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Data access and regime competition
A case study of car data sharing in China

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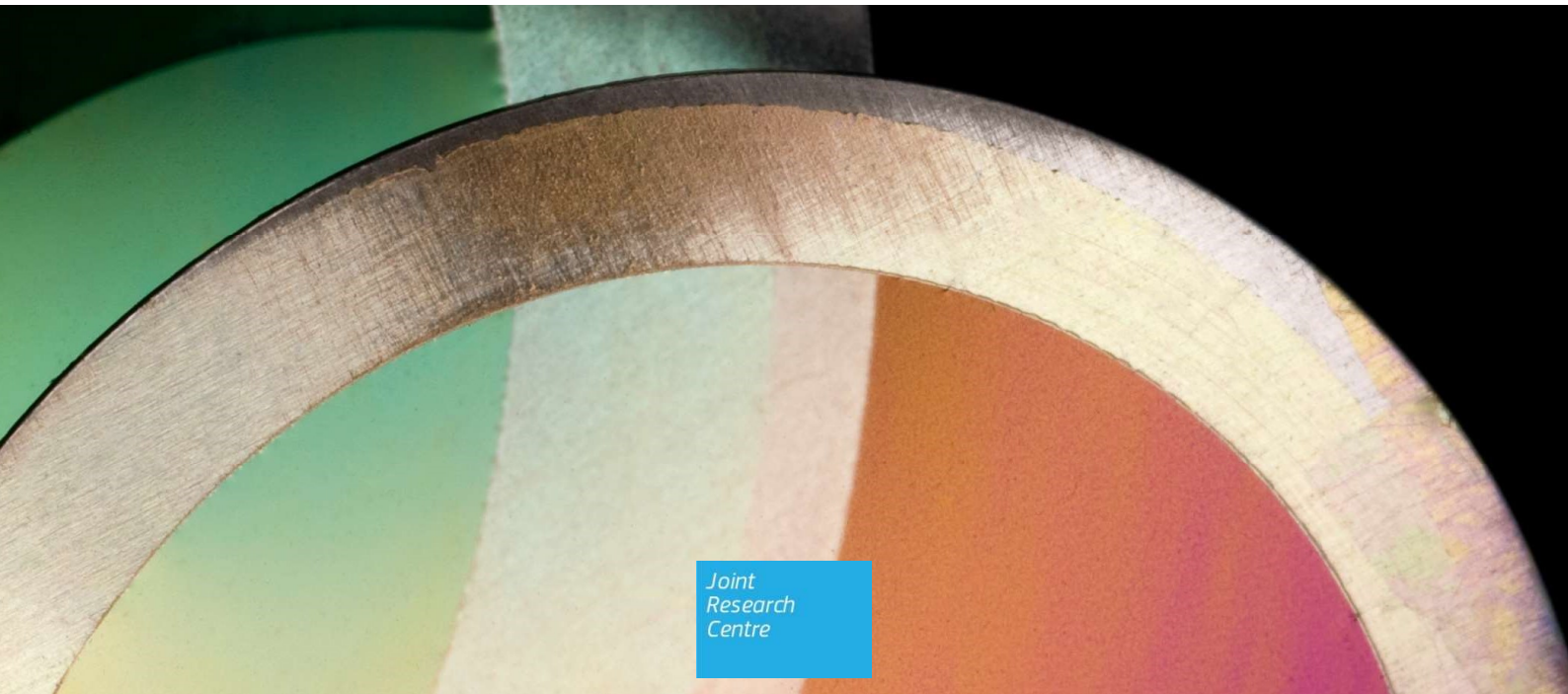

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Abstract

We study the case of a Chinese industrial policy, implemented in Shanghai, that makes it mandatory for car manufacturers to share electro-mechanical performance and real time navigation data from their entire fleet of electric and hybrid vehicles with local and central government authorities. This policy seeks to reduce emissions, assess the performance of New Energy Vehicles (NEVs), prevent fraud in state subsidies and strengthen the competitiveness of Chinese manufacturers of these vehicles. We argue that economies of scope in data aggregation may provide traditional market failure arguments for government intervention and mandatory data pooling. Our paper also illustrates how data access regulation could be used for economic regime competition. The EU and China pursue very similar data policy goals that hinge on economies of scope in data aggregation. However, they follow very different political processes to achieve these goals.

Key words: Data access, data regime competition, B2G vehicle data sharing, China

Contents

1. Introduction

During the US Senate hearing on the Cambridge Analytica case in April 2018, Marc Zuckerberg, Facebook CEO, argued that, if the US would follow the EU's strict privacy regulation, Chinese competitors may gain the upper hand in technological competition[1]. While he agreed with the need for data regulation, he also suggested privacy carve-outs to enable innovation in the face of rivalry from China ((Horwitz, 2018)[2]. In short, strong data regulation would give China an advantage and thus Zuckerberg urged privacy carve outs to compete with China ((Lomas, 2018). Zuckerberg's reasoning not only underscores the critical role of data in corporate competition in the digital era. It also draws the attention of policy makers to the importance of data regime competition between countries. Economists have discussed regime competition since the 1950s. For instance, Tiebout (1956) developed a regime competition argument for tax competition between local authorities. When people and firms can migrate between jurisdictions this imposes restrictions on policy makers' choices in regulatory regimes. Conversely, when they cannot migrate policy makers have more freedom of manoeuvre.

This also applies to data protection regimes. Taking a pragmatic approach, data regime competition could be defined as the use of data, and data access regulations, to give a competitive advantage to firms in the domestic jurisdiction over firms from foreign jurisdictions. While individuals are unlikely to switch countries because of differences in data protection regimes, large global firms may prefer to locate data-intensive operations in jurisdictions that allow them to extract more value from data, although they will also prefer jurisdictions that offer strong protection of their commercial secrets and intellectual property. Data regulation will depend largely on the nature and characteristics of political regimes, including how they account for heterogeneity in domestic consumers' and firms' preferences, how they trade off private welfare versus overall social welfare, and how they deal with this trade-off in a global competition setting. A proper analysis of data regime competition should thus not only compare data regulations between regimes but also the outcomes that they produce for firms and consumers. In this study we show how the effectiveness of data regime competition depends on the availability of various knowledge spill-over channels from data and to what extent they can be contained to local markets.

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[1] Similar arguments have been used by Facebook and other American tech corporations to respond to regulatory constraints over technological competition and data privacy. "We understand that we've made mistakes. But don't you realize that if you damage us, you'll just be handing over the future to China? Unlike America, China is standing behind its tech firms, because it knows that the competition is global, and it wants to win." See: Tim Wu, *Don't Fall for Facebook's 'China Argument,'* THE NEW YORK TIMES, December 10, 2018,https://www.nytimes.com/2018/12/10/opinion/facebook-china-tech-competition.html (last visited Jul 23, 2019).

[2] Josh Horwitz, *Zuckerberg's talking points: Breaking up Facebook "strengthens Chinese companies"*, QUARTZ ,https://qz.com/1249660/zuckerbergs-senate-talking-points-breaking-up-facebook-strengthens-chinese-companies/ (last visited Jul 23, 2019).

We present a case study of data sharing in the automotive sector in China. In 2017, a Chinese law entered into force that makes if mandatory for all manufacturers of New Energy Vehicles (NEV, mostly electric and hybrid vehicles) in the country to pool vehicle mechanical and navigation data on a government-operated server. While manufacturers are responsible for the transfer of vehicle usage data to the government, the transfer includes personal data from drivers. It is thus a combination of mandatory business-to-government and consumer-to-government data sharing. Implementation of the data collection process has been decentralized to local and regional authorities. We trace the implementation of the law in the city of Shanghai.

From an economic perspective, the main advantage of this data sharing regime is the possibility to generate economies of scope in data aggregation and accelerate the pace of innovation (a) in the electric vehicle industry and (b) in environmental and mobility management. In a free and voluntary B2B data sharing market, market failures will occur because asymmetric and incomplete information about the performance of innovative electric car technologies remains locked into manufacturers' private data silos. Private firms have no incentive to share the information because it may erode their innovation rents. The government's mandatory data pooling overcomes these obstacles and generates economies of scope from the aggregation of complementary datasets. This B2G data regime is in the public interest because it can increase innovation-driven social welfare for all, including manufacturers and drivers. However, the intermediary is not necessarily neutral and may create new distortions in the competitive level playing field between manufacturers, in particular between domestic and foreign manufacturers, in order to strengthen the position of Chinese manufacturers in domestic as well as in foreign markets. We also find that the actual use of the data, as far as can be observed from available reports and studies[3], remains rather minimal and far below its potential with limited evidence to show otherwise

At first sight, one may wonder to what extent this is actually a case of data regime competition because neither car drivers nor manufacturers have a choice of jurisdiction. In contemporary platform economics jargon: neither consumers nor producers can switch between different data regimes. Car drivers are unlikely to move to another country because they do not like the local car data access regime. Similarly, car manufacturers will want to be present in the Chinese car market and will not withdraw their cars because of this data regime. We focus on a more indirect channel for data regime competition through spill-over's rather than movement of firms or production processes that is the subject of the more traditional regime competition literature. Contrary to the traditional literature, we argue that knowledge and insights obtained from data may, under certain conditions, have global spill-over effects that temper regime competition between jurisdictions. Even though direct knowledge spill-overs may be contained, there are indirect positive spill-overs outside China through knowledge embodied in exported technologies, vehicles and reductions in global emissions. Data regime competition can only work if these knowledge spill-overs between firms and/or countries can be contained. We discuss two different cases of spill-over containment with respect to the use of the Chinese electric vehicle data.

[3] This paper is based on published reports and studies. The authors have been in contact with relevant Chinese authorities but could not access unpublished work.

We compare this case of very wide-reaching B2G automotive data sharing in China with several automotive data sharing initiatives in the EU to make better use of car data to improve road security, aftermarket services, mobility and the environmental performance of cars. Recently, the EU has started to explore policies for B2G data sharing in the public interest[4] that may be more in line with the objectives of the Chinese initiative. Roberts et al. (2019) argue that an important difference between EU and Chinese approaches to data regimes is that the EU prioritizes individual privacy[5], commercial confidentiality and respect for private interests. This makes it easier for EU car manufacturers to push back against major data sharing initiatives when it does not suit their private interests. The emphasis on individual freedoms has been the hallmark of Western economic thinking since the Age of Enlightment. It contrast, the Chinese approach prioritizes collective national and societal welfare over individual welfare. Similarly, China seeks to maximize the social value of data, even if this may come at the expense of private interests of firms and individuals (Roberts et al., 2020). The more fundamental societal question is whether the Western individualistic approach can be maintained in the digital age that puts a premium on data sharing and pooling. It confines data to manufacturers' silos and impedes reaping the benefits of data aggregation. That may slow down competition, innovation and growth in societal welfare[6], and ultimately reduce the competitiveness of economic regimes that adhere to this principle. Answering that question goes far beyond the scope of this paper. Our only intention is to draw attention to this issue of growing importance in a more digitalized, connected world.

The remainder of this paper is structured as follows. Section 2 gives a short overview of the wider literature on regime competition. Section 3 compares data regulation in general and in the automotive sector in the EU and China. Section 4 describes the specific case of the regulation for business-to-government (B2G) data sharing for electric cars in the city of Shanghai. Section 5 discusses the economics of data sharing and applies this to the case of electric cars in Shanghai. It shows how the Shanghai database could affect electric vehicle manufacturers and consumers in China, compared to their counterparts in the EU. Section 6 examines actual use of the Shanghai database. Section 7 concludes.

2. From traditional regime to data regime competition

Regime competition is not a new concept in social science, including in economics and political science. We define regime competition as geographic competition between governments with a

[4] On B2G data sharing in the EU, see https://www.euractiv.com/wp-content/uploads/sites/2/2020/02/B2GDataSharingExpertGroupReport-1.pdf

[5] Some news media reported the existence of these NEV data platforms. They mostly ignore the industrial applications and emphasized potential privacy violations in data collection and use. We focus on industrial policy issues and do not look at privacy issues in this paper.

[6] Mann, Savulescu and Sahakian ({Citation}2016) argue that the "duty of rescue" principle prescribes that if an action can benefit others and poses little threat to the individual, the ethical option is to complete the action;

policy monopoly in their respective jurisdictions. The objective can be to ensure that a regime prevails and reinforce the economic competitiveness of firms and industries in its jurisdiction. Regimes can also compete in terms of social welfare of their citizens to reinforce their legitimacy and attract citizens to their jurisdiction.

Political regime competition emerged between Western liberal democracies and Eastern socialist countries during the old Cold War period. Obinger and Schmitt (2011: 301–330) discussed whether regime competition is really a causal factor behind the massive post-war growth of the welfare state. Budzinski (2008) linked the term to governance of global competition, including regulatory competition, that constructs markets for institutions, law, regulation, etc. with governments being suppliers and citizens as taxpayers as well as market participants (enterprises, investors, labour, consumers) representing the demand side. A related use of regime competition between countries is associated with social dumping and competition in labour law and labour market regulation. This came up for example at the time of EU enlargement to refer to competition between existing and new Member States in Central and Eastern Europe in labour and product markets. For instance, Streeck (1992: 301-330) pointed out that the progressive integration of European product markets would increase competition between labour market regimes of individual member states (Simmel, 1906: 125). By contrast, Maslauskaite (2013: 52) suggested that there is little space for regime competition between the European core and the new Member States. McDowell and Thom (1999) argued that if they would stay outside the EU, they would compete with the EU particularly in the area of labour market policy. Marginson and Sisson (2004: 135) suggested that one of the most problematic aspects of competitive corporatism is that it transfers the microeconomic logic of competition between companies to the macro-level of regime competition between nations. Marginson (2006: 102) argued that at macro-level, regime competition between labour market systems has been exacerbated by the onset of Economic and Monetary Union; at meso-level, regime competition happens between regions and localities in order to attract new investment.

The EU has a market-driven economic regime where state intervention in the private sector is restricted by competition law. EU governments can intervene through taxes and subsidies but this is subject to restrictions in order not to distort the normal activities of open markets. Attempts by Member States to distort the level playing field through subsidies to give local firms an advantage in international competition are subject to strict state aid rules. Guidelines on regulatory intervention emphasize that this can only happen in cases of demonstrated market failures, regulatory failures or equity concerns[7]. Intervention can also come in the form of stimulating more competition between Member States, for instance, by reducing barriers to trade in the EU Single Market. In contrast, China's political economy regime allows for stronger state intervention whereby the Communists party, the State authorities and industry are closely interwoven and interacting with each other. The government can largely intervene in industry, whether public or private enterprises, whenever it deems useful and necessary, without having to provide market failure arguments. Especially the Chinese government has direct control of SOEs (State Owned Enterprises) as a legacy of the old

[7] See European Commission "Better Regulation Toolbox", 2017, pp 85-92. Available at https://ec.europa.eu/info/sites/info/files/better-regulation-toolbox_2.pdf.

socialist economy. They are some of the biggest players in both the domestic and global markets, and remain in charge of China's key industries, pillar industries and other large general industries (Zhang, 2019). There is strong competition between provincial governments to promote the competitiveness of their local firms by means of subsidies and other advantages. This can also involve interventions by local governments.

Regime competition between jurisdictions is a well-known concept in economics. Thiebout (1956) presented a model of tax regime competition between jurisdictions. As people and firms can migrate between jurisdictions this imposes restrictions on policy makers' choice of tax regime. High taxes may motivate firms and people to move to another jurisdiction. The model does not imply that tax rates should converge across jurisdictions. Taxpayers will take into account taxation levels but also the quantity and quality of public services that they receive in return for their taxes. This may result in sorting of firms and people between jurisdictions in function of their preferences for public services. For firms that operate in global markets, local taxes will affect their competitiveness in these markets. Local governments have an interest in lowering taxes on these firms in order to strengthen their global competitiveness. Large global digital companies have exploited differences in tax regimes to set up tax headquarters in low tax jurisdictions. This has triggered action from the EU competition authority, most famously in the Apple-Ireland tax case[8].

Regime competition can also occur with respect to data protection and access to data. Researchers have studied the impact of the entry into force of the new EU General Data Protection Regulation (GDPR) in 2018 on the competitiveness of EU firms. Some have argued that the GDPR may have a chilling effect on investment and may be considered as a case of the EU harming itself. For example, Layton (2019) explained, among other negative impacts, how the GDPR significantly reduced investment in digital start-up firms and hindered innovations (Layton, 2019). As in the Tiebout (1956) model however, costs as well as benefits have to be taken into account, including consumer preferences for privacy protection. The positive welfare effect on consumers might exceed the chilling investment effect, though we have as yet no evidence on that. There are indications however that these preferences are globally shared among consumers, resulting in pressure to adopt GDPR-like legislation in jurisdictions outside the EU, including in the US[9]. That would level the playing field again among data-driven firms.

China has also adopted a number of general regulations that include provisions to protect personal data, such as in China's Tort Liability Law (Art. 30), the new E-commerce Law,[10] the Cybersecurity Law, the recent cross-border data protection draft law (Luo et al., 2019), and a new draft of Personal Data protection Law recently released for public consultation (Zhang and Yin, 2020) They include

[8] See the European Commission's decision on Irish illegal tax benefits to Apple worth up to €13 billion https://ec.europa.eu/commission/presscorner/detail/en/IP_16_2923

[9] The state of California adopted a personal data protection law that has many similarities with the EU GDPR. See https://oag.ca.gov/privacy/ccpa The EU's normative power extend far beyond data. See for example Ian Manners (2002) Normative Power Europe: A Contradiction in Terms, Journal of Common Market Studies, vol 40(2), pp 235-258.

[10] With Article 18 addressing the issues of consumer profiling and Article 13 requests e-commerce business shall collect or use individual information of its users shall follow relative regulations. Article 24 provides the rights of consumers to access, correct, delete their own information registered with service providers and the corresponding duties of the latter. Ibid.

clauses for data protection and legal duties for data controllers and processors[11]. Moreover, the State has adopted specific measures to strengthen personal data protection in practice, for example the revision of national standards for Personal Information Security establishes a data protection certification scheme. At the same time, however, these regulations grant state authorities access to all data held by private firms[12], whether personal or non-personal and for whatever reason deemed in the interest of the state. In the EU, the GDPR does not prevent government access to personal data for security reasons but not for economic reasons.

In the EU, government access to firm data is very restricted. There are some specific legal frameworks that allow access for taxation and statistical purposes for example, or for specific reasons such as environmental reporting or prudential supervision of banks. With the rise of digital data, however, digital firms often hold data that could be very useful for policy making. In many cases, it could be in the public interest if governments could access these data. The European Commission (2020) released a policy report on initiatives to facilitate business-to-government (B2G) data sharing that identifies the conditions under which this can be realized[13]. Some Member States have been pushing ahead. In France for example, the Loi Numérique (2018)[14] includes provisions that facilitate government access to data held by government-affiliated firms. The recent Loi sur l'Orientation des Mobilités (2019)[15] goes a step further and includes access to data from private transport firms. As in China, these initiatives have been set up with the public interest in mind, the overall welfare of society. However, unlike in China, they are not designed to promote innovation or industrial competition between firms or countries. Nevertheless, these B2G data sharing initiatives may have impact at the firm level when data, or the insights and knowledge derived from data, would spill over to other firms or when the policy initiatives to which the data contribute would have a differential impact on firms.

3. Access to automotive data in the EU

Modern cars produce substantial volumes of data while driving. These data can be collected outside the car and used for a wide variety of aftersales services as well as for more public services such as

[11] For instance, Article 25 of the E-Commerce Law of the PRC. For an English version of the law, see: E-Commerce Law of the People's Republic of China, available at: http://en.pkulaw.cn/display.aspx?cgid=321035&lib=law (last visited Jul 31, 2019).

[12] For instance, Article 25 of China E-Commerce Law (promulgated in 2019) requests e-commerce operators to provide e-commerce data information according to laws and administrative regulations without further illustration of which laws and regulations for procedural safeguards of personal data privacy For an English translation (not official), see: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiQrqyu_Z3tAhWCy6QKHUscCasQFjANegQIHBAC&url=https%3A%2F%2Fwww.scmp.com%2Ftech%2Fapps-social%2Farticle%2F2180194%2Fheres-how-chinas-new-e-commerce-law-will-affect-consumers-platform&usg=AOvVaw0ncKP-vO22CXl5fsUAoCys.

[13] "Towards a European strategy on business-to-government data sharing for the public interest", final report prepared by the high-level expert group on B2G data sharing. See also Bertin Martens and Nestor Duch-Brown (2020) The economics of business to government data sharing, JRC Digital Economy working paper, available at https://ideas.repec.org/p/ipt/decwpa/202004.html.

[14] https://www.vie-publique.fr/eclairage/20301-loi-republique-numerique-7-octobre-2016-loi-lemaire-quels-changements

[15] http://www.assemblee-nationale.fr/dyn/15/dossiers/loi_orientation_mobilites

environmental policies and the promotion of innovation in new car technologies. The use of data access and market regulation policies in the automotive sector is likely to have a significant impact on innovation in car markets and aftersales services markets and on the environmental performance of private car transport.
Policy makers are aware of this. In the EU, automotive (and more generally transport and mobility) data policies have been geared towards data sharing for a number of years now, including in the automotive sector. However, data sharing initiatives often run into opposition from private firms that collect data. The private incentives to share data for the social benefit of society as a whole are often not aligned. Sharing data may entail not only private production costs for firms. It may also be used by competitors to improve their market position (Carballa, 2018). In order to overcome market failures from incentive misalignment, government intervention with mandatory data sharing rules may be required, as in the case of the Chinese electric vehicle data sharing initiative.

B2B car data sharing is not new in the EU. Car manufacturers have to share basic repair and maintenance data with service providers under the Type Approval Regulation. The latest revision (2018) includes some provisions regarding access to digital data. There are also some mandatory B2G data sharing provisions for road safety data, between manufacturers and road traffic authorities (Regulation EU 883/2013). Policy initiatives to launch B2B data sharing for connected car data started in 2014. The European Commission (EU Commission, 2016) brought together all stakeholders under the C-ITS platform (Cooperative Intelligent Transport Systems) initiative to discuss the issues of access to in-vehicle data such as access principles, technical and policy solutions, etc. In 2016, an industry working group admitted that conflicting interests between stakeholders prevented the realisation of this goal[16]. Proposals for a common server to collect and share car data among car manufacturers and aftermarket service providers have not materialised.

The European Commission's Third Mobility Package (May 2018) launched more ambitious policy proposals for wider data access and sharing between transport devices, infrastructure and mobility management services. In the EU attempts to promote data sharing started with the CITS (Cooperative Intelligent Transport Systems) programme in the EU, now followed by the CCAM (Cooperative Connected and Automated Mobility) programme(EU Commission, 2016). These programmes seek to promote data sharing among automotive and transport service providers with a view to develop more efficient transport and mobility systems. However, there has been no special data policy regulation in this area. An announced European Commission Recommendation on data governance in the mobility sector did not materialize so far.

4. Mandatory access to electric vehicle data in China

16 Final report of CITS Working Group 6, European Commission 2016. See https://ec.europa.eu/transport/sites/transport/files/themes/its/doc/c-its-platform-final-report-january-2016.pdf

The Chinese government is aware of the significance of New Energy Vehicles (NEV) for the future of China's car industry, and launched a car data sharing initiative as part of its industrial policy in the automotive sector (Heller, 2017). While Western car manufacturers have a comparative advantage in combustion engines and car mechanics, the Chinese strategy seeks to leap-frog towards the development of electric cars that it sees as the most promising future of car technology. Heller documents how the Chinese government has taken five measures to boost China's NEV sector, including tax cuts, government subsidies to consumers and car makers, industrial policy measures (including "Made in China 2025"), and mandatory government procurement of NEVs (Heller, 2017). These policies explicitly seek to boost domestic NEV manufacturers and enable them to compete with top foreign players, on domestic and foreign markets(*Xinhuanet*, 2018)[17]. The most important law is the *2014 Provisions on the Market Entry of New Energy Vehicles Manufacturers and Products*,[18] which came into force as of July 1st. 2017.[19] Article 3 defines NEVs as vehicles "that adopt new types of power systems and that are completely or mainly driven by new types of energy, including plug-in hybrid, pure electric and fuel cell vehicles, among others." This national regulation makes it compulsory for all NEV manufacturers, both domestic and foreign, to establish their own NEV data platform to monitor the security and operating status of their cars. More importantly, these monitoring platforms must be connected to and share their data with both national and local platforms as a condition for market entry (Art. 17).

The stated objectives of the 2014 law include the promotion of sustainable economic development and carbon emission reductions. However, other applications are legitimate in the law. This includes government oversight of NEV technology developments and enhancing product quality and safety for Chinese NEV manufacturers, stimulating the adoption of break-through technologies, improving public safety and governance such as land planning for charging stations, and combating fraud in applications for NEVs subsidies. Article 18 mandates NEV producers to collect data over each NEV's lifespan, tracking its driving record, repairs and maintenance, and battery use and recycling. It is also mandatory under Article 18 to analyse and synthesize the technical status of their NEVs, problems and other major issues, and compile annual reports. Article 22 allows relevant government authorities at provincial level to check the NEV monitoring platforms of all manufacturers and request reporting of major changes in technology, security risks in production and management, and any breaches of the law to the Ministry of Industry and Information (MITT). The law has caused concern from foreign car manufacturers because it may affect their competitive position and commercial secrets, as well as privacy protection for drivers (Kinetz, 2018). [20] While they are forced

[17] New Energy Vehicles Opening Big Data Age-Energy Field (新能源汽车开启大数据时代 - 能源界), (2018), http://www.nengyuanjie.net/article/14442.html (last visited Jul 30, 2019).

[18] The Directive on Facilitating Promoting New Energy Vehicles (Guabanfa 2014-No. 35), and Notice on Financial Support for Facilitating New Energy Vehicles 2016-2020 (Jiancai, 2015-No. 35)《关于加快新能源汽车推广应用的指导意见》（国办发2014-35号）和财政部、科技部、工业和信息化部、国家发展改革委《关于2016-2020年新能源汽车推广应用财政支持政策的通知》（财建2015-134号）

[19] Chinese text available at: https://www.nengapp.com/news/detail/866720 .

[20] In this paper we do not consider the privacy implications of B2G NEV data collection in China. The China Cybersecurity Law allows the government to access personal data collected by digital services companies at any time. The NEV legislation makes it easier for the government to look into

to comply with the law in order to gain access to the world's largest NEV market (O'Kane, 2018), some foreign manufacturers stated that they will not send customer's personal data to NEV data centres to protect privacy.[21]

China also established a national NEV data centre, the New Energy Vehicle Monitoring and Managing Platform, located at the National Engineering Laboratory for Electric Vehicles at the Beijing Institute of Technology. This national centre collects NEV data from all local data centres. By July 2018, 1.025 million NEVs were connected to the state data platform, which is over half of all NEVs in China and not far from the maximum monitoring capacity of the Centre (about 1.6 million)(Yulan, 2018). Some provinces, and even lower level municipalities and local governments, established their own NEVs data centres to monitor and analyse vehicle data and to connect to the national data centre[22]. The local government of Shanghai adopted a temporary policy to encourage purchase and use of NEVs in 2016, and more permanent rules as from 2018[23]. As more or less a copy of the national regulation, the 2016 policy provided subsidies for NEV owners (both individuals and institutions) up to 50% of the purchase price. According to Articles 8(2) and 9, subsidies are conditional on a remote real-time connection to transfer vehicle data to Shanghai's NEV data centre. Article 9 explains the legal status of the Shanghai Electric Vehicle Development Centre (SHEVDC) as an independent institute in charge of establishing Shanghai's NEV data platform for data collection and monitoring, management and operation, data research and information distribution, etc. The data are collected and analysed for the purposes of the government's oversight, promotion and deployment of NEVs, and improving public policies and public services (Yulan, 2018). SHEVDC's responsibilities include: 1) collect data related to NEVs in Shanghai and provide security monitoring for NEV promotion; 2) conduct customer behaviour analysis and battery health research; 3) provide consulting support for NEV promotion, policy making and evaluation, and complementary infrastructure planning; 4) establish the Shanghai NEV Data Open Innovation Laboratory and explore open data innovations; 5) actively conduct domestic and international cooperation and exchange, and build a professional, open and integrated platform for cooperation and exchange[24]. The Centre cannot carry out any for-profit activities connected to the data processing without permission of car manufacturers (Article 9 of Shanghai's 2016 NEV temporary Policy). The Centre has been incorporated into a larger local industrial project by Shanghai Municipality "Xiaozheng Strategy" that aims to develop a world-class open data and innovation centre. Five university data

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personal data collected by NEVs because they are centralised on a government-operated server. However, the legislation does not fundamentally change government access to personal data.

[21] For instance, Volkswagen said that it ensures protection of personal data such as the identity of the drive, with its own systems and claimed that cars would not give away more information than smartphones (SPIEGEL, 2018).

[22] For instance, the provincial capital city of Chengdu makes it mandatory for NEV manufacturers to connect their cars after sale to a local monitoring platform, transferring real-time data for 70 items in NEVs. See: A Notification on Connecting NEVs and Charging Facilities in Chengdu to Municipal Minotoring Platform 2018 (关于成都市新能源汽车及充电设施接入市级监测监管平台的通知-文件- 成新汽办〔2018〕10号), at: http://gk.chengdu.gov.cn/govInfoPub/detail.action?id=101312&tn=6 (last visited Aug 1, 2019).

[23] 2016 A Temporary Policy of Shanghai on Encouraging Purchase and Use of NEVs (上海市鼓励购买和使用新能源汽车暂行办法(2016年修订)), at: http://www.nengyuantoutiao.com/xinnenyuanqiche/20200315/24695.html.

[24] See the Center's website, at: https://www.shevdc.org/zyzn.jhtml

labs and one state-owned local data centre joined the project to set up a data innovation lab within the Centre.

The Centre currently collects 44 static data points for each car[25], including information on car models, registration number, chassis and vehicle identification number, engine and battery types and fuel use, mechanical malfunction codes, E-engines and batteries, etc. Furthermore, it collects 61 real time dynamic data points and 19 locally defined real-time data points, covering car navigation, engines, batteries, energy consumption, charging status, alarms in the electric system, etc. While the data do not go down to the level of all individual mechanical and electrical components, key components can be identified because the type and brand name of components used in each vehicle model are known. The identities of cars and parts manufacturers are identifiable in the dataset.

The Centre compiles basic analytics of NEV use, including charging and energy consumption patterns (Hai, 2017). It can also provide tailored research reports upon request on market monitoring and other special topics, for instance on the second hand NEV market, charging points and charging patterns, user behaviour patterns, etc.[26] The Centre has a data lab where researchers can access the collected data subject to certain conditions[27]. In principle, any researcher including car manufacturers, can access the data provided that permission is granted by the Centre. Access is allowed to anonymized data upon payment of a fee[28]. The Centre has also organised research competitions, for instance to study the performance of batteries, that was open to all university researchers[29].

According to the Centre's website, it has published a series of annual reports on NEV use in Shanghai (2017 & 2018),[30] on Shanghai's NEVs market characteristics and customer behaviour (2014 & 2016), on the state of charge of batteries in NEVs, including the length, time, and charging locations, and driver's charging habits, on designing and planning of charging stations, and a report on consumer awareness and experiences (2015). One report found that for 48% of purely electric cars the cruising radius is less than 200 kms[31]. Besides, the open data competitions will have produced research reports that are not published. The Centre asserts that data are processed with privacy

[25] All information is available at SHEVDC's website, see: http://www.shevdc.org/sysbtp06.jhtml
[26] https://www.shevdc.org/sysbtp06.jhtml
[27] Researchers cannot take such data away from the Lab. See the brief introduction by the Centre, at: https://www.shevdc.org/sysbtp06.jhtml
[28] The meaning of "anonymization" is ambiguous here. The identity of the car and driver can be eliminated from the data, but any navigation data will usually reveal the home address and regular routes and destinations of the drivers. Complete anonymization would thus require eliminating navigation data.
[29] University Battery Research Open Competition Result Released (高校电池数据研究团队招募结果公布) - SHEVDC | 上海市新能源汽车公共数据网, SHEVDC (2019), at: https://www.shevdc.org/laws1/1935.jhtml (last visited Jan 7, 2020). The National NEV Data Center at Beijing Institute of Technology organized a similar open competition on NEV data in 2019 (called NCBDC) focusing on data analysis and algorithms innovation, at: China's NEV Big Data Research Report Released (新能源汽车大数据研究报告发布), , CHINASCIENCENET (2019), http://news.sciencenet.cn/sbhtmlnews/2019/8/348866.shtm (last visited Jan 7, 2020).
[30] See: http://www.shevdc.org/report/original_report/.

protecting measures for these studies[32]. We found only one academically published research paper that cites the Centre's research reports as sources (Yang et al., 2018). It is not clear how the Chinese government has used NEV data for economic policy making in the public interest at local or national level. While the technical implementation of the central data system seems to be operational, the actual use of the data to promote an efficient competition, innovation and welfare-enhancing ecosystem is somewhat shrouded in mystery, which is not a rare thing considering the long tradition of non- transparency in Chinese bureaucracy. There are few signs of efficient use of the data pool for social welfare and innovation enhancing policies. Of course, it is equally conceivable that the authorities do not give much publicity to technical innovation initiatives, while the collected data have been used in secret ways, unknown to the public.

5. The potential economic implications of the NEV database

In this section, we examine the potential economic impact and welfare gains that could be achieved through mandatory B2G car data sharing. We start by pointing out a peculiar economic characteristic of non-rival digital data, economies of scope in aggregation of complementary datasets. We argue that these externality benefits from data sharing are unlikely to occur in private car data markets where data remain confined in manufacturers' silos. This may constitute a market failure that would justify regulatory intervention in the form of mandatory data sharing, similar to the conditions that the Chinese government is imposing on car manufacturers. Data pooling creates a new problem: how to allocate the welfare gains from these informational externalities. We discuss two scenarios. The first scenario revolves around the production of innovative technologies that are privately appropriable by car manufacturers. In the second scenario, welfare gains dissipate in society through the production of pure public goods that cannot be privately appropriated: emission reductions and environmental improvements. These two scenarios are explicitly mentioned as policy objectives for China's NEV policy. The spill-over effects of each of these scenarios beyond Chinese firms and consumers are also discussed.

5.1. Economies of scope in data aggregation

Cars are rival goods, like any other good. Cars can only be driven by one driver at the time on one route. Contrary to rival goods data are non-rival. They can be used for many purposes at the same time. Their use for one purpose does not affect their use for another purpose. If cars would be non-rival, many drivers could use the same car to drive on different routes at the same time. Cost savings would be enormous. It would suffice to build one car to satisfy the needs of all drivers. That is precisely the promise of non-rival data: they can be used for many purposes at the same time. For example, car data can be used to monitor technical performance and produce efficiency gains in maintenance services, improve the technical quality of cars and strengthen the manufacturer's

[32]See: http://www.shevdc.org/laws1/1910.jhtml . (Note: privacy protection means privacy of the driver, not the private interests of the manufacturer of the car)

competitive position in the car sales market Martens and Mueller-Langer, 2020; Kerber and Frank, 2017). For this reason, non-rivalry is usually associated with economies of scope in re-use of the same source for different purposes (Panzar and Willig, 1981; Teece, 1980)

However, a peculiar economic characteristic of non-rival data is that, on top of economies of scope in re-use, non-rival data may generate additional economies of scope in data aggregation. These occur because the value of the insights that can be obtained from merging two complementary datasets is greater than the sum of the values of insights obtained from separate datasets. Keeping complementary datasets in separate silos entails a loss of knowledge or insights that can be extracted from the data (Martens et al, 2020). Economies of scope in the aggregation of complementary data can be traced back to the economics of learning and division of labour (Rosen, 1983). When two datasets are complementary and not entirely separable, applying data analytics – the equivalent of learning – to the merged set will yield more insights and be more productive than applying it to each set separately, especially when the marginal cost of applying analytics to a more complex dataset is relatively small. In the case of car data for example, the aggregation of mechanical and electrical performance data across car models and brands would produce better insights into the performance of different makes and models of batteries and electrical engines, and the overall electro-mechanical architecture of different car models, than keeping the data in separate pools for each manufacturer.

5.2. Using pooled car data to promote industrial innovation

The benefits of economies of scope in data aggregation or data pooling between car manufacturers are unlikely to occur in a free market setting. Manufacturers of cars and parts invest in innovation to become more competitive and attractive to consumers. Industrial designs and technological innovations are non-rival but they can be made excludable, either because they are protected by Intellectual Property Rights (IPR, i.e. patents, trademarks, copyright) and/or by asymmetric information between competing firms, or by trade secrets. IPR enable manufacturers to reap the innovation rents. IPR exist to keep a balance between private technology rents and spill-over effects to promote innovation. Although competitors can at least partially observe the technical construction of cars and parts, they cannot use this information for commercial purposes. While parts in cars are observable for all, the performance of these parts in response to driver behaviour is not readily observable or testable in laboratory settings. Digital sensors make it possible to collect that information *in vivo*. This brings faster and more fine-grained feedback to manufacturers to improve car design. Centralizing the data on manufacturers' servers provides them with exclusive access to a performance overview of all cars and parts from their own brand. They may share some of the insights with parts producers to improve the performance of parts. But they will not share it with competing car manufacturers because it erodes their technology rents and may be used against them and increase competitive pressure in their markets. Manufacturers know the true performance of their cars and parts but not of other cars and parts from other brands. This reduces technology spill-over effects and competition in the car market. It results in underinvestment in innovation by manufacturers and slows the pace of innovation.

There is consumer demand for better-performing NEVs. However, incomplete information on the performance of cars prior to a purchase may steer consumers towards sub-optimal choices. They can only use general and more subjective car tests in consumer periodicals for example to fill up their technology information gaps. This preserves commercial confidentiality and technology rents for manufacturers but lowers competitive pressures, resulting in welfare losses for society. Many technological improvements will therefore remain pure externalities that cannot be monetized by the manufacturer through higher prices and sales because the consumer is not aware. At the same time, technology laggards may monetise inferior technology through consumer sales. Manufacturers have better information thanks to digital data but cannot credibly signal this to consumers. They have an incentive to exaggerate benefits and understate consumer or social costs[33] to strengthen their market position and consolidate rents from existing technologies. This leads to adverse selection by consumers who will make errors in selecting the car that best matches their technology preferences and budget constraints.

Withholding all this information creates information fiction problems in the car market, both for consumers and manufacturers. This is a well-known source of market failure[34]. Sharing and pooling this information could reduce frictions in markets caused by incomplete, imperfect and asymmetric information. That could boost welfare effects from innovation spill-over's between competitors, speed up innovation and make better-performing technologies more widely and rapidly available. Information frictions may be more important even in a fast-moving technology domain like NEVs and may lead to more sub-optimal choices by manufacturers and consumers. It may hold back the pace of innovation.

To be sure, the same asymmetric information problem existed in pre-digital car markets and in non-electric vehicles. The arrival of digital data makes it potentially easier to address the problem by taking car performance data out of manufacturers' silos into a pool operated by a third party that can credibly measure the technical and environmental performance of various NEV models and components in a more objective way. This requires government intervention and mandatory data sharing. A more fundamental question is how far regulators can go in imposing data sharing costs on private stakeholders with a view to improve overall welfare for society. Two different economic welfare concepts come into play here: Pareto-optimal policy making versus Kaldor-Hicks policy making[35]. In the Pareto case, no individual should be made worse off as a result of a policy decision. Individuals have the right to defend themselves against government intrusion in their private welfare, unless. In the Kaldor-Hicks case, some individuals can be made worse off as long as the overall benefit for society increases such that society could, at least theoretically, compensate the losers while still keeping a net benefit for society as a whole. The fine line that separates the two approaches in precisely in the policy process that determines how to deal with winners and losers.

[33] See for example the VW diesel-gate emissions scandal. See https://en.wikipedia.org/wiki/Volkswagen_emissions_scandal

[34] The European Commission's "Better Regulation Toolbox" (2017) identifies asymmetric information as a cause of market failure that may require regulatory intervention.

[35] For more explanations, see for example https://www.oxfordreference.com/view/10.1093/oi/authority.20110803100028833

China seems to have chosen a top-down approach with a government-imposed regime, while the EU prefers a bottom-up approach that seeks a consensus among stakeholders.

How are the benefits from economies of scope in data aggregation and the innovation spill-over effects allocated between car manufacturers? In theory, innovation benefits can be privately appropriated by car manufacturers through IP and trade secrets, or they can be shared as public knowledge by some or by all. That depends on access conditions to the data pool.

The Chinese government has designated the Beijing Institute of Technology as the national institute that aggregates the data from all regional NEV data centres. Only the national institute and the local data centres have full access to the data. The Shanghai data centre has established research agreements with local university labs that oversee the use of the data and can carry out technological studies with the data. From current publicly accessible data, it is not clear to what extent these research institutes collaborate with NEV manufacturing firms and give them direct access to the data or indirectly share technology insights obtained from analysing the data pool in order to help them improve their technologies and the quality of their cars.

We have found announcements of research competitions with open access to the datasets. Moreover, according to the data access rules, any researcher could use the data upon payment of a fee. One could also imagine a scenario whereby data sharing is extended to all automotive parts and components suppliers and aftermarket service providers, or full data sharing across all firms involved in the NEV industry ecosystem. The governmental NEV data institutes would then serve as a conduit to achieve full B2B NEV data sharing. This scenario would further increase competitive pressures in the NEV industry and accelerate the pace of innovation at the level of components suppliers. The benefits from successful innovations in engines, batteries and other key NEV technologies would rapidly spill over to competitors.

It is important to underline the possible negative effects of full NEV B2B data sharing or innovation sharing. Accelerating the pace of innovation also accelerates the rate of depreciation of capital stock and intellectual property invested in older technologies. This increases investment costs for car manufacturers as well as buyers. To the extent that drivers want to keep up with technological innovation, it increases the private capital replacement cost for driver and car owners. The benefit for manufacturers would be increased sales of newer and better-performing models. A gap may occur between the private and socially optimal rate of innovation in society. As society faces the risks of climate change, faster technological progress in emission reduction is desirable and may be subsidised by governments. There is little risk in this case that the desirable socially optimal rate of innovation is lower than the private rate and cost of innovation.

We have not found any published reports that document technological innovations extracted from the data pools or government-to-industry data sharing policies. Given the stated objective of the NEV law that explicitly seeks to promote industrial innovation in NEVs, and given the strong interaction between universities and domestic industries in China, selective and secretive information sharing and spill-overs to NEV manufacturers is a more likely scenario.

In line with the objective of the law, it is not clear whether domestic NEV manufacturers get privileged access to the data and research findings. Neither is it clear whether foreign car manufacturers could be excluded in order to create a competitive advantage for China's domestic manufacturers who could then leverage this advantage in global NEV car markets, putting pressure on foreign manufacturers globally. In other words, there is the possibility that B2G data pool operator may act in a non-neutral and discriminatory way, giving some parties privileged access to the data. This mechanism could be used to select "domestic industry champions" and increase data regime competition between Chinese and EU/US NEV manufacturers. The feasibility of such a discriminatory approach depends on technology transfers in joint ventures in car manufacturing. Almost all major EU (and US) car manufacturers have joint ventures with local Chinese manufacturers. Joint ventures have many ways of allowing or blocking technology transfers and spill-overs between the partners. There is a long history of technology transfers between foreign and domestic Chinese care manufacturers (Gallagher, 2016) . Even after China lifted foreign ownership restrictions on domestic joint ventures in the car industry (Buckland, 2018), there are still many possibilities to block technology transfers and turn data-driven innovations into private intellectual property that domestic firms can license to foreign manufacturers. At the moment, we have no information if data accessible from the platform may be transferred outside China by joint adventures for global use. If there would be no obstacles to technology transfers, NEV data and knowledge would spill over and accelerate innovation among all EU and US car manufacturers who have joint venture agreements with Chinese firms. Since EU (and US) manufacturers have factories all over the world, they can transfer the knowledge gained in China to all their factories. This would create a global level playing field in NEV manufacturing and disseminate the welfare effects from the China NEV data pool worldwide. It would eliminate the use of data regimes as a tool for industrial competition between China and the EU, or the US for that matter.

In conclusion, the effectiveness of data regime competition depends on the degree of technology transfers between domestic and foreign manufacturers and the extent to which the data centres are neutral or biased intermediaries that favour domestic researchers and manufacturers. This will require more research and field work.

5.3. Using the data to improve the environmental performance of cars and drivers

This brings us to the use of NEV data for the production of pure public goods such as clean air and lower carbon emissions from traffic, an objective that is explicitly mentioned in China's NEV policy. In this case, the positive externalities from economies of scope in data aggregation are dissipated into public environmental goods that are non-rival and non-excludable: everyone benefits from it and nobody can be excluded from these benefits. They cannot be privately appropriated by car manufacturers or drivers. Pure public goods normally result in free-riding: nobody wants to pay for the cost of emission reduction and everyone benefits from it.

A simple way to overcome this problem is to incentivize private consumers by means of a lump sum subsidy for the purchase of NEVs with electric or hybrid engines. This is what the Chinese

authorities have done in Shanghai and other cities. Local subsidies run the risk of fraudulent use by consumers living outside the local area, or fraudulent NEV manufacturers that produce poorly performing and environment unfriendly NEVs to benefit from state subsidies. One of the purposes of the NEV database was to set up a system to monitor the effective use of subsidized NEVs in Shanghai, to avoid fraudulent subsidy claims. It combines car registration with navigation data collected by build-in navigation systems that are a standard feature of modern cars. This requires mandatory B2G navigation data sharing. However, it does not explicitly involve any economies of scope in data aggregation across NEVs since each vehicle is checked individually.

Pooled NEV data could be used however to set up more sophisticated incentive systems to promote the use of electric cars. Data pooling across all NEV manufacturers enables more fine-grained monitoring of the entire NEV fleet in a city. The aggregated data can reveal differences in performance between car models, technologies and components used in the vehicle. Better performing cars can be identified and receive a higher subsidy[36]. The variable subsidy would constitute a credible financial signal to buyers about the environmental quality of the vehicle. For car owners and drivers this information could increase transparency and reduce asymmetric information in the car market, and help them make more informed choices. It puts pressure on car producers to improve the quality of cars and kick poorly performing models out of the subsidy system. It would reinforce feedback from the car aftermarket to the car sales market and thereby validate the so-called "Chicago critique" of efficient consumer behaviour that separates the two markets (Posner, 1979). Governments can use the information to promote competition between manufacturers, design more efficient and mandatory technical standards, and put in place better emission reduction policies and technologies. While manufacturers cannot monetize the positive externalities from better environmental policies, or only partially so, society as a whole, benefits from this, although possibly at the expense of individual manufacturers. This requires data pooling and economies of scope in the insights extracted from the pooled data.

Moreover, the variable subsidy could take into account the driver's behaviour, such as maximum use of the electric motor in hybrid vehicles, energy-conscious driving when the petrol engine is on, and avoidance of rush-hour traffic jams[37]. This application would not require data pooling across cars. Other data pooling applications include tracking congestion in cities, especially when the density of NEVs would increase. One could argue that this is an expensive duplication effort of data already collected by navigation apps. However, NEV data include additional electro-mechanical parameters not usually available in navigation apps, such as the use of electric engines and batteries. One study used the pooled NEV car dataset to estimate the best locations for battery charging stations as public facilities(Yang et al., 2018: 20–30). Apart from this study however, we have found little evidence that the data are effectively used to improve and implement environmental policies. While use of the data for technical innovation in the NEV industry can remain hidden, use for public policy purposes should be visible.

[36] It could also help to avoid fraud in emission reporting by manufacturers, as in the case of the Dieselgate scandals. https://en.wikipedia.org/wiki/Volkswagen_emissions_scandal

[37] This is similar to tracking devices by car insurance companies that offer lower insurance premiums for safe driving behaviour.

6. Conclusions

This paper examines a case of data regime competition. It studies a policy initiative in China that makes B2G sharing of NEV usage data mandatory. The policy seeks to achieve three objectives: prevention of fraud in NEV subsidy applications, the acceleration of innovation in NEV technologies in China's car industry, and the promotion of clean car technologies for environmental purposes. The EU pursues similar policy objectives but has so far shied away from mandatory B2G car data sharing, except in a few minor cases related to road safety. EU car manufacturers are resisting any measures that might erode their exclusive control over car data, as demonstrated by earlier attempt under the EU CITS policy, though some EU industry voices have raised the idea to create a "neutral server" to pool car data[38].. Mandatory B2G data pooling policy would be perceived as excessively interventionist in the EU political economy context that puts more emphasis on industry self-regulation and market-driven initiatives to promote technical standards for data sharing, though often supported by government subsidies and policy coordination initiatives. Regulatory intervention is possible only in the case of clearly demonstrated market failures. In contrast, the state is a dominant player in the Chinese economy and actively intervenes in markets and firms in many ways, far beyond what would be politically feasible in the EU. Paradoxically however, mandatory B2G data sharing for the purpose of promoting innovation may be a case of data market failure that could justify regulatory intervention.

Data pooling exploits a peculiar economic characteristic of data: it can generate beneficial welfare effects by means of economies of scope in data aggregation. More insights can be obtained from the analysis of pooled data, compared to keeping data in manufacturers' data silos. Data segmentation between car brands creates information friction in car markets and markets for innovative technologies, as a result of imperfect and incomplete information and information asymmetries. That slows down innovation. Mandatory B2G data pooling can potentially overcome inherent B2B data market failures that inhibit the realisation of economies of scope in data aggregation. From this perspective, the Chinese government's mandatory B2G data sharing policy initiative is in line with traditional market failure criteria for regulatory intervention, including those advocated by the EU[39].

We find that this form of data regime competition between China and the EU can give China an advantage in terms of promoting innovation in the electric car industry, especially when there can be potential discrimination between domestic and foreign NEV manufacturers in terms of access to the data and the knowledge derived from the data. To what extent this is true is difficult to detect and would require further research and field work on access to innovation in joint ventures in China's car industry.

[38] See for example the position of the International Automobile Federation on car data sharing, https://www.fiaregion1.com/wp-content/uploads/2017/05/20160412fia_policy_brief_on_car_connectivity_fin.pdf

[39] See for example European Commission "Better Regulation Toolbox" (2017).

The EU has been working for several years on data access and sharing policy initiatives[40]. All these initiatives are explicitly or implicitly based on welfare gains from economies of scope in data aggregation and re-use. Regulatory intervention is required because private data holders have no incentive to share their data and prefer to keep their data in inaccessible silos. Most recently, the European Commission proposed a Data Governance Act that seeks to enable common European data spaces (European Commission, 2020). EU-promoted but privately run third-party industrial data pools have come up in the context of AI innovation policy initiatives. While the objectives are broadly similar, the political process to achieve them is different. China goes for a top-down government initiative, while the EU prefers a more bottom-up industry-driven approach. The EU approach is slower because of conflicting interests between private stakeholders that create market failures and obstacles to collective action and the realisation of societal welfare goals. The Chinese approach is faster in creating the data pool but shows signs of underperformance in the actual use of these advantages.

[40]An overview of EC data policy initiatives over the last couple of years can be found here: https://ec.europa.eu/digital-single-market/en/data-policies-and-legislation

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