and increasingly advanced analytics makes it possible decrease risks associated with guarantees, insurance and leasing contracts.

Incrasingly, concerns are raised over both the impact on privacy and cybersecurity, in addition to fairness when pricing is becoming increasingly individualized. We cover the risks, implications and the challenge associated with the fact that even as consumers state that they are concerned about privacy, they also value getting relevant content that is enabled by consumer profiling.

1. Introduction: Mobility From the Perspective of Data Acquisition

In connected cities, the way we move is now transforming into a data generating activity characterized by a crossing of private industry data layers – enabling both insights for improved consumer profiling when demand and preferences are put in a geographical context and creating new monetization opportunities. Urban environments are rapidly being digitalized with sensors, networks, connected devices and vehicles in what is known as the Internet of Things (IoT) revolution that is creating opportunities to collect real-time data on preferences and activities of consumers.[1]

From both a physical devices perspective, and the analysis of data, this is a commercial and largely unregulated development – as lawmakers are unable to keep up with technology.[2] We are therefore proposing a definition of a so-called Digital City that is focused on commercial markets inside of urban centers, and R&D[3], in contrast to the so-called Smart City focusing on government public sector management.[4] This as the later strategy depends on city government – with a culture that is uniformly bureaucratic, inadequately funded, and lacking technical or partnering expertise required to deliver a coherent government strategy for digitalization.[5]

We believe that policymakers often fail at understanding how digitalization is planned and implemented in urban centers, and notably lack understanding of the strategic role of private enterprise R&D investment and expertise. Corporations such as Apple, Facebook, Uber, and others invest a large percentage of their multi-billion R&D budgets into products and services that are targeted at city dwellers.[6] They are the guerilla in the room that is rarely if ever consulted by or taken into consideration by city governments in their plans for the development of their own version of the Smart City. Yet, these same players are sending collected data to each other, combining consumer information and creating a perfect profile of individuals as they move about the city from home to office to event venues.

It is private R&D and technology that is digitalizing our urban environments – as Moore's law has become pervasive across storage and computing, algorithms, sensors, robotics and advanced materials science. Applications are built on top of these technologies, allowing

companies to both deliver new services and gather data used to understand their products and notably their end customer. These developments are simultaneous and difficult – if not impossible – to disentangle, in addition to occurring almost completely without public sector involvement.

At the heart of the digitalization of cities are the mobile devices and applications that we use for things such as giving us directions, buy goods, find housing, and communicate with our friends and colleagues. By using these services, we share a lot of personal information, as the typical model is that consumers trade data in return for a "free" service[7], allowing companies to gain insight into our preferences and learn about what content we should be exposed to.[8]

It is likely that consumers do not fully understand the full extent of data that is shared, and what it implied when data is used to create a consumer profile.[9] When we sign up for a service, it is seldom clear how this data is used, and with whom it is shared. Third-party services (such as usage analytics, crash reports, and integration with social media) are often integrated in applications and run in the background of our devices – effectively tracking movement without any indication given to the user.[10] Sales and collaborations based on the transfer of consumer data has turned into a billion-dollar industry.

This report outlines the broader developments that enable companies to create insight from data and shape our urban environments. A background of key business, technology, and societal changes that motivate this paper follows in chapter 2. Chapter 3 covers the impact of data on business models. Chapter 4 reviews concerns for cybersecurity, privacy and fairness. Chapter 5 summarizes implications for a few key industries. The paper ends with conclusions and a discussion on future developments.

2. Simultaneous Trends are Changing Business, Lifestyle and Urban Environments

Starting off, we believe that several closely related and simultaneous trends provide a good illustration of the interconnectedness between how business models, consumer preferences and cities are changing – and how exponential advances in technology drive these developments. In the sections below, we list four trends that are shaping society at large and consequently impacting business models.

2.1 Seamless Mobility is Not on the Horizon

Cities across the globe are facing congestion and strained infrastructure, and for the foreseeable future, congestion is predicted to get worse across the United States – as urban populations grow and investment in public-transit declines.[11] In fact, a likely to be self-fulfilling cycle of declining transit ridership since 2014, has caused some experts to conclude that there is no point to any public funding for transit at all.[12] The cost of gridlock is enormous, estimated at $ 305 billion in 2017 for the U.S. alone, with Los Angeles, New York, Miami and San Francisco examples of cities were traffic costs exceed $ 2000 per driver and year.[13]

Looking beyond the current state of gridlock and crumbling public transit, the single most significant factor to consider is that of fully autonomous vehicles (AVs), which are predicted to have a transformative impact on the automotive sector.[14] In large because they will decrease cost and make it possible to replace car-ownership with mobility-as-a-service (knowns as MaaS). A key benefit is also added safety, as 90% of car accidents are due to human error.[15] However, the complexity of these technologies makes it difficult to forecast when AVs will be pervasive[16], and some automotive experts state that current enthusiasm and assertions on rapid advances in AV technology is often lacking scientific support[17], and that "*nobody in the automotive industry is anywhere close to full autonomy*".[18] And once AVs are operational, the question of how to resolve a future transitional period of human operated cars and AVs sharing road space also remains.

The added efficiency of AVs – basically more cars on the roads driving more closely together and being better coordinated – is by many presented as a solution to congestion.

It is however far from certain that AVs will make things much better, as the positive effects of increased efficiency is likely to be offset by increased traffic as AVs drive around empty in search for customers, and increases demand for miles traveled due to added convenience, putting additional strain on road infrastructure.[19] Because of this, a growing literature points towards that earlier predictions have been overly optimistic[20], and that several scenarios point towards increased gridlock.[21] Much of the outcome on congestion will depend on how AVs are regulated – as shared autonomous vehicles (SAVs) will minimize empty vehicles driving in search for customers.[22] Existing infrastructure and mobility patterns are also highly important, as AVs are a great first- and last-mile option to increase the reach of existing public transit – i.e. decreasing congestion in cities with efficient transit systems. If AVs result in a shift away from mass-transit, or if transit is lacking as in most U.S. cities, scenarios are far less positive and often indicating a negative impact on congestion.[23]

Adding to this is that and any future scenario will need to be adjusted to current developments – meaning that if AVs hit the market in five years, it is the future and far worse state of congestion that serves as the reference point.

In light of the above, the aim of this report is to highlight that the main development is not *how* we move, but the *insights* that movement creates when it is possible to cross-reference what we know about people with locational data. Notably, how consumer profiles are given a geographical, social and temporal context through location-based services (LBS) that integrate geographic location with services – such as emergency services and car navigation systems.[24]

2.2 All Corporations are Now in the Business of Data

Across industries, business models are increasingly data driven, as retailers want to target their advertising efforts, automakers collect data on usage[25] and ridesharing is managed through monitoring of congestion and demand patterns.[26] The Economist magazine has proclaimed that data is now the world's most valuable resource.[27] Similarly, an oft-cited statement by the British mathematician Clive Humby is that *data is the oil of the 21st century*.[28] Increasing amounts of data available for companies to analyze is in large driven

by IoT, as companies can gain access to ever more detailed and sensitive data through devices that collect information on fingerprints, heart rates and daily calorie expenditure.[29] Even as 90% of the world's data was generated during the last two years, the pace is still exponentially increasing towards an amount of data that is 40 times the size of 2017 by 2020[30], by which IoT investment also will exceed $ 1 trillion annually.[31] Much of this is driven by so-called "Dark Data" meaning unstructured data from the Internet, social media, connected devices, and voice.[32]

Companies such as Google and Facebook have their entire business models based on the collection of data[33] – and an industry of data brokers such as the company Acxiom facilitates this development by collecting data on individuals and selling it to third parties.[34] In 2012, their database was estimated to have information of about half a billion consumers, with about 1,500 data points per person.[35] As consumer data is collected, transfered and analyzed to guide decisions across industries, it is becoming an increasingly valuable asset that is bought and sold like any other commodity. This is not just a trend among technology companies, as customer databases are substantial part of corporate value.[36] Illustrations of this value are sales of customer databases, securities issued with consumer data as the underlying asset[37], that companies are developing new insurance solutions based on data transfers[38], and massive interest in IoT and data driven businesses from venture capital.

One might ask why companies are so interested in this information? And the answer is the same as the one that would be provided if one asked why the five most valuable companies in the world are tech companies of which none existed 30 years ago[39]? The answer is that it comes down to the consumer profile, and the value of personal data which can be described in terms of advertising. Starting off, a newspaper ad is worth very little per view if it we can't identify those who are exposed to it, for traditionally a common truth among marketers was that; *"I know that half of my advertising dollars are wasted…I just don't know which half".*[40] Not only have marketing efforts by companies traditionally been limited in terms of making sure that they are exposed to the right target audience, but the actual effectiveness of campaigns has been difficult, if not impossible, to measure. Looking at these issues, companies like Google have had a transformative impact – shifting marketing spending from traditional sources towards online search advertising, as it

becomes possible to spend more selectively on those with a higher likelihood of responding through profiling based on location and search history.

The more detailed the consumer profile becomes, the more targeted campaigns become – consequently increasing the price of each individual add. An example are so-called AdWords campaigns, were adds are shown based on defined search keywords, so that the company offer is shown when people search for their product or service type.[41] The ads are not only shown based on these keywords as this type of campaign typically includes several ads with different texts are targeted at different groups of consumers based on their geography, device segmentation, and product type.[42] This is where the convergence of data sources and location-based information comes into play. In fact, many applications now run in the background our devices with the purpose of tracking location for advertising purposes.[43]

Facebook now show adds based on geolocation and displays adds based on the user's history of viewing pages, groups and events. The ability to collect, store and analyze big data will make it possible for say, a diaper manufacturer, to identify families with small children, who buy a competing brand, and use targeted offers to identify their price sensitivity and the cost of getting a specific customer to switch brand.[44] It is likely that this will lead to guerrilla like marketing wars when companies identify and target their – and their competitors – target customers. Consequently, every company in every industry will need to adapt – this is no longer something that only matters for Silicon Valley.

The methods and cost of marketing, customer acquisition, and retention is now fundamentally changing as it becomes possible to monitor the effectiveness of campaigns. The ability to measure ROI on advertising helps companies to direct effort where it has the most effect i.e. how many views of an add that resulted in a purchase, signup, web page visit or lead – all of which are tracked by Google for those who purchase adds.[45] As this type of data improves the consumer profile, customer lifetime value can be estimated and related to the cost of acquisition, customer intent and position in the buying cycle can be identified (i.e. what products a customer wants or needs).[46] When this type of estimation is done on data from social media interactions, comments, reviews, search

queries, the concept of the *constantly connected consumer* becomes a reality, and a resulting shift towards a two-way dialog between companies and consumers.[47]

In all, it stands clear that data is transforming industries, were insights on demand, preferences, usage of goods and services create value through marketing, and product offerings. The commercial value that is created by converging data is exponential, and this is resulting in both new service offerings and new ways for marketing when information on consumption, location, preferences and even health are merged to form an increasingly granular consumer profile. Drugstores CVS and Walgreens gain access the number of steps taken, blood glucose values and prescription history in exchange for discounts to customers that participate.[48] Similarly, life insurance premiums are now set based on data from fitness trackers[49], and insurance companies just received regulatory approval to use social media information to assess risk.[50] Offline and online activity is now converging in consumer profiles, so when Google and Mastercard collaborate, online searchers can be used to understand offline purchases – such as what browsing a certain product tells us on subsequent purchases at physical stores.[51] Similarly, Facebook is found to buy third-party data on your characteristics and offline activity, to create an even more granular understanding.[52] Biometric and health data such as heart-rate and movement is creating new opportunities and has already been found to be merged with social-media information to target consumers.[53]

2.3 Everything is a Data Gathering Device

Big data analytics and consumer profiling is made possible by advances across all aspects of technology, that in turn results in an exponential pace of overall technological progress.[54] Specifically, the declining cost of sensors since the early 2000s is a main enabler of the Internet of Things (IoT)[55], resulting in autonomous vehicles, smartphones, tablets, buildings and infrastructure becoming data gathering devices on top of which applications such as mapping, social media platform and applications for shopping are built. In fact, IoT connections are expected to grow at 30% a year until 2023.[56]

Another key aspect of IoT is the ability transfer data. Networks such as LTE, Wi-Fi and Bluetooth and the fifth-generation of mobile networks (5G) makes it possible for this data

to be collected to systems for storage and computing. Innovations within this system of technologies will enable even greater volumes of data to be transmitted, and improved cloud storage and computing solutions that allow for cost-efficient and fast computing, in addition to insights through algorithms. New engineered materials enable for better radar are coupled with network technology and AI that allow devices to communicate with each other and make better decisions.[57]

The value of data will have a significant impact on how to price and market products. A robotic vacuum cleaner now collects "home layout data", such as the floor plan, and where lamps and furniture are placed[58], and smart TVs now track everything users watch, often selling this data to third-parties[59]. Bluetooth connected toothbrushes now collect data on your brushing habits and cavities – and this data can be transferred to third-parties.[60]

Other examples are that fridges will be able to collect data on when and how often you open your fridge, smart door locks that know when you lock and unlock you door[61], fitness trackers keeping tabs on how many steps you take and your heart rate, your smartphone on your movement and when, where and whom you spend time with, and the washing machine will know how often you wash and how dirty your clothes were. BMW has developed a steering wheel that can detect if the driver is stressed or otherwise emotionally distressed[62], and the value of the data cars collect is predicted to eventually surpass that of the vehicle itself as in-car purchases and monitoring of surrounding environments increases.[63] Imagine a future state were all of this is part of your consumer profile, merged with your online search history and movement.

Those companies who know how to best value the value of this data will be able to undercut their competitors on price and succeed in acquiring customers – why do you think a 65-inch smart tv is so cheap? TV manufacturers only need to cover costs, the real value is getting data on what shows are watched, what ads someone is exposed to, and any other online activity done through the smart TV. As stated by the CEO of one manufacturer, "*It's not just about data collection. It's about post-purchase monetization of the TV.*"[64] It is all about selling shows, ads and consumer profiling data - This illustrates why all companies will need to learn how to capture value from data, and that entire industries are shifting towards new data-driven business models.

2.4 The Future is Determined by Cities

We should also bring some attention to why this report uses the term *urban market place*, and why it is solely focused on cities. And the reason for this are several; First, it is where demand is. A good illustration is that the 259 largest U.S. cities contribute 85% of GDP[65], and that upwards of 80% of revenue in the technology sector is generated in cities[66] – and this disparity is increasing, as illustrated by 50% of U.S. employment growth during 2010-2017 going to 20 cities with only 30% of the population.[67] The dominance of cities holds across the globe; the consultancy McKinsey predicts that the 600 cities that contribute the most to global growth will account for 60% of global GDP by the year 2025, while having 25% of the population.[68]

Second, it is also in cities – notably so-called Digital Cities – where insight is enabled by sensors on buildings, infrastructure and devices, applications for mapping, ridesharing, restaurant reviews, and shopping, in addition to mobile networks that allow for constant connectivity of individuals and transfer of data. As this report outlines, when movement, consumption and preferences of individuals can be identified to form increasingly granular consumer profiles it becomes possible to make advertising more accurate, and services more personalized. So, that not only do we have consumers with higher incomes that are more densely packed in cities, but also the ability to create insight.

Third, technology is playing a big role in these trends with upwards of 80% of research and development large technology companies aimed at urban markets. Private R&D are creating new forms of urban infrastructure for mobility, such as ridesharing to move around, mapping that make it possible for people to find their way, LBS that allow companies to put advertisements in a geographical context, and policymakers to track trends such as congestion and crime.[69]

3. The Consumer Profile, Data Convergence and Context-Based Intelligence

The ability to collect, store and analyze data has an impact spanning strategic decision making, development of goods and services, marketing and supply chain management. Yet, despite that companies are becoming increasingly dependent on data, the impact on business models is still an under-researched field.

Business Intelligence (BI) is a term that referrs to methods, processes and tools for fact-based business decision making, and is often interchangeably used with terms such as big data, business analytics and data warehousing both within academia and private organizations.[70] This confusion of terminology and lack of structure is illustrative of academics still lacking knowledge on how IoT will impact business models[71], and that mobility has received little attention from the perspective of data acquisition. Large corporations are finding it challenging to translate opportunities created by IoT technology into value creation and value capture.[72]

Social scientists sometimes stress the difficulty in creating insight from big data[73], as large datasets could tell us large scale patterns but not create contextual depth.[74] We believe that the ability to gain insight from big data can be likened "*Identification Problem*"[75] of econometric models, meaning that it is not possible to identify the best estimate of a coefficient in a regression model.[76] And just as researchers aim to address this issue by including controlling variables and develop new statistical techniques, data convergence that results in increasingly granular consumer profiles coupled with better algorithms enables for better and more reliable insights through big data. Consequently, the depth of what can be understood with big data is increasing. With advances is Machine Learning, the insights from data goes way beyond the surface-level of collected data, with increasingly accurate predictions and inferences done by companies. It is not just the scale of data being collected, it is the unprecedented intimacy of it that is creating insights and creates privacy concerns.[77]

And when companies create insight from data, and use it to drive business decisions, this implies so-called context-based intelligence, i.e.; *The ability to understand the limits of our knowledge and to adapt that knowledge to an environment different from the one in which it*

was developed".[78] Context-based intelligence and the convergence of personal data are closely related, as the later enables the former and that every time an app or service is used, it creates additional data that feeds into services in what can be likened to a feedback loop.

An illustrative examples of what context-based intelligence implies is that search engines personalize search results based on search history and social activity – so when Google knows more about my habits, preferences, location and network, it becomes possible to tailor search results even better – and notably increase advertising revenue when the match between product and likely buyer becomes increasingly accurate. As Google is launching a weight loss and wellness application "Google Coach", it is likely that the search results for recipes will be adjusted for your specific calorie needs, or habits by time or day.[79] Your location adds context, so it is likely that you will get a friendly reminder to order something healthy when the application notices that you are in a restaurant.[80] If your fitness tracker notices that you had a bad night's sleep, you might get an offer for coffee in the morning or have your workout routine adjusted.[81] Much of these services are in fact based on the continuous tracking of movement, as location-based services (LBS) that "*that integrate a mobile device's location or position with other information so as to provide added value to a user*"[82] are what enable for an ad for a coffee shop near you, or a free coupon to the gym close to your work. As we carry our smartphones everywhere, LBS is at the heart of monetizing consumer data.

Looking forward, LBS will be increasingly integrated into a key variety of solutions – and be essential for autonomous applications and virtual reality[83] – as knowing the location of various things at the same time and relating it to mapping data is essential for such systems.

3.1 Impact on Value Proposition and Marketing.

From a marketing perspective, context-intelligence is about giving people the information they want, when they want it[84] – and advances in machine learning is now making this possible by considering the full consumer profile in relation to the context – such as location, time, proximity to other people, and previous activity when determining outcome (such as what add or offer to provide or what some action tells us about a person).

As smartphone users value simplicity and seldom actively search information on the internet – on average, making only 1.25 online searches[85], while spending 3.35 hours on their mobile devices[86] – it becomes increasingly important that applications basically *spoon-feed*[87] the user with information perceived as valuable – such as when your iPhone automatically keeps track of where you parked your car, or when you're shown content on Facebook or LinkedIn that you actually find worthwhile to click on.[88]

As brand loyalty is declining and consumers increasingly value simplicity, the ability for a company to have enough data points and contextual understanding will be essential for customer acquisition and retention. In fact, the single most important factor for making a customer "*sticky*" in the sense that they follow through on intended purchases, make continuous purchases, and recommend the products to others is "*decision simplicity*", meaning how easy it is to get information about the product or service that is deemed trustworthy and allows for an efficient comparison of options.[89] A consequence of these consumer preferences is that what the customer wants perfectly aligns with the business model of search advertising based on consumer profiling.

Another example of how consumers actively participate in creating insight on their demand and references is the trend of what is referred to as the "*quantified self*"[90] and "*lifelogging*" – people gaining self-knowledge through collected data about themselves. Typical examples are fitness trackers, "smart" scales[91], applications aimed at tracking locations of interest[92], identification of DNA and heritage[93], and identification of human microbiomes related to behavior.[94]

A key aspect of increasing consumer understanding is integration between applications from the same company, as it creates opportunities for companies to understand who their customer is, spanning habits, needs and desires. When Apple adds payment solutions and streaming services additional pieces of information users are gathered, just as when Facebook adds a dating function. Similarly, collaborations and third-party data transactions - enables for better insights and linkage of offline and online activity is linked – explaining why social media companies are increasingly either buying or collaborating with companies that provide additional data points.[95] Among many other data points,

Facebook can now offer advertisers the ability to filter on; "*1. Location 2. Age 3…Gender 5. Language 6. Education level 7… School 9. Ethnic affinity 10. Income and net worth 11. Home ownership and type 12…14. Square footage of home 15…16. Household composition…… 21. Users in new relationships… 29. Mothers, divided by "type" (soccer, trendy, etc.)… 33. Employer… 39. Users who plan to buy a car (and what kind/brand of car, and how soon)… 50. Users who have donated to charity (divided by type)… 61. Early/late adopters of technology… 65. Number of credit lines… 66. Users who are active credit card users… 69. Users who carry a balance on their credit card… 71. Preference in TV shows. 80. Users who buy groceries (and what kinds)… 85. Users whose household makes more purchases than is average… 87. Types of restaurants user eats at.".*[96] In addition to activity on the platform, virtually all of your online activity is tracked while logged in, and data on finances are provided from actors such as Experian. Any online publisher has the option of installing Facebook Pixel that allows for tracking of any user with a Facebook account.[97]

With this information, companies can have their content or campaigns displayed for the most relevant audience. Another industry example is what Google describes as their "Customer Match". A tool for companies to; "*use your online and offline data to reach and re-engage with your customers across Search, Shopping, Gmail, and YouTube. Using information that your customers have shared with you, Customer Match will target ads to those customers and other customers like them.".*[98]

Yet another illustration of the value of converging data is that the data broker Acxiom offers any company the ability to purchase "Consumer Insights Packages", which are described as; "*Consumers expect a connected experience. That means you have to understand their offline and online presence, buying behaviors, and interests. Acxiom offers the industry's' most comprehensive data and models, and we can help you choose the most relevant and effective audiences to drive better marketing results both offline and online.".*[99] among other packages, the company offers solutions for Valentine's Day – identifying consumers that prefer jewelry over flowers, or candy; or those who plan a romantic dinner at home and those that plan to eat out.[100] Another offering is aimed at the "Back to School" market, to identify demographics such as the "Stylish Student" for companies that "*Want to target campus trendsetters who are likely to be out spending big on the latest apparel and*

accessories? We can help you identify them for perfect message placement. If your client sells trendsetting apparel to children, teens, or college students, we have a segment to match.".[101]

However, It is not only about the initial matching of campaigns with potential customer – as it is now possible to track effectiveness of a particular campaign when marketers can link exposure to an add and a subsequent action or purchase. Identifying if a campaign was effective and on whom a dollar spent on coupons, promotions or any other marketing effort made a difference, and on whom it was wasted. This has the potential to change the entire revenue model for the ad industry, as companies can identify the value of marketing for the first time.

Despite spending upwards of 20% of revenue on campaigns, large companies have historically had little insight into their effectiveness.[102] Marketing efforts are typically analyzed in isolation, and without knowledge about any counterfactual outcome. Consequently, most marketers often misattribute outcomes to marketing efforts, and finance departments tend to doubt if marketing spending is worthwhile as the returns are double counted – so when added together, the marketing ROI sometime adds up to twice the actual sales.[103]

The need for looking at the whole picture when analyzing return on marketing investment (ROMI) is amplified by companies marketing their products through several touch points and sales channels[104] - so when a consumer is exposed to car reviews, paid adds, YouTube content, billboards and mail campaigns, the question of how to attribute a final sale arises. And this is where companies take advantage increasingly data-driven strategies as it becomes possible to track who that got exposed to what, and use algorithms to determine optimal marketing strategies.[105] IoT and data convergence is central for the ability to identify target audiences and measure ad effectiveness. An illustration is that the effectiveness of Facebook ads can now be tested by seeing how exposure in your feed translates into in-store purchases, phone orders and bookings through their "*Offline Events*" service that also measures offline return on ad spend and allows companies to reach people based on thief actions they take offline, in addition to audiences believed to be similar to those they have offline data for.[106]

3.1.1 Implications of the constantly connected customer

As customers carry their devices at all times, they create data trails from activity such as searches, purchases and movement, companies will be able to continuously follow their changing needs and preferences over time.

As an illustrative example, think of a consumer, Lisa, joining a loyalty program at a grocery store chain. When Lisa enters a store, the LBS enabled app wakens up her smartphone and suggests purchases based on Lisa's past purchasing habits and might even create a promotion on the ingredients for dinner – and since she has two small children, Lisa is shown targeted offers for diapers – thus getting relevant content that increases her satisfaction with the service. As an offer is sent to her smartphone, the customer relationship management program (CRM), keeps track if whether or not Lisa took up on the offer. So, if a discount of $ 1.5 on a new brand of pasta sauce doesn't work this time around, perhaps a $ 2 offer will be offered next week. Over-time, it will be possible to identify how price-sensitive Lisa is, and break it down by product, so that offers can be tweaked to maximize the likelihood of a purchase. It will be possible to identify what promotions Lisa responds to, what personalized pricing offers that are driving her loyalty behavior – so that an exact customer value can be assigned to Lisa based on her expected expenditure and contribution to profit over time, and Lisa's experience will continually improve, as she receives increasingly accurate content. The relationship will seamlessly change as her needs change, such as offerings for diapers changing towards school supplies when her kids grow older.[107] Consequently, a constant two-way interaction between the company and consumer is created through devices, offerings and suggestions.

Once a company has this information in a fully integrated CRM system it becomes possible to track real time shopper behavior and influence it on both a macro and micro scale. ROMI will be continuously monitored and spending will only be spent were results are maximized[108].

If targeting of customers is sufficiently cheap, companies should in theory focus more attention towards their competitors' customers.[109] If, as an example, Proctor & Gamble (P&G) wishes to analyze baby product sales, Lisa would be identified as a valuable

customer as she spends $ 1585 a year on such products. Knowing how this spending is distributed across various supermarkets – say between Walmart and Target– and by brand – such as Proctor & Gamble, Johnson & Johnson and Kimberly-Clark – P&G can now see that Lisa spends less than 10% of that sum on their products. Having this insight, P&G can identify non-P&G high-value customers and create personalized campaigns aimed at changing their purchasing behavior. Offers would be based both on this macro level identification, and what we know since before about Lisa. So initially, an offer for a discount for P&G diapers is sent to Lisa in an effort to make her change brand. And if it does not work a new offer will be tested. In relation to costs of customer acquisition and retention, perfectly identifying preferences and price-sensitivity of consumers and optimizing for lowering marketing cost could result in dramatic decreases in cost for companies.

The ability to communicate with consumers through smart-devices is an essential enabler of the constantly connected consumer, and the way an application creates insight can be thought of in terms of two main categories. First, the data that is created when the application is used that becomes additional data-points in the overall consumer profile. Second, the device is also a medium of communication and a channel that enables for additional sales and marketing. So, with the insight from the consumer profile, offers and the ability to make purchases are given on the device. Similarly, it is through the device that personalized adds are displayed.

3.1.2. Individualized pricing

Consumer profiling is not only a way to reach a desired audience, as it also can provide insight into the purchasing power of consumers, so that a company can individualize price. This is already seen in the insurance industry – with premiums set by individually assessed risk, such as health insurance set by fitness tracking data such as how many steps that are taken[110], or car insurance set by where and when someone drives.[111] Similarly, it is now possible to identify financial risk using spending habits and bank account flow data, which is improving risk management in finance[112], and machine learning is now "*taking credit-risk scoring to the next level*" according to the company SAS.[113] Not only is risk management

improved, companies also have the ability to individualize interest rates and insurance premiums – i.e. prices – to a much higher degree.

For companies, consumer profiling is also about how much you are likely to spend and the ability to set prices through"*behavior-based price discrimination*".[114] Researchers have given some attention to the possibilities of price discrimination created by targeted advertising, having found that it has the potential to increase business sector profits under certain conditions.[115] Other studies indicate that targeted advertising leads to increased market fragmentation resulting in local monopolies, and that some scenarios point towards that consumers benfit more than companies.[116] This is consistent with studies of individualized smartphone-based offers, finding that profits increase from unilateral price differentiation, but that these returns are likely to be mitigated by competitors engaging in similar practices.[117] Similarly, the ability to set higher prices for consumers with a strong preference of the product is offset by increased price competition for value conscious shoppers that compare price.[118]

3.1.3. Persuasive technologies and psychological profiling

As the amounts of marketing efforts and online content increases – it becomes increasingly difficult to create trust with consumers; therefore, new technologies aim at shaping preferences in more subtle ways.

Looking ahead, there will be a shift from not just identifying the right offer for the right person (as described above), as it becomes possible to find far more refined ways of getting people to buy your product or service when the demarcation between advertising and content is blurred. Context-based intelligence is not just about your observable habits – it is also about your relationships, social context and psychology. When your virtual assistant knows that your wife is feeling down, it might give you coupon for flowers or a dinner for two special. Social media platforms are already covering the emotional state of users[119], and from a marketing perspective, *persuasive technology* – machines designed to influence human beliefs and behaviors[120] – offer massive opportunity to identify the psychology of intent, and the triggers that turn intent into action. One type of application is that of creating games and promoting healthy behavior through peer-pressure. This type

of technology does however not only apply to promotion of healthy behaviors. If Facebook knows that you are in the market for a car (the age of your car is part of the consumer profile, and provided from government records[121]), it is not impossible to imagine that your social media will show you pictures of people in your circle of friends with a particular brand of car in the background – reminding you that driving, say a BMW, is a way of fitting in to your social circle. Once the data is large enough, it will be possible to identify which of your friends that have large influence on your behavior and tweak the algorithm further. Knowing your habits, such as regularly driving in snowy conditions (through tracking your location), you will get a tailored offer to lease a 4-wheel drive BMW based on your likely price-point based on other purchases, responses to offers and how that has correlated with auto spending for other consumers. Companies that have access to consumers, i.e. the ability to influence, are going to become increasingly important as a new and more subdued way of marketing develops – were consumers are unable to distinguish between advertising and other content or know *why* they are shown certain content.

As the limits of big data analysis decrease, it makes it possible to gain unprecedent insight into human behaviors and prediction of actions when the data is both deep in insight and large in numbers. Examples of studies within this sphere of data-driven psychology are that psychologists now can predict if someone is entering a depression through tracking location through a smartphone – as people that are depressed tend to move less.[122] At Stanford, researchers are working on a large-scale smartphone sensing study aiming at examining what smartphone data, and notably mobility patterns, tells us about the persons psychological state. There is in fact a startup with an app that tracks your mood based on movement[123], and Stanford researchers has developed an app that detects autism in children.[124] There is also research aimed at linking personality with spending habits[125], which in theory would enable for identification of personality traits and likely spending from credit card data. Imagine a future when similar applications run in the background on your devices, with psychological insights becoming part of your consumer profile.

3.2 Device and Usage Monitoring

IoT is transforming businesses not only through identification of consumer characteristics. The ability to gather, store and process big data can have a profound impact on all aspects of the corporate *Value Chains,* i.e. the set of activities conducted to deliver a service or product[126], and create competitive advantage through more efficient logistics, operations, marketing and service.

For supply chains, knowing the location of all products, supplies and deliveries enables for precise estimates of estimated time of arrival. Smart devices create the ability to monitor the performance of a product, such as a car, which enables for better life cycle management by predicting when the car needs servicing and what parts that will break – based on observations from hundreds of thousands of other cars – which in turn can be used to optimize capacity and inventory at local service centers. It also enables for new and more efficient ways of contracting across the supply-chain, such as outcome-based contracts[127] when the manufacturer can identify if a particular part performed in accordance to specification. And when it is possible to gain this much data – quality can be improved through the insights provided – say how a breakdown correlates with usage and weather – and lower risk by more precise predictions of how a piece of equipment will perform.

For capital goods, this ability to create insight from data enables for a shift towards product-service system (PSS) business models that are focused on as a system of products and services that are continuously updated to meet customer needs.[128] PSS has been driving profits for goods manufacturers as services increase margins.[129] This entails a completely new value proposition and business model[130]. Similar to how software as a service (SaaS) changed how enterprise applications are sold, companies across all industries transition of from a product-centric business model towards a continuous service-centric business model[131], through what is known as *Servitization.*[132]

Data is not only transforming consumer facing industries. For advanced – business-to-business – products, companies have used performance and usage data to optimize complex maintenance contracts and extended warranties, thus shifting towards a greater

focus on service as IoT enables for better risk management. Traditionally, risks have been too high for *servitization* of the core product.[133] However, better management of assets and the ability to monitor performance is changing this. Prominent examples of companies that have managed to do this shift are Rolls-Royce Aerospace, offering power-by-the-hour, so that the buyer buys say 20,000 hours of operation rather than an airplane engine, Xerox having shifted from selling printers and copying machines to selling complete solutions for document management, and Alstom selling train-life services spanning installation and servicing of a train over several years.[134] Typically, this implies a 10-year contract, were the manufacturer shares some of the risk that the equipment works, and the buyer has a payment scheme that is linked to actual usage.[135] The long-term nature of this type of business model, and the necessity to understand the customer business model, naturally leads to much closer business relationships – leading to both business model and organizational impact.[136] Often, new offerings emerge, with an example being that the network manufacturer Ericsson has shifted from selling network equipment towards solutions for telecoms providers spanning maintenance and data insights through AI.[137]

When customer needs are understood, typically services adapt, such as a logistics company using trucks on a pay-per-mile model, with costs and maintenance as part of the contract[138] – in contrast to just buying trucks. This shift across industries is often driven by outside forces. Notably, technologies that fundamentally change an industry – such as AVs that are predicted to change the automotive industry. Automakers are responding, as Ford now stating that they have shifted from selling cars to selling mobility and investing in ridesharing applications and AV technology.[139] Similarly, Volvo has increased focus on monthly car plans rather than just selling cars.[140] And data is central in the ability to tailor the product to customer needs, optimize risk management, supply chain contracts, and manage the inbound and outbound logistics.

As devices and applications collect ever more data, a key aspect that will change business models is the monetization of this data, shifting the model from making money from selling a product or a service towards gathering data, with the initial product and service being an enabler that is optimized for creating insight.[141]

It will be possible to better manage both revenue and costs, and risk will be shared across a greater number of parties that will be bound for longer-periods of time. This provides incentives to increase trust and fundamentally change how sales are done – illustrating how both operations and business models change.

4. Concerns for Cybersecurity, Privacy and Fairness

Analysis of the underlying economic model for getting access to consumer data, the impact on privacy and the consequences of algorithmic decision-making has been primarily analyzed within the field of law.[142] Several regulatory issues emerge relating to consumer profiling; such as that of fairness and transparency when consumers trade personal data in return for services, that of heightened risk associated with security breaches and the consequences of algorithmic bias as algorithms become pervasive in determining increasingly important commercial and social aspects of life.

4.1 Data-for-Service, the Personal Data Economy or Pay-for-Privacy?

The current model were consumers trade their personal data in return for using a service has been criticized, yet, there has been almost no analysis of the relationship between the utility gained by consumers and the value of the data they provide – the "*Return on Data*".[143] As such, it is impossible for consumers to compare data-for-service deals. Thus, some researchers suggest that this return needs to be analyzed in conjunction with privacy laws[144], while others suggest entirely new models for transacting data. Notably, the *personal-data-economy (PDE)* model that implies that companies would buy data from individuals, giving every persona a piece of the action when data is monetized. Another alternative is the *pay-for-privacy (PFP)* model were users of a service would pay extra in return for not giving up data and receiving personalized adds.[145] Although promoted by some, actual implementation of these models would be highly complex. There are also concerns that these models might exacerbate existing inequality issues as lower income and less educated consumers would be unfairly targeted[146], and studies show that lower income individuals have lower confidence in their ability to protect their digital data, in addition to also experiencing higher degrees of monitoring.[147]

Algorithms are "*Unseen and almost wholly unregulated*"[148], so that when the consumer sees the service – but not the underlying consumer profiling data that enables it – it can be likened to the tip of an ice-berg. Questions relating the impact of targeted offers and individualized pricing in relation to fairness arise when offerings are based on a consumer's perceived willingness to pay and psychological traits[149] (see section 3.2.1). Potentially, companies would be able to identify psychological traits associated with bad financial decision-making and make offers that take advantage of those traits.

4.2 Privacy and Cybersecurity

Almost every time an app is installed or even a device is used, some information is traded in return for this service – so the company gets access to location, photos, search activity, music listened to and so forth.[150] As data is becoming more valuable and the amount of it that is collected increases, regulation is increasing, with the European Union through the General Data Protection Rights law (GDPR), leading in increasing individual rights coupled with an enforcement regime. This while the United States is characterized by a decentralized regime with little ability to enforce those few regulations that exist, in addition to a greater focus on commercial needs.[151]

Americans are increasingly concerned about advertisers and companies getting access to their social media information, with 61% of respondents in a study of U.S. adults wanting to do more to protect their privacy.[152] So, while individuals are increasingly concerned about their social media data being shared, consumers also demand services that offer simplicity and ease of use[153] – which is enabled by consumer profiling.

At the moment, it is the privacy agreement or user agreement that regulates what data a company is allowed to collect, and what to do with it (such as transferring it to third-parties).[154] However, only about 26% of free mobile apps and 40% of paid apps have such policies[155], and most privacy agreements allow for transfer of data to third parties in anonymized form[156], or a transfer of data the case of a company acquisition, merger, or bankruptcy.[157] It is also increasingly difficult for consumers to keep track of what is collected, as many third-party applications being built in as part of applications, and these collect our data without active consent or privacy agreements[158], and if a policy does not

exist, a company is often free to monetize consumer data without risk relating to privacy violations.[159]

Consumers are also unlikely to read or understand this type of documentation – in 2014 half of internet users did not know what a privacy policy was[160] – and if they do, researchers question if they understand what they sign up for when installing an app or making a payment through their phone, or even when they buy a device such as smart TV that tracks usage[161], or a toothbrush that tracks brushing habits.[162] Even when providing active consent, consumers are unlikely to understand the full scope of profiling and its implications.[163] About half of U.S. adults state that they do not fully understand what happens with their data when they share information with companies[164], and many privacy agreements take over 20 minutes to read[165], and sometimes require reading skills at the level of a senior college student.[166]

Even if a consumer declines a service, or if new regulation makes it more difficult to collect data – technology is now able to fill in the data gaps, so that a key question is if consent even matters? For if a company knows four of your friends, they know much about you through so-called probabilistic inference – meaning that non-consenting consumers are assigned characteristics from similar consumers for which there is a representative sample. Machine learning can now accurately identify romantic partners in 55% of cases with only anonymized relationship data and Facebook can identify social relationship even the users are unaware of.[167] Another study was able to identify 90% of consumers from anonymized credit card transactions, stating that even data with very little information provide limited anonymity.[168]

As companies are collecting increasing amounts of data – some of it highly sensitive biometric data – the risks associated with cybercrime increase. Large corporations have seen data breaches of millions of customer records with sensitive information such as social security numbers, address and credit card information – with one example being the credit scoring company Equifax.[169] The risks associated with biometric data are even higher, as unlike a credit card, the characteristics of your iris or fingerprint cannot be changed.[170] Transfers of health and biometric data are increasing. In 2014, the Federal Trade Commission found that 12 mobile health applications transferred information to 76 third-

parties, with some 18 parties receiving device-specific identifiers, 14 receiving user-specific identifiers, and 22 receiving other types health information.[171]

As IoT devices are become pervasive, the vulnerability and number of attacks will increase, making security solutions even more important.[172] It is predicted that devices will be used to attack routers and networks through botnets[173], i.e. a third-party controlling a large number of compromised devices, which can be used for gaining access to data through spyware, making a computer make purchases without the real user's knowledge, or denial-of-service attacks. In 2017, the cyberattack that made Twitter, Netflix and the New York Times inaccessible was initiated through IoT devices.[174]

Analyzing cybersecurity and threats for the year 2025, researchers at the University of California at Berkley found that cyberthreats are now evolving into protection against increasingly advanced devious manipulation, rather than just brute force data theft. States and criminal organizations could potentially use deep fakes (i.e. fake audio and video that looks convincingly real) and adversarial machine learning for malign purposes and make small changes in datasets to infuse bias in algorithms.[175]

Cyber-threats will become potentially more harmful as algorithms become pervasive in determining key aspects of everyday life such as if a mortgage will be approved and even if a suspected criminal is going to get bail and the length of sentencing. With advances in machine learning, risks rise in relation to how such insights will be used when it is possible to identify if a young child has autism through how they use an app[176], depression and mood from how we move[177], and spend[178], linking personality to eye movement[179], the risk of insuring your car through how we drive[180], the likelihood to default on your debt based on spending habits[181], if you are likely to get fired on your new job based on assessment of cultural fit based on the language you use.[182]

5. Industry Sector Examples and Implications

In the below section, we provide few examples of how the ability to create insight from data is shifting business models across industries.

5.1 Insurance and Healthcare

Insurance is an industry at the forefront of using this type of data as customer knowledge is essential for assessing and pricing risk.[183] Examples are that life insurance risk and premiums are based on fitness tracker data[184], car insurance related to driving behavior and the location of timing of driving[185], and insurance companies are currently exploring the use of social media to create risk profiles.[186] This shifts the industry focus from risk management through pooling, towards a greater focus on risk management through individualized risk assessment.

Smart devices that we carry, have at home, at work, in vehicles and across public space are creating what the consultancy McKinsey refers to as an "*avalanche of data*" that will transform the insurance industry.[187] In fact, in a report on the impact of IoT, the insurance giant AIG states that; "*At the center of this new universe of data will be the insurance industry, which has been using massive amounts of data to understand and mitigate risk. It's only a slight exaggeration to say that insurers invented the idea of Big Data. Naturally, as IoT objects proliferate and permeate all levels of our economy, it will be the insurers who are best placed to analyze this data and extract meaningful and actionable insights – insights that could make our world a safer and more productive place than we could ever have imagined.*".[188]

In terms of converging data, State Farm, in 2014 patented a platform for aggregating and combining data from smart home devices, vehicles and personal health data, so that; "*…Based on the determined underlying factors and correlations for each of the determined patterns, the method and system may provide the individual with various benefits such as personalized recommendations, insurance discounts, and other added values or services that the individual can use to better manage and improve his or her life.*"[189]

Private companies have never before had access to health data.[190] Data from wearables have the ability to track how many steps taken walking and running, physical activity, caloric intake, blood oxygen, blood sugar and heart rates[191] – infusing health data into the consumer profile. That companies collect and transfer this type of sensitive data raises increasing privacy concerns – it is however almost wholly unregulated. Notably, most laws aimed at regulating health data only applies to health providers – not technology companies.[192] This creates opportunity to assess risk and set insurance premiums. As an example, the insurance company John Hancock now sets life insurance premiums based on data collected from fitness trackers such as Fitbit or Apple Watch[193], stating that; "…*in a departure from the traditional life insurance business model, all John Hancock life insurance policies will come with Vitality – a behavior change platform that rewards customers for the everyday steps they take to live longer, healthier lives. Built on the convergence of behavioral economics and consumer technology, John Hancock Vitality policies incentivize healthier choices linked to physical activity, nutrition and mindfulness.*"[194] And their CEO, Brooks Tingle, statest that; *"We have smart phones, smart cars and smart homes. It's time for smart life insurance that meets the changing needs of consumers. We believe offering Vitality on all life insurance policies, at no additional cost, is the right thing to do for our customers, our business and society. We believe this is the future of our industry, and I encourage other insurance companies to follow suit.".*[195]

The insurance industry is moving toward data-driven strategies, and have recently received regulatory approval in the state of New York to use social media information for assessment of risk and set insurance premiums.[196]

5.2 Retail

Consumer profiling has been transformative for the retail sector, most notably in relation to development of the value proposition and marketing (see section 3).

Retailers have typically collected data on consumers through opt-in programs to build consumer loyalty and gather information on purchasing habits, which is now becoming more refined as smart devices enable for collection of more types of data – such as the drugstore chains CVS and Wahlgreens now have smartphone applications that give

consumers discounts in return for health data constantly streamed to their systems. Additional discounts are provided if customers agree to relinquish their right to health care privacy.[197] As the LBS app provides locational data through smartphones, health is given geographical context and consumers are given offers for products they are likely to buy while in the store.[198] When increasing amounts of information are collected, it becomes possible to merge information on the number of steps taken and how often someone works out. Heart-rate and other health information has already been found to be merged with social-media information to target consumers.[199]

The potential impact of consumer data on how to drive sales is well-illustrated by a statement by Fabrizio Freda, who is CEO of the global cosmetics company Estée Lauder who attributed annualized sales- and earnings-growth of 9% and 61% respectively to improved data analytics[200], and relating to the company's digital strategy the CEO states; *We treat data and information as key strategic assets that power a world-class, interconnected analytics "ecosystem" across our brands, regions and functions. Using cutting-edge tools and techniques, we are connecting the dots from data and predictive insights to implications and actionable recommendations. Our enhanced marketing analytics capabilities give us access to consumer journey insights across global markets, providing a deeper understandding of when, how and where our consumers are purchasing and re-purchasing, further enabling the shift from trial to loyalty.*[201]

This is not just about marketing, data analytics will transform all aspects of retail, with companies that provide retail technology for inventory management, cashiers and marketing impacted by a fundamental shift in how stores function, likely causing widespread disruption.[202]

Automated payment and supervision are making stores more efficient and cheaper to run when we are automatically tracked within an Amazon Go store that allows customers to simply walk out of the store with their merchandise as long as they have the app downloaded.[203] Cameras and advanced algorithms identify who is in the store, and what that is taken with payment being automatic. Data convergence and movement is central to this – with the LBS Amazon app as the key enabler. The consumer profile becomes a key foundation for an entire ecosystem spanning from marketing to payment.

Across retail, the fundamental economics will shift when costs for employees is dramatically reduced, as are costs associated with shoplifting. Couple this with targeted advertising and offers and a continuous digital dialogue with consumers and what we are seeing is an almost fundamentally new industry.

Looking ahead, the field of of consumer neuroscience offers a lot of promise and is likely to have significant impact on retail. It covers research on how emotion and brain activity relates to offers and consumption.[204] Related to behavioral economics and how consumers make decisions, the technology is described by the company Nielsen as something that enables retailers to; "*Capture non-conscious aspects of consumer decision-making with the most complete set of neuroscience tools at a global scale.*"[205], which is enabled by EEG sensors that measure attention, emotion and memory; facial coding that identify emotions and reactions; Biometrics that track skin conductance and heart rate to identify emotional reactions; and eye tracking that keeps track of visual focus.[206] It is not unthinkable that data from wearables is coupled with in-store CCTV cameras to allow for algorithms to create insight from this type of data, which can be used to change store outline, inventory, and understand how real-world in-store browsing relates to online activity.

5.3 Mobility

Technological advances will change the auto industry economics, as the ability to analyze real-time road data can improve sales and marketing, while digitalization and simulation can save money on R&D and manufacturing productivity.[207] Ownership models are also changing, as technologies have enabled industries to shift towards service provision. Mobility-as-a-service – in contrast to car ownership – can be put in this context.[208] Auto manufacturers are shifting from selling cars to business of mobility, and that of data. Notably, ridesharing is an example of LBS and smartphones that track when, where and how we move, which is used by providers of mapping, ridesharing, and public transport agencies to determine congestion, travel patterns and demand.[209]

Modern cars collect upwards of 25gb of data every hour[210] identifying what the driver is looking at, level of concentration, and mood, in addition to locations traveled, driving

behavior and usage of the in-car systems. This is driven by the current state of level 3 autonomy – cars that can drive themselves under certain conditions – which require sensors that collect data on the surroundings. Just as data is converging, cars will become an integral part of a wider mobility system – sending and receiving data from other IoT devices and vehicles so that efficiency and safety increases. This will be increasingly important as a driver of profits for automanufacturers as consumers no-longer pay for a greater number of gadgets in their cars – which has been the main way of competing between auto manufacturers.[211]

The data that is captured could amount to three-quarters of a trillion dollars in value by the year 2030, as automakers are exploring new revenue streams, such as selling data gathered on the surrounding environment to mapping companies and applications that map traffic conditions.[212] In-car activity is a potential source of revenue, with General Motors offering "GM marketplace" that connects the car's information on its location and available range to other companies[213], so that the car can make hotel reservations and take orders coffee at a nearby Starbucks.[214] This type of LBS allows for notifications when you are close to a regular stop and the car asking if an order should be made.[215] As GM receives fees for each transaction, this is one new revenue stream that illustrates how mobility is blending with the overall urban marketplace.

From a manufacturing perspective, cars that continuously keep track of performance and usage enable for new ways of contracting across the entire supply-chain through outcome-based contracts and *servitization* (as described in section 3.2). This will span from parts suppliers to end consumers with an example of the latter that Tesla keeps track of all aspects of usage. (although not sharing the data with the car owner) – sometimes making the insights public when crashes occur.[216] BMWs will note a fender-bender and notify local dealerships that a car will be coming in for repairs while also sending a quote of the cost to the owner by text shortly after the accident. IoT makes it possible to identify the context of breakdowns and accidents, in addition to quantifying cost and assigning responsibility.

5.4 Finance

As an example of the trade of data for service, free digital payments (such as the payments company Finja) are given to consumers in the hope that they will be buying additional services such as insurance, which are marketed using data gathered from the platform. It is likely that more of this type of "free" financial services will be offered as the value of consumer data is highly valuable, as the financial services industry is similar to insurance in that it is about identifying and pricing risk.

Data is making risk-assessments, credit decisions and pricing more refined, such as using in-and-out flow from bank accounts and the types of spending someone does is used as a substitute for credit-scoring. Starting in early 2019, a new type of "UltraFICO" credit-score will be available to a few U.S. lenders, giving them the opportunity to analyze in-and-out flow in bank accounts rather than credit-history.[217] A new platform in Latin America aggregates utilities payments, geography and socio-economic information to assess credit risk[218], and is already collaborating with large local banks.[219] This type of data could potentially shift finance towards a more adaptive type of consumer interactions, with a constant bi-directional information between the financial institution and the customer when credit decisions are automated and continuous, so that transaction history, cash flows and use result in continuously adjusted risk-based credit limits.[220] Machine learning and LBS is a key aspect of this development, as illustrated by a hypothetical consumer credit scenario described by the company SAS; "*Suppose you have a customer who has opted into location- based awareness and typically uses 90 percent of his credit card limit. You see that he is going to a business where he normally makes purchases of $150 to $300, but he only has $120 credit remaining on his card. Since he has a good payment history and good cash flow in his other accounts, the system automatically sends him an SMS with a limited-time offer to increase his credit limit by $500 for one month. The bank may have just earned (or reaffirmed) the customer's loyalty.*" [221]

Data is improving decision-making across all aspects of finance. Fraud detection is enabled from knowing when, where and on what someone spends, similarly, banks now can scan documents for insight automatically rather than have employees do the work manually.[222]

6. Summary and Concluding Comments

In this report, we have outlined simultaneous and closely related trends that relate to how data is impacting business models and how convergence of various data layers from devices and applications create increasingly granular consumer profiles. A key aspect of this development is that location-based-services set demand and preferences in a geographical context. Notably, this is a primarily urban phenomena, for not only is it in cities that wealth is concentrated, it is also in cities that insight is created through connected devices and networks.

We find two primary channels through which data is transforming business models. First, an impact on value proposition and marketing, as companies can identify the right target audience and track the efficiency of marketing campaigns – which is at the center of turning data into a tradable asset. The convergence of data is now driving a development towards a constantly connected consumer – with insight created by target offers and individualized pricing. Responses and reactions can now be monitored, so that *behavioral based pricing* becomes a reality. Companies will be able to identify how consumers react to various incentives and effectively target their competitors' customers – potentially leading to commercial guerilla like warfare. In terms of industry impact, it is likely that increased profits on consumers with a high willingness-to-pay are offset to various degrees by increased competition for lower-end consumers. This will make retail more unpredictable and competition increasingly cut-throat.

Consumer profiling is not just about retail. Insurance and finance are at the forefront of this development, as the industry builds on assessment and pricing of risk. Unregulated and ill-understood, algorithms coupled with data from social-media, smart-home appliances, fitness trackers, credit card transactions, and smartphones now enable for individual risk assessments of life- and car-insurance and credit card debt. Consequently, the industries are shifting away from models based on pooling risk, towards a data-driven strategy of identifying individual risk characteristics. What is framed as discounts is a likely first step towards increasingly individualized pricing

The second category of impact on business models is that created by the ability to monitor devices usage and performance, as everything is becoming data gathering devices. This enables for new ways of contracting across the supply-chain, such as outcome-based contracts with suppliers and more refined risk-sharing when relationships in-between companies become shift from far-in-between transactions of goods to ongoing partnerships as IoT enables for what is known as *servitization,* when sales of airplane engines is replaced with contracts for hours of operation, and auto manufacturers can keep tabs of how parts perform to predict breakdowns and handle risks associated with selling mobility rather than cars. Not only does this change the fundamental business model but also the organizational needs – so that companies will need re-focus their organizational structure and employee competencies when all aspects of the value chain are changing, spanning the way contracts are formulated to the value proposition for the end consumer.

Overall, a key aspect of data-driven business models is that the transaction of goods for cash is shifting towards a transaction of often "free" services in return for data, making it essential for companies to determine the value of data and have a strategy for data collection. Part of this is that everything is becoming a data gathering device – so that a large part of the value of a car, smart-tv, or any application lies in the information that it collects and how it can be used to create insight. Consequently, as the value of customer data increases, pricing and costs of customer acquisition will need to be reevaluated.

Another key aspect is that the fundamental way of conducting R&D is changing, as companies now need to be keeping track of technology being developed outside of the company to identify relevant applications before the competition does – rather than the other way around when a business need or problem prompts development of a new technology to address that specific need or problem.

As biometric data and psychological insights become part of the consumer profile, risks associated with cybersecurity increase – as a fingerprint cannot be replaced like a credit card number. As data is becoming a traded asset, and algorithms become pervasive in determining pricing, credit and even the probability of getting bail, concerns on fairness and privacy are raised as consumers only sees the service and not the data that enables it. Basically, it is only the tip of the ice-berg of personal data that is visible. However,

consumer preferences perfectly align with consumer profiling as simplicity and the provision of relevant content is highly valued and a key determinant of what makes a customer "sticky".

Convergence and the creation of context-based-intelligences are also addressing previous limitations of big data, as big data is also becoming *deep* data when additional data-points are added. It is likely that this will create unprecedented opportunity to learn about psychology and human behavior.

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