Competing with Giant Platform Operators: An Analysis of Which Traditional Manufacturing Companies are at Risk from Strategic Dependence on Other Companies' Platforms in the Emerging Era of the Internet of Things

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Abstract

Digital platforms have gained importance across a wide range of industries because they enable superadditive value creation in their platform ecosystems. Giant platform operators such as Google, Apple, Facebook, and Amazon dominate areas such as web search, mobile applications, social media, and online shopping and harvest most of the superadditive value in their ecosystems. With the advance of cloud computing technology and the Internet of Things, traditional industries such as manufacturing will also move towards *platformization*. If manufacturing companies become dependent on other companies' platforms, these platform operators may be able to exploit manufacturers' strategic dependence. In particular, platform operators may be able to extract much of the value that their platforms create, leaving the manufacturers with limited gains from their platform strategies. To understand how traditional manufacturers can address this issue, we first construct a simple mathematical model of the sources of value in digital platforms. We then study two German manufacturing groups and use this model to evaluate the groups' platform strategy. We identify control of relevant information domains, control of the customer interface, and collaboration in joint platforms as important factors to understand when developing strategies to deal with giant platform operators and to avoid strategic dependence on these competitors. We contribute to the literature on digital platform emergence in two ways, through the construction of our model and through the use of this model to examine the platform strategies of traditional companies.

Keywords: Digital platforms, platform ecosystems, superadditive value creation, modeling platform power, Internet of Things, Industrial Internet of Things

1 Introduction

Digital platforms create enormous value for users. In fact, the definition of a platform starts with the idea of value. A platform begins with an extensible core, and then augments it with a family of additional applications that interact to create *superadditive value* for users.

We have already seen and documented the emergence of a small set of giant American platform-based companies that have achieved global dominance (Clemons, Krcmar, Hermes, & Choi, 2019). Significantly, we document the fact that this dominance has reduced European competitiveness in most areas of customer-facing online services; virtually all online customer-facing applications are currently dominated by American companies. As importantly, the superadditivity of applications on platforms almost guarantees the continuation of American domination of online customer interactions in Europe.

Platforms and platform-based strategies are not new. Perhaps the earliest example of a platform using superadditive value creation to limit competition occurred in the 1930s. AT&T had a monopoly over America's telephone network which it leveraged to broadcast the first radio station, WEAF. Only strict regulation inhibited the expansion of the monopoly from telephone to radio (Clemons, 2019; Wu, 2011). Platform-based businesses are among the most successful, and among the most difficult to compete against. When Microsoft bundled the Internet Explorer with Windows, it became the most popular browser, making it hard for Netscape to compete. With Android, Google has established a web of applications and services that create value for users at no costs—an offer that competitors can hardly match (Clemons, 2019).

There are frequent calls for all companies, even traditional providers of manufactured products and essential services, to transform themselves into platform companies. Parker, Van Alstyne, and Choudary (2016) argue that platform-based strategy is nothing short of revolutionary, and that all companies need a platform strategy. Along that line, it has been argued that a platform strategy is essential to the survival even of traditional companies (Sebastian et al., 2017), and even that *all* companies should become *platform* companies. But is this possible? Is it possible for traditional European companies to develop effective platform-based strategies of their own? Is it possible for traditional European companies to develop strategies that will enable them to prosper in the presence of American platform domination? Or are European traditional companies going to find that they are the next generations of providers of goods and services that have become marginalized due to the domination of giant global platform operators? There is no doubt that German heavy industry, retailing, automotive manufacturing, and mainframe software will survive. However, the questions of how they can develop platform-based strategies, and how much of their power and profit they will retain, both remain critical.

To answer these questions and examine how European traditional companies can prosper, we first conducted two case studies of traditional manufacturers that establish digital platforms. Consistent with the research traditions of Eisenhardt (1989), Lee (1989), Benbasat, Goldstein, and Mead (1987), and Clemons, Constantiou, Marton, and Virpi (2019), we use these semantically rich ethnographic observations to construct models and hypotheses. The first case study was with a manufacturer of premium cars that is establishing a digital platform for the cars' onboard infotainment system, with plans to extend the platform much further, into control of scheduling of autonomous vehicles. The second is a group of production equipment manufacturers, such as a manufacturer of painting plants, digital scanning for product quality control, or CNC machining units. Their goal is to establish a platform for digital service that allow for superadditive value creation, by allowing machines to communicate and to coordinate adaptive manufacturing and scheduling of production operations. Based on these semantically rich case studies we formulate hypotheses on which of the two manufacturing groups has a better chance to succeed with their platform strategy and why.

We present a model of platform power, platform profitability, and superadditive value creation. We use this model, and the hypotheses from our case studies, to make recommendations on how traditional manufacturers can succeed in the face of competition from giant platform operators.

2 Theoretical Underpinnings

We first introduce the concept of digital platforms and show how a few companies applied platform envelopment strategies to become dominant players. Then, we establish the model of superadditive value creation that is the bases of our analysis.

2.1 Digital Platforms and platform envelopment strategies

Again, we define platforms as a core application to which additional functionality can be added; what makes platforms interesting is the possibility of superadditive value creation from the interactions between the core and the additional applications. When the owner of the core has monopolist power, and can determine which companies can and cannot interact with the core, the owner of the core can limit competition. This enables the platform operator to earn monopoly profits from the additional applications as well.

Digital platforms are platforms where the core application is a piece of software; as we saw with the example of AT&T / WEAF, not all platforms need to be based on code and not all platforms are digital platforms. We borrow the definition. of digital platforms from Tiwana, Konsynski, and Bush (2010, p. 676) and define a digital platform as "the extensible codebase of a software-based system that provides core functionality shared by the applications that interoperate with it and the interfaces through which they interoperate." Due to their extensible nature, digital platforms enable the platform operator to "unlock" the potential of a broader platform ecosystem of third-party developers for value co-creation (Kuk & Janssen, 2013; Ondrus, Gannamaneni, & Lyytinen, 2015;

Zittrain, 2006). It is this extensibility, and the potential for cocreation that have led to the increased importance of digital platforms. We refer to the digital platform, its interfaces and complementary applications, and the platform's stakeholders and users, as the *platform ecosystem*.

All platforms start with a core product or application. In the case of Google the core product was Search. In the case of Microsoft the core was DOS, now Windows. For Apple it was the integrated Apple II and its operating system, updated and replaced by the Mac and OSX; now Apple's ecosystem is built around the iPhone and iOS or the Mac and OSX, integrated through iTunes. All dominant platforms also include the rewards from superadditive value creation from a family of supporting apps that interact with the core. Superadditive value creation is a formal shorthand for saying that in a platform the total value created by the platform is greater than the sum of the values created by its parts. Excel is valuable for calculations and exploration of budgets, but its value is increased when users can copy a section of a spreadsheet budget from an Excel workbook and seamlessly drop it into a proposal they are creating as Word documents.

Additionally, most platforms deliberately and artificially maintain and defend the border between their core and at least some of the capabilities provided by other parties. Superadditive value creation envelops users in an environment which cannot be duplicated by companies without access to the core; creating this value is the basis of a platform envelopment strategy. Controlling and limiting which companies can create additional applications that interact with the core allows the platform operator to eliminate competition in areas that are especially important to them. This is an important element of profiting from a platform envelopment strategy.

Control over the platform, its core, and interactions with its core creates a platform ecosystem that allows platform operators to provide varying degrees of openness, allowing other parties to participate when they choose to do so, and limiting other parties' ability to participate when that is more profitable for the platform operator. Unlike the other two characteristics, artificially limiting competitors' interoperability and thus limiting their access to the core is not essential to our definition of a platform. But it is essential to the platform operator's harvesting as much value as possible, and it is rare to see a platform operator that does not engage in some form of limiting interoperability. Some form of limiting interoperability is essential to profiting from a platform envelopment strategy.

We note that all successful new technologies are widely adopted, change business practices and business models, and create possibilities for new forms of monopoly power. Thus new technologies create new forms of anticompetitive behavior and often create needs for new forms of regulation as a result. We saw this in the 1880s through the 1930s, with waves of new forms of regulation to deal with new potential for abuses (McCraw, 2009). Thus, while platform envelopment strategies benefit both users and platform operators, there is almost certainly a threshold beyond which this goes beyond profitable business practice and becomes illegal monopolistic predation. That was the justification for the recent EU decision to fine Google €4.34 billion for imposing illegal restrictions on Android device manufacturers and mobile network operators such as pre-installing the Google Search app (European Commission, 2018).

Digital platforms that create superadditive value along with platform envelopment strategies to harvest much of that value have contributed to the emergence of giant platform operators such as Microsoft, Google, and Amazon. As we noted previously, Microsoft and Google have successfully limited competitors' access to their core applications, which contributed to regulatory decisions against them (European Commission, 2018; US Department of Justice, 2001). This power has effectively forced European firms out of most customer facing online applications. Interestingly, we see that these platform operators and their platform envelopment strategies pose a threat for traditional industries as well. Numerous EU industries, such as the automotive industry, manufacturing, consumer white goods (appliances), and retailing are attempting to develop their own platforms for interaction with their customers, as they prepare for upcoming developments like smart appliances, the smart home, home control interfaces, and the industrial Internet of things. Existing platform operators already have a core and a family of supporting applications; that is, Amazon's Alexa, Apple's Siri, and Google's Assistant already exist and already enjoy superadditive value creation for their users. It is difficult to see how individual manufacturers could justify investments in new platforms, and even more difficult to see how they could create viable "smart home" or "smart assistant" platforms to compete with Alexa, Siri, or Assistant. Volvo has already decided to adopt Google's Assistant, and Mercedes is working with Apple's iOS. It is difficult to predict how the giant platform operators will use their power, and it is difficult to predict how this will affect users' privacy and manufacturers' future access to customers.

It may not be immediately apparent why a traditional company's dependence upon a giant platform operator may represent a form of strategic vulnerability or future risk. Appendix A presents two use cases that explain these vulnerabilities. The first is for an automobile company that has become dependent upon Google, and the second is for a retailer once smart appliances have become dependent upon Amazon.

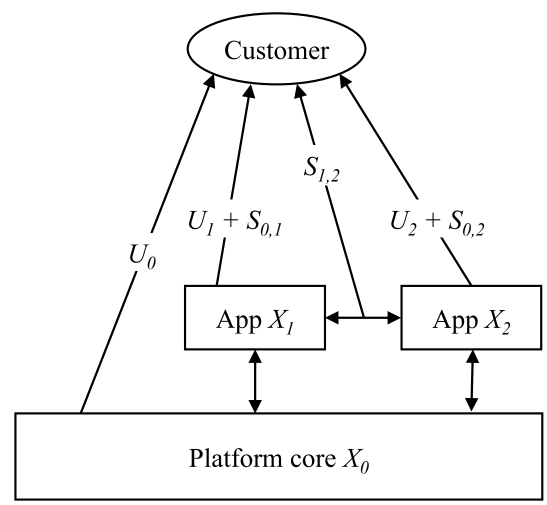
Table 1 summarizes our notation and terminology, introduced above.

Term	Definition	Sources
Digital platform	"The extensible codebase of a software-based system that provides core functionality shared by the applications that interoperate with it and the interfaces through which they interoperate."	Tiwana et al. (2010, p. 676), Baldwin and Woodard (2008)
Application (app)	An add-on software subsystem or service that connects to the platform to add functionality to it. Also referred to as a module, extension, plug-in, or add-on.	Parker, Van Alstyne, and Jiang (2017), Tiwana (2014)
Interfaces	Specifications and design rules that describe how the platform and applications interact and exchange information.	Tiwana (2014)
Platform operator *Creators* *Users*	Main stakeholder groups of IT platforms. platform operator is an individual or organization representing the legal entity that owns the platform (also referred to as platform owner. Creators are individuals or organizations that develop one or more applications for the IT platform (also referred to as third-party developers or complementors). Customers are individuals or organizations that use the applications available on the IT platform (also referred to as customers).	Tiwana (2014), Evans, Hagiu, and Schmalensee (2006)
Platform ecosystem	The platform and the applications specific to it as well as the stakeholders of the platform. Also referred to as platform-based software ecosystem or software ecosystem.	Cusumano and Gawer (2002), Tiwana (2014)
Superadditive value	The total value created by the platform is greater than the sum of the parts.	Clemons (2019)
Platform envelopment	Platform operators deliberately limit interoperability to limit competition	Clemons (2019)

Table 1: Definition of key terms related to platform ecosystems

2.2 Model of superadditive value creation in digital platforms

To understand how superadditive value is created, we establish a basic model:



Variables

- X_i product X*i*, with X_0 referring to the platform core and X_1..*Xn* referring to complementary applications
- U_i value a customer gains from standalone use of the platform core X_0 or application X_i
- $S_{0,i}$ super-additive value a customer gains from using applications X_i jointly with the platform core X_0
- $S_{i,j}$ super-additive value a customer gains from using applications *i* and *j* jointly

Figure 1: Superadditive value in digital platforms

Users get a specific amount of user value U_i from using an individual product X_i. We designate the platform core as X_0 and the value users obtain from the core alone as U_0. In addition to value from individual components X_0 through *Xi*, users also get superadditive value from the interactions among products, which is key to every platform's value proposition. There is a specific amount of extra value that comes not merely from using two products individually; there is additional value that comes from using them together. *Sij* is the value created for users by the interactions between products X_i and X_j. If U_i is the value a user gets from Word and U_j is the value the user gets from Excel, then S_{ij} is the additional value the user gets from the way Word and Excel interact. The superadditive value users get from the interactions between the core and products *Xi* and *Xj* is S_0i and S_0j. If users use Word an Excel on a Windows platform, they have additional value from the interaction of the software applications with the operating system.

Sellers of individual products get specific seller revenue from consumers' purchases of each specific product. That is, all products have a selling price. Sellers receive revenue R_i from the sale of Product X_i. Sellers may include the platform operator; Microsoft earns revenue whenever users purchase Windows or Office. Sellers may also be third parties cooperating with the platform operator; individual authors earn revenue whenever their apps sell on Apple's App Store, and individual retailers earn revenue whenever their they sell products through Amazon's marketplace.

Platform operators frequently get platform value V_i from having users actually use product X_i. This value can come from both direct and indirect revenue sources. Direct revenue sources include sales of software, usage charges for software, or commissions on products and services sold through the platform. Indirect revenue sources include the various forms of revenue available from selling access to data obtained on customers through data mining their usage of the wide range of apps on the platform.

Depending on the platform operator's strategy and the competitive situation in the market, the superadditive value is distributed between users, sellers, and the platform operator in different proportions. We have seen several cases of dominant platform operators that harvest most of the superadditive value, leaving creators just as much as they need to survive. Sometimes these platform operators do still leave their users with superadditive value; other times the indirect costs associated with platform use are well hidden, but users receive very little of the value created by the platform.

The model helps us understand the strategies available to platform operators. It helps us understand which strategy an individual platform operator is likely to follow, based on our understanding of the platform operator's business model and the relative importance of different revenue sources. This in turn helps us understand the likelihood of success for traditional companies that attempt to create their own digital platforms, based on their ability to create superadditive value to compete with existing platform giants. It also enables us to assess the costs associated with strategic vulnerability and dependence upon one of the existing platform giants. We illustrate both by analyzing two cases of traditional manufacturing groups exploring creating their own platforms.

3 Methodology

Our methodology starts with ethnographic observation and a small set of semantically rich case studies to aid in the development of formal testable hypotheses and to model creation (Eisenhardt & Graebner, 2007; Galliers & Land, 1987; Lee, 1989). We have used this methodology for decades, in the development of the move to the middle hypothesis, the newly vulnerable markets hypothesis, and the resonance marketing hypothesis (Clemons, Croson, & Weber, 1996; Clemons & Hitt, 2006; Clemons, Reddi, & Row, 1993).

We have found through experience that it is often best to start with two case studies that are as different as possible. We start with two companies attempting to solve the same strategic challenge and, if our initially choices were sufficiently different we can gain insight that helps us understand why one company will succeed while the other will not. When we examine the two studies side by side we can create testable hypotheses for further exploration.

Our use of a contrasting pair of diametrically opposed examples is an extension of the methodology endorsed by Eisenhardt (1989), and we believe makes it easier to construct models and hypothesis than a single ethnographic observation would do.

We conducted series of interviews at two traditional German manufacturing groups. The first was automotive manufacturer and the second was a joint venture formed by a consortium production equipment manufacturers. By choosing two very different businesses with different approaches to a digital platform strategy, we can derive hypothesis on what factors are important for the success of digital platforms of traditional companies.

Data collection included 14 in-depth interviews for the automotive manufacturer and 8 in-depth interviews with the consortium of production equipment manufacturers along with secondary data such as internal meeting minutes, presentations, and reports but also public data such as press releases and articles from tech blogs. The questions discussed in the in-depth interviews included, among others, (1) why the companies came up with a platform strategy, (2) how this strategy was implemented so far, (3) what challenges arose in terms of value creation and value capture, and (4) what risks they see for their digital platforms.

4 Hypotheses: Who Benefits from Superadditive Value?

Based on the observations from the two case studies we suggest the following hypotheses:

H1: **Using IoT and cloud technologies, traditional manufacturing products that are used by consumers will begin to interact with their customers using some form of smart home interface or digital assistant to create superadditive value.**

In the software industry customer interaction through digital platforms emerged as early as in the 1990s; Microsoft's Windows interactions with Word, Excel, and Internet Explorer provide the some of the best known examples. In contrast, technological limitations and the nature of customers' use of manufacturing equipment have limited interactions on digital platforms in traditional manufacturing companies. Large amounts of data produced at customer sites, limited connectivity of machines and devices involved in manufacturing, and the wide range of customized on-premises software made it difficult to provide a basis for a digital platform. The IoT and cloud technologies are enabling extensible platform cores in manufacturing, since these technologies provide a high degree of connectivity, standardized communication protocols, real-time analyses of large amounts of data and the availability of cloud platform development frameworks such as Cumulocity[1] or Cloud Foundry[2], became easier to implement.

***H2:* Existing platform operators already serve individuals and have an inherent advantage that will be difficult for new stand-alone platforms to match.**

The superadditivity of platforms that already control users' music, or already have access to smartphone data on appointments, contacts, and activities will limit the attractiveness of any new standalone platforms that traditional manufacturing firms may attempt to develop. Traditional manufacturers do have products that can be enhanced by digital services to create further value. Be it cars, production equipment, agricultural machinery, or medical devices, digital services that interact with these products can add value such as real-time information on the status of a machine or the quality of the outcome. But if these services are offered on standalone platforms that compete with those of giant platform operators, it will be difficult to attract users. Users are far more likely to use existing platforms to interact with the products from traditional manufacturers.

***H3:* New platforms that do not depend on data from smartphones or other sources controlled by existing platforms have a greater chance of success.**

If traditional manufacturers are in control of the data needed on their platform to create superadditive value, they can establish a standalone platform. But if their platform only achieves

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[1] Cumulocity is an IoT platform considered as a leading device management and application enablement platform in Germany. It was initially spun-off from Nokia Siemens Networks and is now a part of German software vendor Software AG. ("Cumulocity IoT recognized as IoT platform leader, launches new release," 2018).

[2] Cloud Foundry is an open source cloud application platform developed by the Cloud Foundry Foundation. The foundation is supported by major IT companies such as Cisco, Google, IBM, Microsoft, Pivotal, SAP, and SUSE and aims at establishing Cloud Foundry as the standard for platform-as-a-service offerings (Cloud Foundry Foundation, 2018).

superadditive value creation when data from sources controlled by other platforms is available, operators of these competing platforms can harvest the superadditive value while manufacturers are degraded to a supplier of equipment. These competing platform operators could grant or deny access to these data sources or charge for it once the traditional manufacturers are dependent on the data.

H4: **A traditional manufacturer's new platform that can combine resources, data, or apps from numerous sources has a greater chance of success than would separate platforms created by each of the resource owners.**

The markets of traditional manufacturers are often fragmented and their products are used together with products from other manufacturers. A platform that is jointly created by several manufacturers has access to more relevant data sources and can cover more uses cases of the customers, increasing the attractiveness of the platform for customers.

H5: **As smart assistants interact with smart appliances over the internet of things, it will become increasingly important even for traditional companies to have interactive customer-facing apps to control and interact with their devices. Companies that cannot control the data that their platforms require cannot retain a share of the superadditive value their platforms create for their customers.**

Those companies that lose control over their interfaces will increasingly be marginalized and subject to control by giant platform operators, irrespective of the quality and reputation of their traditional products. If customers already use an interface by a different platform operator, they might expect to also use this interface for interacting with the traditional manufacturer's products. For example, many individual consumers use their smartphone as their "control my life" interface to manage their schedule, their contacts, their activities, their photos, and much more. Every additional interface has the challenge to compete against this already established interfaces.

In the following sections we *explore* our hypotheses through our experiences with two platforms created and operated by traditional manufacturing groups in Germany. We do not *test* the hypotheses in any formal sense; clearly, we cannot test five hypotheses with a sample set of two companies. But we do find plausible for support for our hypotheses, and for our model of platform envelopment strategies.

5 A Digital Platform Ecosystem for Mobility Services

The automotive industry is preparing for a profound change in consumer behavior. Customers are shifting away from the car as a status symbol, and towards the car as a source of mobility services. This shifts manufacturers away from satisfying *pride in ownership,* and towards providing mobility services. This shift, from owning a car to consuming mobility as a service (Botsman, 2015; Kessler & Buck, 2017), will profoundly affect consumers purchasing decisions, and their tradeoffs among owning a car, using rental services like ZipCar, and using mobility services booked online, like Uber. It is expected that in the future, when consumers do decide to purchase a car they will base their purchase decisions on a range of services, and that the marketplace will force vehicle manufacturers to provide those services to remain competitive (KPMG, 2017). Users are already constantly online, and the interaction of smart vehicles, mobile internet, and the Internet of things, consumers will expect their mobility services to be fully compatible to their existing digital ecosystems. Indeed, the use case we explored in Appendix A suggests that users will expect that their mobility services will be based upon their existing digital ecosystems and will include the full capabilities of their existing digital ecosystems.

To address these needs, automotive manufacturers are working to create appropriate digital platform ecosystems for their mobility services. It will be crucial for automotive manufacturers to have access to customer data (Häußermann, 2016). A project leader of app platform summarizes:

> "Google strives for the deployment of open source software layers into cars of as many manufacturers as possible. And then, not manufacturer A or B controls anything, but Google. And we don't want to lose this control."

To study the case of automotive manufacturers, we analyzed the platform project of an automotive manufacturer that is currently making the transition to a provider of seamless mobility for their consumers. Given the reputation of the company, the manufacturer wants to provide premium services, even during their preliminary roll-out. We use our experience with this automotive manufacturer to assess how well their platform strategy is predicted by our model.

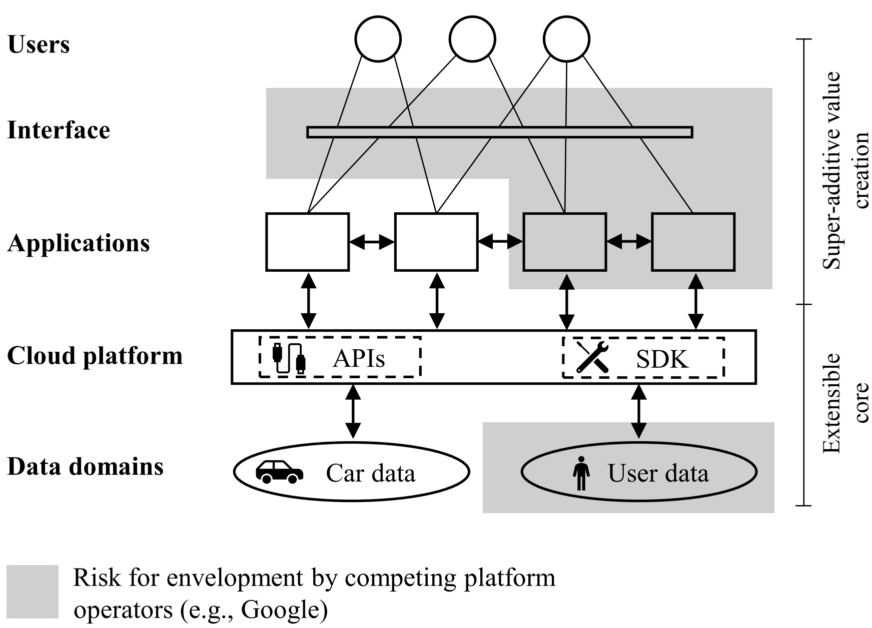

Figure 2: Superadditive value creation in an automotive manufacturer's digital platform ecosystem and the risk for envelopment

The manufacturer started by establishing an extensible core as foundation for a digital platform, as we would have expected. The manufacturer started by consolidating the onboard infotainment system that runs on the head unit with a platform architecture and connected the head units to the Internet. This is a logical place to start. In the absence of a fully functioning Mobile Internet of Things (*MIot)*, and before the availability of autonomous vehicles, most of our use case from Appendix A cannot be implemented; however, informational services like routing based on current traffic conditions and entertainment can both be fully implemented with current technology. Thus, all electronic control units stream data to a central bus which allows the head unit to access this data. While the head unit includes some proprietary services such as navigation and other telematics services, the manufacturer also provides a development environment for third-party applications. The development environment includes a software development kit (SDK) and application programming interfaces (APIs) to access car data. This digital platform project illustrates hypothesis 1 by showing that the automotive manufacturer is enabled by IoT and cloud technologies to create an extensible core for superadditivity in a digital platform ecosystem.

But the manufacturer's platform development entails significant challenges. In particular, existing platform operators already provide individuals with many of the mobility services that the manufacturer seeks to implement. Moreover, platform operators such as Google possess far more information about customers than the manufacturer, including customers' daily schedules, their preferences for stores, restaurants, and many activities, addresses of friends and family, and often even the schedules of their friends and family. This enables Google to provide many of the future mobility services that the manufacturer might seek to develop later (see also Appendix A). This will enable Google to offer services that the manufacturer cannot; this makes it extremely difficult for the manufacturer to establish a stand-alone digital platform ecosystem. The manufacturer has control over the relevant information for only a few, car-specific technical applications, Unfortunately for the manufacturer, this kind of information is losing its importance as customers increasingly assume that their automobiles are in perfect working condition.

Given their control of relevant information domains, giant platform operators are in a better position to create superadditive value than the manufacturer. As importantly, given their control over the information needed to create this value, they are also in a better position to retain some of the value generated by the platform. Teece would view this information as a *co-specialized asset* (1987) and he would argue that in the absence of a perfect market for this asset the owner would be able to retain significant value from any innovations that depended upon it. He might also argue that while the *ideas* that make a platform so valuable cannot easily be protected, Google's control over what can and cannot be placed on an Android platform gives it a stronger *appropriability regime*, further increasing Google's ability to retain value created by their platform,

As we noted in our description of our model, platform operators do not need to benefit directly by charging for the services they provide. Their ability to harvest additional information on users' activities enables them to generate revenue indirectly. Waze shows how Google can leverage detailed routing data for advertisement (Schultz, Wohl, Pasquarelli, & Neff, 2019).

As we would anticipate, the automotive manufacturer has so far had limited success with its standalone digital platform ecosystem. Existing platforms already offer many of the services the manufacturer wants to add to its vehicles, and because manufacturers' platform requires data that competing platform operators such as Google possess. This is consistent with hypotheses 2 and 3, and shows that the automotive manufacturer's platform is vulnerable to a platform envelopment strategy from an existing platforms operator.

A second challenge that arose for the automotive manufacturer was its need to have interactive customer-facing apps to control and interact with their existing smart devices. While cars traditionally had an important customer interface for navigation or radio, many drivers nowadays use their smartphones to navigate or listen to music via Bluetooth. Also, customers use their smartphone outside of the car for various issues of daily mobility such as when to leave given the traffic situation or to identify whether public transportation would be the better option. Evaluating mobility options therefore has become part of customers "control my life" interfaces, typically their smartphones. With cars becoming part of end-to-end mobility processes for consumers, it is no longer sufficient for the manufacturer to just interact with customers through the head unit in the car, but it would need to continuously interact with the customer even when he or she is outside the car. To do so, the manufacturer needs to embrace the existing interfaces, in particular of Apple and Google – but also of Amazon with Alexa when it comes to interaction with the consumer in the smart home. This leads to a loss of control of the customer interface linked to the risk of being marginalized to a hardware provider, consistent with Hypothesis 5.

The manufacturer has no obvious path to creating superadditive value acting alone. As a result, the manufacturer is attempting to cooperate with partners in the hope that collectively they can generate superadditive value that would allow them compete with existing platform operators. On example is a strategic collaboration with another premium automotive manufacturer to provide mobility services beyond those that could be created by a single automotive manufacturer, but it is not clear that this will be sufficient. Collaborations with other players in other product segments such as the smart home could help, especially as a source of additional information and as a source of additional apps for superadditive value creation. Unfortunately, these other platform operators, like Alexa and Siri, may prove to be as powerful and as threatening as Google.

6 A Joint Venture Creating an Industrial IoT platform

The second case we analyzed also covers a manufacturing group but one from a very different industry, the production equipment industry. This is a very important industry in Germany with many world-leading manufacturers, many of them medium-sized companies, so called "hidden champions". With the increasing digitization, customers of production equipment expect more than just high-quality outcome in the production, they also expect that production data will be available from the machines and that this data can be evaluated in real-time. This trend towards smart factories is enabled by Industrial Internet of Things (IIoT), which enables connecting production equipment to the Internet to provide value adding services. Many manufacturers of production equipment have recently integrated additional digital services with their products. While some manufacturers offer standalone digital services for each device, the consensus is that multi-vendor digital platforms that integrate data from numerous machines will create ecosystems that provide superadditive value for the customers.

We analyze the case of a joint venture of several German-based manufacturing companies such as a manufacturer of opto-electronic production equipment (e.g., for scanning manufactured products for quality), a manufacturer of painting plants, and a manufacturer of CNC lathe and milling centers. In addition to the manufacturing companies, a German software companies is part of the consortium to provide its expertise on IoT platforms. The joint venture was founded in 2017 and has since then established a cloud platform for the IIoT (**Error! Reference source not found.**).

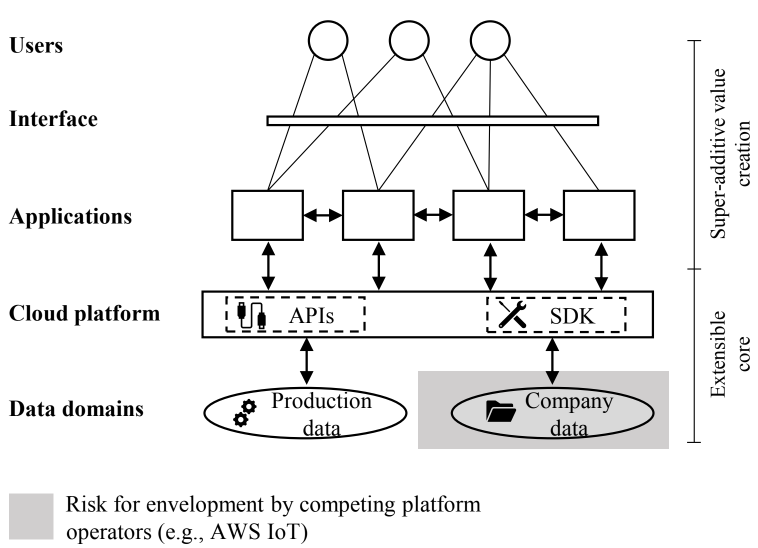

Figure 3: Superadditive value creation in the IIoT platform joint venture's digital platform ecosystem

Consistent with Hypothesis 1, the first step of the joint venture was to launch a digital platform that enables the manufacturers to interact with the customers, the users of the production equipment. The platform therefore included functionality that allowed the manufacturing companies to connect their machines to the Internet and to make machine data available on the platform. In particular, the platform's extensible core includes functionality such as device management, data management, data visualization and analytics, and administration. These functionalities are possible given the high speed of data transfer and the ability to store and analyze large amounts of data in real-time with cloud technologies. With the IIoT platform, the manufacturers avoid creating stand-alone digital services for different products, since these create only limited value. Instead, the machines, together with the platform core, form an extensible core for a digital ecosystem. Based on the extensible core, the IIoT platform enables superadditive value creation. Once customers use machines provided by one of the manufacturers of the joint venture, there is potential for superadditive value each time another machine with additional functionality is acquired.

Furthermore, as more applications become available on the platform, customers also gain superadditive value from interactions among applications. Customers who use machinery from different manufacturers that are involved in the joint venture will benefit more when all machines are integrated in the platform and the respective applications interact. For example, an application that creates a digital workpiece and tracks the productions steps is more useful for customers if it is connected to the different machines that process the product.

To understand whether the IIoT platform joint venture is in a good position to harvest superadditive value, we explore our Hypotheses 2 and 3 on whether competing platform operators already serve users and control relevant data domains. In the industrial domain, so far there are no dominant platforms that control production data and serve users with value adding services. Many machines are not yet connected to a platform and offer standalone user interfaces and relatively simple and unintegrated services such as remote maintenance. The relevant data domain in which an IIoT platform is active usually entails information on production, logistics, and procurement. Customers typically are in control of this information themselves, and this data does not reside on their smart phones or with their personal platform providers. As the IIoT platform is created “by manufacturers for manufacturers”, customers choose to make this information available on the industrial platform.

But the giant platform operators are also trying to gain control in the industrial sector. They already provide infrastructure services in the cloud and have started to offer more and more IoT services (e.g., AWS IoT, Azure IoT). If the customer uses these platforms, the platform operators will gain access to the domain of production information and might become a threat for emerging IIoT platforms such as the one we analyzed. However, these offerings have not yet achieved widespread adoption, creating at least a brief window of opportunity for the joint venture’s IIoT platform.

Illustrating our Hypothesis 4, the case shows that the manufacturing companies benefited from collaborating in a joint venture, bringing together data, services, and resources from different manufacturers. Their customers typically use machines and equipment of different manufacturers. Because the manufacturers focus on specific types of machinery, it is not their goal to replace other manufacturers and become the sole provider of production equipment for the customer. Thus, different manufacturers can cooperate and seek to provide digital services for their customers via digital platforms, without fearing that doing so will undercut their competitive position in the marketplace. If they cooperate to create a joint platform, they can create superadditive value because the applications on the platform can interact with each other. The collaboration also helps to stay in control of the relevant information domain. If enough equipment manufacturers participate, the platform will have information about the whole production process, becoming a very valuable source of information for the customer. It then becomes difficult to replace even if other platform operators enter the market and have slightly better service offerings in other areas.

Illustrating our Hypothesis 5, we argue that the joint venture currently has control over the data that its platform requires. Moreover, we argue that if it can stay in control of the customer interface by providing customer-facing apps on their digital platform, then it will be able to retain its ability to appropriate at least some of the value it creates for its customers. In the industrial domain, it is still common for a production process to have many different interfaces for the different parts of the process. The joint venture offers a more centralized user interface, which becomes more centralized the more of a customer's machines are connected to the IIoT platform.

7 Conclusions: Summary, Contributions, and Discussion of Future Research

7.1 Summary

We used case studies of two traditional German manufacturers to understand how companies likes these can establish digital platforms for superadditive value creation and what challenges they face in attempting to get them widely adopted. We confirm that the advance of IoT and cloud technologies enables traditional manufacturers to interact with their customers and thus to create superadditive value on digital platforms. However, we also observed that it is not always easy for established companies to harvest the superadditive value, since it will be difficult for them to compete with the platform envelopment strategies of existing giant platform operators. Access to relevant information domains and control of the customer interface are crucial factors that would enable traditional manufacturers to benefit from superadditive value creation; unfortunately, in many settings existing platform operators already control both information and customer interfaces.

Joining forces in joint ventures and consortia can sometimes help traditional manufacturers obtain control over relevant information domains and over customer interfaces, in those settings where these forms of control have not already been seized by others. However, if other players already control relevant information domains and customer interfaces, and if they already enjoy a vast suite of apps that create superadditive value fur customers, it will be virtually impossible for traditional manufacturers to harvest the superadditive value.

As our cases show, automotive manufacturers are in a challenging position. Many automotive manufacturers have already conceded defeat, and are seeking to develop their platform strategies based on existing platforms like Android or iOS. In contrast, manufacturers of production equipment face a brief window of opportunity to establish digital platforms to interact with their customers as no dominant platforms have as yet emerged in the industrial Internet of Things and no giant competitors already control the essential data or the customer interfaces.

We conclude that many traditional manufacturers face serious challenges. Platforms will emerge for interacting with their products, but those products are likely to be controlled by existing platform operators. Our model shows the importance of information, and the importance of cooperation with other firms. Traditional firms will need to do more than rethink the way they do business by changing their architecture, their governance structures, and their business models to create superadditive value in platform ecosystems (Parker et al., 2016; Sebastian et al., 2017; Tiwana, 2014). They will also need to choose their partners carefully and to decide on a strategy that allows them to preserve at least some of the value that their platforms create.

7.2 Contributions

We make two contributions to our understanding of digital platforms.

First, our simple model allows us to assess how the revenue model of the platform operators influences their decisions to permit or to limit interoperability, which helps us assess how they will treat traditional manufacturing companies that seek to form partnerships with them. This in turn helps us understand the competitive platform strategies available to these manufacturing firms.

We also contribute to our understanding of platforms by looking at the factors that influence whether their creators can succeed or not, and at the factors that influence the strategies available to manufacturing firms that seek to create new platforms. Most studies on digital platforms have looked at already established, successful platforms (De Reuver, Sørensen, & Basole, 2018). There has not been sufficient study of the emergence of new digital platforms. We not only show the reasons why digital platforms emerge in traditional industries, we also show the challenges that result for traditional companies. Addressing these challenges translates into requirements for platform governance such as deciding with whom to collaborate, what standards to adhere to, or how to distribute decision rights (Tiwana, 2014).

7.3 Limitations

Our study was of qualitative nature. Although we were able to generate insights on platform strategies of traditional manufacturers, our data set was too small to test our hypotheses or to explore the validity of our model. While these insights support our hypotheses, longer-term observation of the cases would enable us to deepen our understanding of how they compete with giant platform operators.

Moreover, our data set entailed only two companies. This is clearly insufficient for hypothesis testing. Nevertheless, we think that our hypotheses can provide guidance for traditional companies across industries and, to a limited extend, in other traditional domains such as healthcare, government, or education.

7.4 Future research

In general, the hypotheses we generated from our case studies need further analysis. A larger study would allow formal hypothesis testing and formal exploration of our model.

Furthermore, we identified three issues for future research that we could not answer within the scope of this study. First, it would be valuable to better understand when what kind of joint venture or consortium is best for a traditional manufacturer's platform strategy, and when no platform strategy can succeed. As we have seen, this is closely related to decisions on whether to create a new digital platform alone, which to create a new digital platform with partners, and when to join an existing platform ecosystem (Clemons, 1989). Second, we realized that the same challenges that European challenges face are also relevant for Asian firms. Future research should study the impact of platform strategies on Asian manufacturers, in particular Chinese manufacturing companies. In China, giant platform operators such as Alibaba also target traditional industries. The context, however, differs given a different political approach to the economic system and a higher speed in changing companies strategies. As Chinese manufacturers have for long been important competitors for European manufacturers such a comparison can be of value for academia and practice. Third, the power that giant platform operators exert over traditional industries might also require regulatory action to protect incumbents. This is complicated for several reasons. First, regulation in this area is poorly understood, and we must first ensure that regulation does no harm. Second, the evolution of platforms is still poorly understood, and we do not yet know which abuses will naturally and automatically be corrected by the marketplace. Finally, it is essential that regulatory policy actually enhance competitiveness and consumer welfare, and not become a new form of industrial protectionism (see also Clemons, Krcmar, et al., 2019).

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Appendix A

Car manufacturer in the era of autonomous vehicles. User owns a BMW and a Mercedes. User has an appointment at a friend's for dinner. User requests that the cars pick up his wife, his daughter, and himself; he leaves the routing and the schedules to the cars, which know family members' locations from their smart phones and coordinates pickups with them by text. Cars know time of dinner from smart phone calendars and know the location of the friend from smart phone contacts list. Vulnerabilities: Will users want to be data mined, in real time? Will users want their cars' histories tracked at all times? Will Google, keeper of the data, continue to share it with the cars' platforms without cost if the cars' platforms do not permit detailed data mining?

Retailer in the era of smart appliances and the internet of things: My smart fridge knows I am having a dinner party and knows what I intend to serve. It knows what I need to order, and it is able to order it. The appliance's interface is based on Alexa. As a result, the appliance orders from Amazon, essentially blocking out the traditional retailer from consideration.