INSTITUTE OF DEVELOPING ECONOMIES

IDE DISCUSSION PAPER No. 714

Value chain governance in the age of platforms

John HUMPHREY*
April 2018

Abstract

Global value chain (GVC) theory focuses globalisation in the late 20th century. While the theory claims to apply generally to interfirm relationships, much of GVC analysis has focused on the incorporation of developing country manufacturers into the supply chains of global lead firms. This literature has frequently expressed doubts about whether integration into such chains offers opportunities for innovation and upgrading. More recently, globalised production has seen the emergence of market and technology platforms and platform leaders. The distinctive feature of platforms is that they require innovation by other companies to turn platforms into products. Analysis of platform governance can contribute to the further development of GVC governance theory. Using secondary material on platform leaders such as Intel and Apple and primary research on Chinese-owned mobile phone companies, the paper shows how examination of governance in the context of platforms allows a recuperation of understudied and undertheorised elements of GVC governance theory.

* School of Business, University of Sussex, Brighton, United Kingdom (humphrey041@gmail.com)

Value chain governance in the age of platforms

John HUMPHREY[*]

Abstract

Global value chain (GVC) theory focuses globalisation in the late 20th century. While the theory claims to apply generally to interfirm relationships, much of GVC analysis has focused on the incorporation of developing country manufacturers into the supply chains of global lead firms. This literature has frequently expressed doubts about whether integration into such chains offers opportunities for innovation and upgrading. More recently, globalised production has seen the emergence of market and technology platforms and platform leaders. The distinctive feature of platforms is that they require innovation by other companies to turn platforms into products. Analysis of platform governance can contribute to the further development of GVC governance theory. Using secondary material on platform leaders such as Intel and Apple and primary research on Chinese-owned mobile phone companies, the paper shows how examination of governance in the context of platforms allows a recuperation of understudied and undertheorised elements of GVC governance theory.

Keywords: global value chains, governance, platforms, platform leadership, standards

JEL Classification Number: D23; F2; L14; L20

---

* School of Business, University of Sussex, Brighton, United Kingdom (humphrey041@gmail.com)

1 Introduction

Global value chain (GVC) analysis arose as an attempt to understand the specificities of globalisation in the latter part of the 20th century. While many theories and writers pointed to the increasing fragmentation of production across national boundaries and the incorporation of developing and emerging economies into global production networks, GVC analysis drew attention to two further characteristics: the outsourcing of manufacturing activities to firms in developing countries and the emergence of branded companies and retailers as new agents in the construction of transnational value chains. Early empirical work on global value chains showed these non-manufacturing global buyers exercised control over their suppliers even in the absence of ownership (Bair and Gereffi, 2001; Dolan and Humphrey, 2000; Gereffi, 1994; Gibbon, 2001; Schmitz, 1995).[1] It was argued that more attention had to be paid to forms of industrial organisation lying between market and hierarchy.

The 2005 paper by Gereffi *et al*. (2005) used the variables of information complexity, codification and supplier capabilities to explain the prevalence of three intermediate forms of governance: modular, relational and captive. It aimed to provide a theory of value chain governance applicable to inter-firm relations in general that could explain the different ways in which outsourced activities might be managed. In spite of the broad ambitions of this theory, subsequent GVC research has tended to focus on relationships between suppliers in developing and emerging countries and global lead firms, mostly located in OECD countries.[2] This work has addressed the issue of whether the incorporation of developing country manufacturers into the supply chains of global lead firms facilitates or constrains the acquisition of knowledge and capabilities by the suppliers. Recent contributions emphasising the way in which value chains constrain the opportunities for developing country suppliers to upgrade include Lee *et al*. (2017) and Pietrobelli and Staritz (2017).

The objective of this paper is to consider how GVC governance theory might explain and be enriched by a consideration of industry platforms. The concept of platform has been used to refer to the business models of companies such as Intel, Microsoft and Cisco (Gawer and Cusumano, 2002), mobile phone operating systems and their associated apps (Grønli *et al*., 2014) and two-sided markets, such as Uber and Airbnb (Hagiu and Wright, 2015; Van Alstyne *et al*., 2016). At first sight, such platforms present a challenge to GVC analysis. First, while the lead firms most often analysed by GVCs generally outsourced manufacturing but kept innovation in-house, platform vendors require and actively promote innovation by complementors.[3] Second, the centrality of global buyers to the GVC perspective leads to an emphasis on how suppliers are managed. Platform governance, on the other hand, is about how platform providers incentivise and control downstream providers of complementary goods and services. Does GVC theory offer a convincing explanation of platform governance,

---

[1] This early literature frequently used the term "global commodity chains", with the switch to global value chains coming in 2001. For discussions of the links between global commodity chain analysis and GVC analysis, see Bair (2005: 161-164) and Sturgeon (2009: 114-117).

[2] More recently there has been work on South-South value chains and lead firms from developing and emerging economies (for example, Kaplinsky and Farooki, 2011).

[3] For example, the value of a mobile phone to its user is substantially enhanced by the apps available for it. Many of these apps are not developed by handset manufacturers.

and to what extent can the literature on platform governance enrich the GVC governance framework?

To answer these questions, this paper draws on the literature on GVC governance, as well as on the author's extensive empirical work on GVC governance and more recent collaborative work on platforms in the Chinese mobile phone industry. The next part of the paper considers both the context in which GVC theory developed and the theoretical underpinnings of the GVC governance framework. Section three focuses on platforms, providing a definition of platforms and the governance challenges that they entail and then considering three examples of platform leadership: the Apple iOS and its apps, Intel's chipset, and baseband IC for mobile phones. Section four concludes by considering the implications of the findings on platform governance for GVC theory. It suggests that that a better understanding of platform governance has the potential to enrich GVC governance theory by drawing attention to elements of the theory that have been either neglected or understated and by contributing to a more general understanding of forms of governance.

2   Globalisation and governance: global value chains

Governance is about the determinants of the boundaries of the firm and the ways in which firms manage their relationships with other firms. Approaches to these issues include hold-up models (Holmström and Roberts, 1998), of which transaction cost economics is one variant, resource-based views and knowledge-based theories of the firm (Grant, 1996; McIvor, 2009), and modularity theory (Baldwin, 2008; Hoetker, 2006). In all these theories, the core challenge is managing interdependence in the context of uncertainty. Interdependence means that the decisions taken by one firm have consequences for other firms. If there is no interdependence (for example, a business sells a standard product to many customers), arm's-length market relationships suffice. If there were no uncertainty about the future, then future contingencies could be specified, and suitable contracts devised to manage interdependencies.

GVC governance theory addresses these issues in the context of late 20th century globalisation, which had two distinctive features at the macro level. The first was the rising share of developing countries, and above all developing Asian economies, in global merchandise trade. The second feature was the increasing fragmentation of international production, expressed in concepts such as "'global supply chains', 'global value chains', 'international production networks', 'vertical specialization', 'offshore outsourcing' and 'production fragmentation'" (WTO, 2013: 78). One indicator of increasing fragmentation is the rising share of intermediate goods in global trade, and much of this trade involves developing and emerging economies. For the electronics industry, seven Asian economies (China, Taiwan, Hong Kong, Singapore, South Korea, Malaysia and the Philippines) accounted for 21.3 percent of world exports of intermediate goods in 1991. By 2008, this figure had risen to 56.5 percent (Sturgeon and Kawakami, 2011: 123) .

Many writers on globalisation have noted these changes. Peter Dicken, for example, contrasts late 20th century globalisation with the pre-1914 period, stating that:

> "International economic integration before 1914…was essentially *shallow integration*, manifested largely through arm's-length trade in goods and services between

independent firms and through international movements of portfolio capital. Today, we live in a in which *deep integration*, organised primarily within the productive networks of transnational corporations (TNCs), is becoming increasingly pervasive" (Dicken, 2003: 10-12, emphasis in original).

This equates the shift from shallow to deep integration with a shift from market to hierarchy (the increasing importance of intra-firm transactions in trade).

Manufacturing and non-manufacturing businesses have been involved in this process. GVC analysis recognises the importance of offshoring by multinational firms, but also points to the combination of offshoring and outsourcing. GVC analysis identified new drivers of globalisation: "large retailers and brand-name companies that buy but don't make the goods they sell" (Gereffi, 1994: 95). These firms did more than just "buy". Appelbaum emphasised increasing integration:

> "Traditionally, manufacturing firms and retailers were relatively independent of one another.... Since the mid-1980s retailers have increasingly brought their suppliers and more *direct control* through 'lean retailing', requiring them to 'implement information technologies for exchanging sales data, adopt standards for product labelling, and use more modern methods of material handling." (Appelbaum, 2008: 70, emphasis added)

Others referred to the increasing role of retailers (and brand-name companies) in designing and commissioning products. This role is expressed in the business literature by terms such as "factoryless goods producing firms" — firms not engaging in manufacturing but concentrating instead on pre-production (design, input sourcing, specification development, etc.) and post-production (marketing, distribution and branding) activities, while continuing to be "*heavily involved* in activities related to the production of goods" (Bernard and Fort, 2015: 518, emphasis added). Buyers may also be concerned about conformance with standards relating to food safety, labour conditions and environmental impact. Such control can be found in the cases of partial outsourcing of activities and also in retailer controls over food supply chains (Dolan and Humphrey, 2000). Bair (2005: 159) refers to big buyers that "call the shots for the many firms involved in the buyer-driven commodity chains they control, although they may have no equity relation to the firms actually producing the goods made on their behalf."

GVC governance theory is concerned with what lies between market and hierarchy. From an international business perspective, Hennart refers to this as the "swollen middle" that lies between pure hierarchy and pure market (Hennart, 1993: 530). Hennart argues that in this "swollen middle", businesses manage relationships using a combination of the price mechanism typical of markets and the behaviour control typical of the firm. One way of characterising this is "control without ownership" (Humphrey and Schmitz, 2008: 262; Sako, 2011: 23). GVC analysis has emphasised the role of lead firms in defining product characteristics and production processes, choosing where to produce, distributing tasks along the chain, influencing the distribution of risks and rewards along the chain, influencing the inclusion and exclusion of suppliers, specifying how product should be produced and checking on compliance with customer requirements (for example, Bair and Palpacuer, 2015: s4; Dolan *et al.*, 1999: 18-21; Ponte and Gibbon, 2005: 3).

Gereffi *et al*. (2005) refer to these activities as "explicit coordination", defined by Clemons and Row as "the extent to which decisions are coordinated between economic activities through processes and information that are specific to the two activities" (1992: 14). In other words, explicit coordination takes place after a decision about supplier selection has been made and refers to coordination taking place directly between one firm and another.

GVC case studies showed that explicit coordination was clearly taking place, but it needed to be explained rather merely observed. Humphrey and Schmitz posed the question "why is chain governance needed?" (Humphrey and Schmitz, 2001: 23), providing two answers, both relating to transaction costs. The first is that lead firms frequently compete on the basis of design and product differentiation, with the result that they require customised products. This not only results in the need to communicate designs and specifications to suppliers, but might also require transaction-specific investments, leading to bilateral monopoly/oligopoly, as suggested by Williamson (1971). This requires governance arrangements. The second explanation refers to the risk of supplier failure in areas such as of quality, response time and delivery.[4] such risks might be expected (at least temporarily) to increase in the new stage of globalisation because of mismatches in the capabilities required in the domestic and export markets. This line of thinking draws on the idea of latecomer firms in the global economy, as discussed by Keesing and Lall (1992) and the perception that these latecomer is face a "technology gap" (Hobday, 1995) and a "marketing gap" (Schmitz, 2007).[5] Managing suppliers in this context means would involve oversight of suppliers and the need for the buyer to have the necessary leverage to influence supplier behaviour. Gereffi *et al*. refer to a strategy by large buyers to lock in suppliers and protect investments in their capabilities: "encouraging the build-up of transactional dependence as lead firms seek to lock in suppliers in order to exclude others from reaping the benefits of their efforts" (2005: 86-87). This is the thinking behind the category of captive governance.

Gereffi *et al*. go beyond this line of reasoning by incorporating Sturgeon's findings on the electronics industry (Sturgeon, 2002). This had four important consequences for the theory of governance. First, Sturgeon drew heavily from knowledge-based theories of the firm and work on modular product architecture and production systems, making a distinction between the costs of transmitting knowledge between firms and the costs of containing opportunism. This distinguishes two types of transaction costs: coordination costs (sometimes referred to as mundane transaction costs) and the transaction risks that arise from the potential for opportunism (Clemons and Row, 1992: 11). Second, Sturgeon highlighted how both costs were low in the electronics industry. Mundane transactions costs remain low because, "In the modular network, supplier firms take a 'full-service' stance toward their customers, providing turn-key services that require very little support or input—beyond design specifications— from customer firms" (Sturgeon, 2002: 483). Equally, contract manufacturers do not need to make transaction specific investments in equipment: "Because the new equipment is highly flexible and relatively standardised it can effectively be shared across the supplier's customer

---

[4] Issues relating to supplier performance in the area of compliance with labour and environmental standards could be added to this list, and much work has been carried out on this topic (for example, Barrientos *et al.*, 2011; Nadvi, 2008)

[5] Over time, developing country producers should close these gaps, although they may be recreated by the search for new, low-cost production locations and evolving buyer requirements.

base" (Sturgeon, 2002: 470). As a result, electronics firms can outsource assembly to contract manufacturers without having to develop specialised governance arrangements.

Third, the key factors driving this reduction in both types of transaction costs are the processes of codification and standardisation associated with the development of modular product architecture. The reduces the need for explicit coordination:

> "In essence, the standardized component interfaces in a modular product architecture provide a form of *embedded coordination* that greatly reduces the need for overt exercise of managerial authority to achieve coordination of development processes, thereby making possible the concurrent and autonomous development of components by *loosely coupled organization structures*." (Sanchez and Mahoney, 1996: 64, stress in original)

Fourth, transaction costs are not fixed — they can be altered by codification strategies that reduce the costs of information sharing and diminish transaction-specific investments. This is often achieved through industry-wide initiatives on standardisation. These arguments are the foundation of the category of modular governance.

Gereffi *et al.* also needed a theory of how businesses would manage relationships when there were low levels of codification and high levels of asset specificity. For this, they introduced the concept of relational governance. Relational governance arises when there is mutual dependence between the parties and high levels of asset specificity. This argument draws on both network theory and Williamson's arguments about opportunism (Williamson, 1983). One obvious reference point for this literature is the analysis of joint ventures between businesses that need to share complex, inimitable and hard-to-develop competences. However, this argument was not fully developed and GHS, and the focus on relational governance has rarely been followed through in subsequent GVC research. In part, this reflects the concern of many GVC scholars with issues of globalisation and opportunities for developing countries.

Finally, Gereffi *et al.* included market and hierarchy in their five categories of governance but provided little explanation about them. Hierarchy was left as a residual category that would arise when complex information, lack of codification and absence of qualified suppliers ruled out outsourcing. Similarly, market governance was described as arising whenever the information required to sustain a transaction was "simple", but there was no discussion about the ways in which information complexity might be reduced (in contrast to the extensive discussion on how to codify complex information).

By combining empirical material drawn from different industrial sectors and drawing on a range of theoretical approaches, Gereffi *et al.* provided a general theory of GVC governance that applies broadly to inter-firm relationships. It will be argued in this paper that the categories of modular and relational governance and the ideas on standards and modularity incorporated into the theory from Sturgeon's work are particularly relevant for the analysis of platform governance. However, it will also be suggested that an understanding of platform governance requires further development of the categories of market and hierarchy that were not analysed in detail by Gereffi *et al*.

This review of the development of GVC governance theory suggests that some elements , and in particular Sturgeon's work on modular governance, could provide a basis for analysing platform governance. Even if much subsequent work on GVCs has emphasised explicit coordination and captive governance, the theory is broader than this. Equally, however, some parts of the GVC governance that might be particularly important for analysing platform governance (notably relational governance) were left relatively under-developed because of both the particular context in which the theory was developed and the specific theoretical and policy interests of GVC researchers. To what extent, then, can the GVC governance theory provide insights into platform governance, and how much can the platform governance literature add to the understanding of GVC governance?

3 Platforms and governance

Increasing discussion about the role of platforms as a distinctive mode of industrial organisation has been stimulated by both the increasing prominence of two-sided and multi-sided platforms such as Uber, mobile phone apps, Airbnb and others (Hagiu, 2007; Hagiu and Wright, 2011), and the technology platforms that are important in the computer industry, such as the Intel chipset. The analysis of platforms has involved different theoretical approaches and definitions. According to Tiwana *et al.* (2010: 675):

> "The notion of platforms refers to disparate things in marketing (product lines), software engineering (software families), economics (products and services that bring together groups of users in two-sided networks (Eisenmann *et al.*, 2006)), information systems (infrastructural investments (Fichman, 2004)), and industrial organization (forming systems (Katz and Shapiro, 1994))."

Gawer argues that the "engineering design perspective" views platforms as "modular *technological architectures*", while economic theory sees platforms as "types of *market*" (Gawer, 2014: 1239, stress in original). Negoro and Ajiro make a similar distinction (2012: 10). One common features of all of these approaches is that the platform has no value until it is linked with other components, or complements: "Its value is only realised when it is plugged into some kind of broader platform or system that consists of other companies' products, such as operating systems, software applications, software-development tools, and hardware" (Perrons, 2009: 1300). Apps create increased functionality for mobile phones. An Intel chipset is the core of a computer but has no value by itself.

Rather than choosing one definition of platform, this paper considers cases where firms act as platform leaders, which are defined as follows:

> "'Platform leaders'…are organizations that manage to successfully establish their product, service or technology as an industry platform. Platform leaders tend to drive industry-wide innovation in a trajectory that allows them to exert architectural control over the overall system, as well as derive large profits and erect barriers to entry in their own market" (Tee and Gawer, 2009: 219).

In the GVC framework, lead firms also perform some of these functions.

Gawer and Cusumano argue that platform leaders face three fundamental challenges: (1) to maintain the integrity of the platform, (2) to evolve the platform over time (increasing functionality and efficiency), and (3) to maintain the platform's market leadership (Gawer and Cusumano, 2002: 3). Similarly, Tiwana *et al.*, define the key governance challenges for the platform provider as maintaining control over the platform and simultaneously promoting innovation by complementors : "A central governance challenge is that a platform owner must retain sufficient control to ensure the integrity of the platform while relinquishing enough control to encourage innovation by the platform's module developers" (Tiwana*, et al.*, 2010: 679).[6] Tilson *et al.* (2012: 1325) refer to "paradoxes of change and control" to characterise the same challenge. This raises questions about not only the balance between control and innovation, but also the resources used by platform leaders to exercise platform leadership.

The nature of these challenges and how they might be managed is clearly related to the interdependence between platform providers and complementors. If the platform and its complements are fully modular, then the relationship might be managed through market or modular governance, combined with some (possibly contractual) mechanisms to control access to the platform and the nature of the complements. If, in contrast, there is a high degree of interdependence and a need for transaction-specific investments in situations of uncertainty, then relational governance or vertical integration might be more viable options.

The platform literature takes differing views on this issue. Tatsumoto *et al.* argue that a platform creates a "completely modular product", and while the platform itself has an integral architecture, it is partitioned from the complements required to turn the platform into final products (Tatsumoto *et al.*, 2009: 350-351). Hence, the amount of coordination required between the platform provider and complementors will be low. Baldwin and Woodard take a similar position, stating that platforms combine stable core elements that have low variability but a high level of reusability in different products with peripheral elements that have high variability and can evolve rapidly (2009: 7). Rapid evolution is possible because of the low interdependency of platform and complements.

In contrast, Gawer and Henderson suggest a much higher degree of interdependence:

> "Following Gawer and Cusumano (2002) we define a product as a 'platform' when it is one component or subsystem of an evolving technological system, when it is strongly functionally interdependent with most of the other components of this system, and when end user demand is for the overall system, so that there is no demand for components when they are isolated from the overall system." (Gawer and Henderson, 2014: 4)

These three features — "an evolving technological system", strong functional independence with other parts of the system and the need for complements — taken together pose big challenges for platform governance. First, platforms evolve. If they were part of a system

---

[6] It should be noted that firms that exercise platform leadership and face the core challenges outlined in this paragraph may also face governance challenges of the type described in the GVC literature. Intel, for example, has to manage relationships with suppliers of components, as described by Perrons (2009), while the issues arising in Apple's relationship with its largest contract manufacturer, Foxconn (see, Chan *et al.*, 2013; Locke *et al.*, 2013), would be familiar to GVC researchers.

whose core technology and interfaces were relatively static, then governance challenges would be greatly simplified. Over time transactions would be routinised, made more predictable and become easier to manage, as discussed by Langlois (1992: 104-105). Second, the interdependence between platform and complements means that platform evolution has consequences for the development of complements. The fact that complements exist is not unusual: "Many products have little or no value in isolation, but generate value when combined with others" (Katz and Shapiro, 1994: 93). A car needs fuel and roads, and products may require new complements to be developed, but the interdependencies are not necessarily difficult to handle. One example is the introduction of vinyl long-playing records, analysed by Langlois and Robertson (1992: 303-305). The technology for making 33 rpm vinyl recordings was developed by Columbia. The recordings required a complement — the turntable. Columbia licensed its technology to at least one hardware manufacturer, as well as licensing the technology to other recording companies in order to make more recordings available to consumers. However, this was a "start-up" problem for Columbia. The technology, once established, did not require successive, coordinated changes. It follows that the governance challenges for platforms will vary according to the rate of change in different platforms, the extent to which this has consequences for complementors, and the nature of these consequences — and in particular the extent to which platform evolution requires new, transaction-specific investments by complementors.

The nature and range of governance challenges for platform providers can be illustrated by taking three examples of challenges that particular businesses have encountered. These are Apple's strategy for developing the providers of apps for its iOS operating system, Intel's strategy for platform leadership, and the role of providers of baseband IC chipsets for mobile phones in the Chinese domestic market. Prior to these examples, the section provides a more detailed discussion of governance challenges for platforms.

3.1   Platform governance: Apple and third-party developers

One highly visible form of platform development and associated complementors is the growth of application software provided by third parties for mobile phone operating systems. Apple's iOS and its App Store and Google's Play Store for the Android OS are examples. In both cases many thousands of applications were developed in the short space of time by a large number of providers. The first Apple 2G iPhone was announced in January 2007 and started shipping at the end of June that year. There were 65,000 applications available for the iPhone in June 2009, and 185,000 in March 2010 (Ghazawneh and Henfridsson, 2013: 184-191). Not surprisingly, the authors suggest that "Third-party development tends to be governed by arms-length, contractually oriented relationships" (2013: 174). How then does the Apple platform meet the three governance challenges outlined above: platform evolution, platform integrity, and market leadership?

The platform evolution challenge is fundamentally one of incentivising complementors. One way of addressing this problem is to reduce the costs of entry into the complementor market. This can be achieved through the provision of "boundary resources". For software complementors, such resources include supplier development kits (SDKs) and application

programming interfaces (APIs),[7] roadmaps to provide information about future developments and free or low-cost licensing of some intellectual property. These provisions not only stimulate the entry of complementors — ensuring the availability of complementary assets and promoting competition among complementors — but they also contribute to the uniformity of the complements and common approaches and understandings across the many different firms supplying them.

Various mechanisms are used to address the platform control challenges. Apple exercises tight control over the development and sale of apps. Complementors are vetted so that only approved companies can access the platform. Apps can only be marketed and sold through the App Store, and all apps have to go through the Apple Store review process (Hein *et al.*, 2016: 6-8). This process controls the quality and functionality of apps placed on the platform, as well as securing the iPhone "from potential viruses, malware, and privacy attacks" (Ghazawneh and Henfridsson, 2010: 7).[8]

These mechanisms aimed to ensure compliance with the rules created by Apple, but the company has a further control mechanisms. In particular, it can vary the extent to which it opens up functionalities for use by app creators. Changes in the availability of different functions for use by app creators and the interaction between Apple and app creators have been described in detail by Ghazawneh and Henfridsson. Major changes were made in 2010:

> "The most significant features of this [2010] release were: multitasking, folders, enhanced mail, iBooks, enterprise features, game center and iAd. These features were responses third-party developer requests. Multitasking for instance, was supported by seven services that could give developers the ability to add various multitasking types to their applications" (Ghazawneh and Henfridsson, 2010: 11).

The more that development opportunities are provided to complementors, the more it is likely that controls are also introduced in parallel to ensure that the platform provider maintains overall control of the platform. At various points in the development of the iPhone after 2008 Apple changed its restrictions on software developers. Once again, Ghazawneh and Henfridsson describe this process, referring, for example, to the requirement for non-disclosure agreements placed on app developers in 2008-9 (2010: 9-10).[9]

The third governance challenge is maintaining platform leadership. The platform provider has decision rights over the availability of functionalities, and this can be used to ensure that the platform leadership is not undermined. One clear example of this is Adobe's flash. Once Adobe had developed a way of turning "Flash applications into iPhone applications automatically" (Ghazawneh and Henfridsson, 2011: 12), Apple prohibited its use on the platform. Apple and

---

[7] According to Wikipedia, an API is "a set of subroutine definitions, protocols, and tools for building application software. In general terms, it is a set of clearly defined methods of communication between various software components. A good API makes it easier to develop a computer program by providing all the building blocks, which are then put together by the programmer. " Source: https://en.wikipedia.org/wiki/Application_programming_interface.

[8] Similar types of controls are widely used by games platforms (Schilling, 2009: 197-198). For a discussion of how owners of multi-sided platforms regulate them, see Boudreau and Hagiu (2009).

[9] The issue of nondisclosure agreements is also discussed by Tilson *et al.* (2012: 1327-1328).

Google had both developed platform-specific APIs, and maintaining the specificity of platforms was part of the overall strategy of protecting the platform and maintaining leadership in the hands of the operating system companies (Grønli, *et al.*, 2014: 636).

The relationship between Apple and hundreds of thousands of app developers can be characterised as "market" or "arm's-length". While apps are reviewed and controlled, there is no commitment by Apple to any of these complementors. Apple does not provide complementor-specific resources and does not take ownership of the apps made by them. There is little or no explicit coordination. Nevertheless, this is a market with a monopoly buyer that is able to exercise supervision over complementors through contractual obligations and conditions for access to the platform. It is not the market of standard products with many buyers and sellers as described by Gereffi *et al.* (2005: 80).

3.2   Intel and platform leadership

The development of platform leadership frequently involves a change in product architecture that is accompanied by a change in the division of labour between enterprises — what the GVC approach refers to as bundling and splitting (or unbundling) of activities (Humphrey, 2008: 75). Intel is a case in point. Prior to the introduction of the Pentium processor and the chipset developed around it in 1993, Intel produced CPUs (central processing units, or processors). The CPUs had to be matched with DRAM, I/O bus and IDE controllers made by other companies, and compatibility problems that delayed the introduction of new products frequently arose Intel was being challenged by other processor manufacturers, and it wanted to maintain competitive advantage by bringing new products to market more quickly and increasing its scale (Tatsumoto, *et al.*, 2009: 354-355). Intel address this problem in its first Pentium processor by integrating the CPU with and controllers in a single chipset. This resolved the coordination problems and allowed Intel to create standardised interfaces between the chipset and the rest of the computer: "the PCI and chipset designs introduced to local modular architecture into this part of the PC that decoupled Intel's zone of innovation from the rest of the computer" (Gawer and Cusumano, 2002: 31).

In spite of this modularity, Intel still had to manage interdependencies. One set of interdependencies related to the companies that turn platforms into functioning PCs. Intel collaborated with these companies through the development of "Strategic Interest Groups" that brought together industry leaders to agree on new standards, such as USB. In the case of the PCI bus, the Strategic Interest Group consisted of Intel, DEC, Compaq, IBM and NCR (Gawer and Cusumano, 2002: 47-53). At the same time, Intel's market strategy was to keep ahead of its competitors by developing increasingly powerful processors, and it needed to promote new uses for this power, as described by Gawer and Cusumano:

> "By driving or 'orchestrating' innovation activities at other firms that complemented Intel microprocessors, IAL [Intel Architecture Lab] engineers tried to create new uses for PCs and thus generate demand for new computers — most of which would probably use Intel microprocessors" (Gawer and Cusumano, 2002: 25).

Intel could not do this on its own. It needed complementors to provide a stream of new products requiring increased processor power in order to use the faster processors. This

required broader stimulation of innovation within the industry, which posed risks for the complementors. Complements, such as graphics cards, that worked with the new chipsets and interfaces, would have to be available at the time of Intel's new product launches, requiring complementors to make upfront, product-specific investments with no certainty about future success. The risks are described by Perrons:

> "By playing a role in designing a highly integrated technology platform, complementors frequently expose themselves to a relatively high degree of risk. First, the platform leader might fail to support the technology platform in a way that is profitable to all of the collaborating firms, and the supplier might find itself trapped with sizeable R&D investments that are too specific to apply to any other customer or technology….Second, fellow complementors must necessarily share highly proprietary design information so that there component or subsystem can be successfully integrated with others by the platform leader" (Perrons, 2009: 1301).

Intel lessened these risks partly by the provision of boundary resources (roadmaps, non-proprietary interfaces, industry standards, etc.) that enable businesses to develop new software and hardware that took advantage of increased processor power. In the case of the PCI bus, Intel facilitated its adoption by making the specification of the PCI freely available.[10]

Alongside this stimulation of innovation, Intel also protected its platform leadership. While some intellectual property was made available to complementors freely or at low cost, the position of platform leaders has been protected by hiding other elements of intellectual property. According to Gawer and Cusumano, example, Intel "jealously guarded the internal architecture of its microprocessors" even though it shared specifications on interfaces (2002: 252-253).

A further way of protecting the platform is through what Jacobides *et al*. (2006) refer to as "architectural manipulation". They define industry architectures as "templates that emerge in a sector and circumscribe the division of labour among a set of co-specialised firms" (2006: 1201), adding that architectural manipulation means "managing the industry's architecture carefully so that they become the 'bottlenecks' of their industry" (2006: 1208). Referring specifically to the cases of Microsoft and Intel, they suggest that:

> "What Intel and Microsoft have done…is to shape the architecture of the PC sector. Through a judicious use of standards, they *facilitate* entry and competition in the complementary assets (anything but their core activities), *without* participating actively in these parts of the value adding process. So the success of Intel and Microsoft can partly be attributed to the creation of *convenient rules of the game* that ensure they will end up with the lion's share of the benefits although their activities have been joined with many other parties" (Jacobides*, et al.,* 2006: 1209, stress in original).

In other words, there is a lot of shaping of the industry and determination what other firms can do without any need to engage in explicit coordination of the sort described in the GVC

---

[10] For the subsequent development of the USB interface, Intel made the intellectual property available without royalties, and only asked for companies to agree to make any related product IP equally open to the industry (Gawer and Cusumano, 2002: 51-52).

governance literature. As well as market power, lead firms use the development of industry standards to reinforce their position.

3.3 Mobile phones

Platforms are central to the mobile phone industry. Thun and Sturgeon refer to mobile phones as having a "nested platform structure" that integrates platforms provided by companies such as ARM, Qualcomm and Google (2017: 30 and 43). Mobile phones are complex products, but it is possible to simplify the interfaces between platform providers and handset manufacturers. The strategy of the Taiwanese fabless chip design company, MediaTek (MTK), shows how this can be done.

MTK developed integrated chips that proved very successful in the fields of optical disc drives, digital televisions and mobile phones (Kawakami, 2016). Its strategy for market penetration has generally focused on serving the needs of less technically competent manufacturers and lower-income markets that are underserved by global leaders. In the era of 2G mobile phones, MTK transformed the industry in China by developing a "system on a chip" that bundled many hardware and software functions into a single chip. The result was "a complete turn-key solution: a domestic handset firm could purchase an MTK solution and extensively customise the user interface and functionality, or it could use the basic interface and essentially slap on a casing." (Brandt and Thun, 2011: 166). MTK facilitated the adoption of this product by providing boundary resources (Ghazawneh and Henfridsson, 2010), such as reference designs[11] for printed circuit boards, bills of materials, roadmaps and a licensing policy that facilitated take-up by small firms (Ding and Pan, 2014; Yasumoto and Shiu, 2007). In this way, it was possible for MTK to use arm's-length market relations with these firms.

Ease-of-use came at a cost. First, the bundling of so much of the hardware and software into a ready-made, black box solution limited the scope for innovation by handset manufacturers and their component suppliers. Second, the "turn-key solution" referred to above required some prior problem solving, which meant that companies only gained access to the product sometime after it was first introduced to the market. As is noted by Yasumoto and Shiu (2007), MTK did engage in problem-solving with selected handset manufacturers. These would be larger companies with greater technical skills that would be given advanced access to new products and engage in problem-solving.

Imai and Shiu, focusing specifically on relationships between platform providers and handset manufacturers, highlight tacit knowledge and problem-solving, arguing that:

> "when technology platforms with new technologies and functions were adopted in the initial phase of third-generation (3G) handset development, this link in the value chain was essentially decodified, driving close collaboration between technology platform vendors and firms that develop handsets." (Imai and Shiu, 2007: 47)

---

[11] A reference design ss "a generic design for a complete system…that often includes a menu of features that can be customized according to the wishes of the client, or…can give some guidance to the client's engineers as they develop their own system" (Dedrick *et al.*, 2008: 13).

The importance of these relationships increased when smart phones and 3G and 4G mobile technologies were introduced in the Chinese market. Chinese companies competing against Apple and Samsung in the smart phone market from 2010 onwards increasingly looked to product differentiation rather than low price as a means of gaining market share. In part, this was the result of the changing profile of Chinese consumers, who became more willing to pay for premium products (Atsmon and Magni, 2016) and improved functionality — particularly if it could be provided at a price lower than that set by the global market leaders.

Competing on the basis of product differentiation meant a re-structuring of relationships between Chinese handset manufacturers and baseband IC providers. According to Yasumoto and Shiu (2007: 38), it is "difficult to develop a novel technology platform into a distinctive product design without inter-firm collaborations between the concerned technology platform vendor and product developer(s)." This is because there will be unknown and unexpected interactions between the different parts of the product once they are placed into a working system. Therefore, as the Chinese firms began to compete on features and innovation, increased collaboration in problem-solving between handset manufacturers and chipset providers by Ding and Hioki (2017) revealed extensive interactions between platform providers and handset manufacturers. As well as regular, structured interactions between the two parties — often taking place on a daily basis at the level of engineers, and less frequently between senior management — "emergencies" might lead to the mobilisation of 30-40 engineers from the platform provider to solve problems. Such interactions might involve multiple companies. For example, the development of flash charging for phones by the Chinese company, OPPO required extensive interactions between OPPO, the baseband chipset provider, Qualcomm, and the power chip provider, Texas Instruments (Ding and Hioki, 2017). Furthermore, handset manufacturers, platform providers and component companies would also exchange ideas about market trends and the features required in the next round of technology. With such a rapidly changing industry, the need for the exchange of tacit knowledge and the coordination of activities across firm boundaries becomes a permanent feature of the industry and requires arrangements more typical of relational governance. Such examples point to the breakdown of modularity and the need for governance mechanisms to manage interdependence.

4   Discussion and conclusions

The cases of platform governance analysed in this paper show clear differences to many of the cases analysed by Gereffi *et al*. (2005). The most striking differences relate to the characteristics of market governance, the capacity of platform leaders to shape markets without engaging in transactions with many of the other players, and the importance of platform leadership. First, it is clear from the platform governance literature, that arm's-length market relations are widespread, but the characteristics are not those described by Gereffi *et al*. Platform leaders may choose to use their market power (access to the platform) to regulate the activities of complementors, in terms of both checking the suitability of apps designed for the platform and in the functionalities available to platform providers. Platform leaders possess a lot of resources derived from the fact that they own the platform. Ownership and the rights it gives to determine the platform architecture is decisive in both setting out the design of the product (allocation of functions to modules, interfaces, design rules, etc.) and defining the opportunities available to complements. More generally, in cases where product

characteristics are well-established and design rules restrict the potential for downstream innovation to lead to changes outside of the module, arm's-length market relations will suffice, and boundary resources provide further support for such relationships. This implies that more theorisation of "market" is required in GVC governance theory. It is well known that markets operate in a complex environment of formal and informal rules and norms and more work needs to be done on how these facilitate market relationships.

Second, the analysis of platform governance highlights the way in which platform leaders can shape the options open to complementors without engaging in explicit coordination. In many cases, the platform leaders do not engage in transactions with the complementors. This is seen most clearly in the case of Intel, where Intel does not purchase downstream complements itself. Without engaging in transactions with complementors, the platform leader is able to restrict or open up the options available to the complementors through the use of both sponsored standards, "where one or more sponsoring entities holding a direct or indirect proprietary interest…creates inducements for other firms to adopt particular sets of technical specifications" (David and Greenstein, 1990: 4), and agreed standards developed by standards writing organisations such as the IEEE. More generally, the analysis shows the importance of architectural manipulation as a means of shaping value chains and capturing value.

Third, platform leadership emerges as selective strategy in the platform literature. From the GVC perspective, the ability of lead firms to lead is recognised, but not theorised. Within the GVC literature, the ability of lead firms to lead is attributed to their size, their particular capabilities (for example, design) and their market strengths (in particular, the possession of brands). This literature does not, however, make explicit the strategies that lead firms use to create and reinforce their leadership. In part, this may reflect the general tendency of GVC theory is to emphasise structure rather than strategy and agency in its analysis of value chains. The platform literature provides pointers to how this question might be better considered within GVC theory. In particular, the platform literature shows that the governance strategies of platform leaders are determined not only by the search for efficiency, but also by the pursuit of continued platform leadership.

The cases analysed in the platform governance literature are clearly different to those that inspired the GVC approach. One indication of this is the absence of captive governance being used to manage platform-complementor relationships. In part, this is because of the absence of transactional dependence between platform providers and complementors. Equally, there may be enough competent complementors to meet the needs of platform providers, and any lack of complementors is resolved through the provision of boundary resources that are made available to all interested firms. Nevertheless, the GVC framework does possess the concepts to analyse platform governance, largely as a result of the incorporation of theories of modular design and production. It is able to consider the choices by platform leaders about vertical integration, market governance and relational and modular governance. In particular, the analysis of mobile phones shows how the complexity of turning platforms into products and the unpredictability of interactions between the many different constituent parts may well require relational governance. Some further discussion of platform governance will allow the category of relational governance to be further developed by GVC theory.

References

Appelbaum, R. (2008). 'Giant transnational contractors in East Asia: Emerging trends in global supply chains'. *Competition & Change,* 12(1), 69-87. doi:10.1179/102452908X264539

Atsmon, Y., and Magni, M. (2016). 'Chinese consumers: Revisiting our predictions'. *McKinsey Quarterly,* 2016(4), 71-79. Retrieved from http://www.mckinsey.com/industries/retail/our-insights/chinese-consumers-revisiting-our-predictions

Bair, J. (2005). 'Global capitalism and commodity chains: Looking back, going forward'. *Competition & Change,* 9(2), 153-180. doi:10.1179/102452905X45382

Bair, J., and Gereffi, G. (2001). 'Local clusters in global chains: The causes and consequences of export dynamism in Torreon's blue jeans industry'. *World Development,* 29(11), 1885-1903. doi:10.1016/S0305-750X(01)00075-4

Bair, J., and Palpacuer, F. (2015). 'CSR beyond the corporation: Contested governance in global value chains'. *Global Networks,* 15(Supplement), S1-S19. doi:10.1111/glob.12085

Baldwin, C. (2008). 'Where do transactions come from? Modularity, transactions, and the boundaries of firms'. *Industrial and Corporate Change,* 17(1), 155-195. doi:10.1093/icc/dtm036

Baldwin, C., and Woodard, J. (2009). *The Architecture of Platforms: A Unified View* (Working Paper No. 09-034). Cambridge MA http://www.hbs.edu/faculty/Publication%20Files/09-034_149607b7-2b95-4316-b4b6-1df66dd34e83.pdf

Barrientos, S., Gereffi, G., and Rossi, A. (2011). 'Economic and social upgrading in global production networks: A new paradigms for a changing world'. *International Labour Review,* 150(3-4), 319-340. doi:10.1111/J.1564-913X.2011.00119x

Bernard, A., and Fort, T. (2015). 'Measuring the multinational economy: Factoryless goods producing firms'. *American Economic Review,* 105(5), 518-523. doi:10.1257/aer.p20151044

Boudreau, K., and Hagiu, A. (2009). 'Platform rules: Multi-sided platforms as regulators', in A. Gawer (Ed.), *Platforms, Markets and Innovation* (pp. 163-191). Cheltenham and Northampton: Elgar Publishing.

Brandt, L., and Thun, E. (2011). 'Going mobile in China: Shifting value chains and upgrading in the mobile telecom sector'. *International Journal of Technological Learning, Innovation and Development,* 4(1/2/3), 148-180. doi:10.1504/IJTLID.2011.041903

Chan, J., Pun, N., and Selden, M. (2013). 'The politics of global production: Apple, Foxconn and China's new working class'. *New Technology, Work and Employment,* 28(2), 100-115. doi:10.1111/ntwe.12008

Clemons, E., and Row, M. (1992). 'Information technology and industrial cooperation: The changing economics of coordination and ownership'. *Journal of Management Information Systems,* 9(2), 9-28. doi:10.1080/07421222.1992.11517956

David, P., and Greenstein, S. (1990). 'The economics of compatibility standards: An introduction to recent research'. *Economics of Innovation and New Technology,* 1(1-2), 3-41. doi:10.1080/10438599000000002

Dedrick, J., Kraemer, K., and Linden, G. (2008) *Who Profits from Innovation in Global Value Chains? A Study of the iPod and Notebook PCs*. Paper presented at the Industry Studies Annual Conference, Boston. http://web.mit.edu/is08/pdf/Dedrick_Kraemer_Linden.pdf

Dicken, P. (2003). *Global Shift: Reshaping the Global Economic Map in the 21st Century* (4th ed.), London: Sage Publications.

Ding, K., and Hioki, S. (2017). *A Study of Technology Platform Driven Global Value Chains* (Interim Report for project 'Industrial Organisation in China: Theory Building and Analysis of New Dimensions'). Chiba

Ding, K., and Pan, J. (2014). 'The Shanzhai Cell Phone: Platforms and Small Business Dynamics', in M. Watanabe (Ed.), *The Disintegration of Production: Firm Strategy and Industrial Development in China* (pp. 101-126). Cheltenham: Edward Elgar.

Dolan, C., and Humphrey, J. (2000). 'Governance and trade in fresh vegetables: the impact of UK supermarkets on the African horticulture industry'. *Journal of Development Studies,* 37(2), 147-176. doi:10.1080/713600072

Dolan, C., Humphrey, J., and Harris-Pascal, C. (1999). *Horticulture Commodity Chains: The Impact of the UK Market on the African Fresh Vegetable Industry* (IDS Working Paper No. 96). Brighton https://www.ids.ac.uk/publication/horticulture-commodity-chains-the-impact-on-the-uk-market-of-the-african-fresh-vegetable-industry

Eisenmann, T., Parker, G., and Van Alstyne, M. (2006). 'Strategies for two-sided markets'. *Harvard business review,* 84(10), 92-101.

Fichman, R. (2004). 'Real options and IT platform adoption: Implications for theory and practice'. *Information Systems Research,* 15(2), 132-154. doi:10.1287/isre.1040.0021

Gawer, A. (2014). 'Bridging differing perspectives on technological platforms: Toward an integrative framework'. *Research Policy,* 43(7), 1239-1249. doi:10.1016/j.respol.2014.03.006

Gawer, A., and Cusumano, M. (2002). *Platform Leadership* Boston MA: Harvard Business School Press.

Gawer, A., and Henderson, R. (2014). 'Platform owner entry and innovation in complementary markets: Evidence from Intel'. *Journal of Economics & Management Strategy,* 16(1), 1-34. doi:10.1111/j.1530-9134.2007.00130.x

Gereffi, G. (1994). 'The Organisation of Buyer Driven Global Commodity Chains: How US Retailers Shape Overseas Production Networks', in G. Gereffi & M. Korzeniewicz (Eds.) *Commodity Chains and Global Capitalism* (pp. 95-122). Westport CT: Praeger.

Gereffi, G., Humphrey, J., and Sturgeon, T. (2005). 'The governance of global value chains'. *Review of International Political Economy,* 12(1), 78-104. doi:10.1080/09692290500049805

Ghazawneh, A., and Henfridsson, O. (2010) *Governing Third-Party Development through Platform Boundary Resources.* Paper presented at the International Conference on Information Systems, St Louis MI. http://aisel.aisnet.org/icis2010_submissions/48/

Ghazawneh, A., and Henfridsson, O. (2011) *Micro-Strategizing in Platform Ecosystems: A Multiple Case Study.* Paper presented at the Thirty-second International Conference on Information Systems, Shanghai. https://pdfs.semanticscholar.org/0107/8bf604e025ffd4428629b6ae91b73bf6859e.pdf

Ghazawneh, A., and Henfridsson, O. (2013). 'Balancing platform control and external contribution in third-party development: The boundary resources model'. *Information Systems Journal,* 23(2), 173-192. doi:10.1111/j.1365-2575.2012.00406.x

Gibbon, P. (2001). *At the Cutting Edge: UK Clothing Retailers and Global Sourcing* (CDR Working Paper). Copenhagen

Grant, R. (1996). 'Toward a knowledge-based theory of the firm'. *Strategic Management Journal,* 17(S2), 109-122. doi:10.1002/smj.4250171110

Grønli, T.-M., Hansen, J., Ghinea, G., and Younas, M. (2014) *Mobile Application Platform Heterogeneity: Android vs Windows Phone vs iOS vs Firefox OS.* Paper presented at the IEEE 28th International Conference on Advanced Information Networking and Applications (AINA) Victoria, BC, Canada. paper presented at retrieved from http://ieeexplore.ieee.org/abstract/document/6838724/

Hagiu, A. (2007). 'Merchant or two-sided platform?'. *Review of Network Economics,* 6(2), 115-133. doi:10.2202/1446-9022.1113

Hagiu, A., and Wright, J. (2011). *Multi-Sided Platforms* (Working Paper). Cambridge, MA http://faculty.chicagobooth.edu/workshops/marketing/pdf/MultiSidedPlatformsHagiu.pdf

Hagiu, A., and Wright, J. (2015). 'Multi-sided platforms'. *International Journal of Industrial Organisation,* 43, 162-174. doi:10.1016/j.ijindorg.2015.03.003

Hein, A., Schreieck, M., Wiesche, M., and Krcmar, H. (2016). *Multiple-Case Analysis on Governance Mechanisms of Multi-Sided Platforms*). Munich http://andreas-hein.info/portfolio/MKWI_2016_Paper_Camera_Ready_256.pdf

Hennart, J.-F. (1993). 'Explaining the swollen middle: Why most transactions are a mixture of 'market' and 'hierarchy''. *Organization Science,* 4(4), 529-547.

Hobday, M. (1995). 'East Asian latecomer firms: Learning the technology of electronics'. *World Development,* 23(7), 1171-1193. doi:10.1016/0305-750X(95)00035-B

Hoetker, G. (2006). 'Do modular products lead to modular organisations?'. *Strategic Management Journal,* 27(6), 501-518. doi:10.1002/smj.528

Holmström, B., and Roberts, J. (1998). 'The boundaries of the firm revisited'. *Journal of Economic Perspectives,* 12(4), 73-94.

Humphrey, J. (2008). *Private Standards, Small Farmers and Donor Policy: EUREPGAP in Kenya* (IDS Working Paper). Brighton http://www.ids.ac.uk/files/Wp308.pdf

Humphrey, J., and Schmitz, H. (2001). 'Governance in global value chains'. *IDS Bulletin,* 32(3), 19-29. doi:10.1111/j.1759-5436.2001.mp32003003.x

Humphrey, J., and Schmitz, H. (2008). 'Inter-firm relationships in global value chains: Trends in chain governance and their policy implications'. *International Journal of Technological Learning, Innovation and Development,* 1(3), 258-282. doi:10.1504/IJTLID.2008.019974

Imai, K., and Shiu, J. M. (2007). *A Divergent Path of Industrial Upgrading: Emergence and Evolution of the Mobile Handset Industry in China* (IDE Discussion Paper). Chiba http://ir.ide.go.jp/dspace/bitstream/2344/640/3/ARRIDE_Discussion_No.125_imai.pdf

Jacobides, M., Knudsen, T., and Augier, M. (2006). 'Benefiting from innovation: Value creation, value appropriation and the role of industry architectures'. *Research Policy,* 35(8), 1200-1221. doi:10.1016/j.respol.2006.09.005

Kaplinsky, R., and Farooki, M. (2011). 'What are the implications for global value chains when the market shifts from the north to the south'. *International Journal of Technological Learning, Innovation and Development,* 4(1-3), 13-38. doi:10.1504/IJTLID.2011.041898

Katz, M. L., and Shapiro, C. (1994). 'System competition and network effects'. *Journal of Economic Perspectives,* 8(2), 93-115. doi:10.1257/jep.8.2.93

Kawakami, M. (2016) *The rise of Taiwanese IC firms as industry platform vendors: The Case of MediaTek's and MStar's TV core chip business.* Paper presented at the 52nd Congress of the Business History Society of Japan, Tokyo. paper presented at retrieved from

Keesing, D., and Lall, S. (1992). 'Marketing manufactured exports from developing countries: Learning sequences and public support', in G. Helleiner (Ed.), *Trade Policy, Industrialisation and Development* (pp. 176-193). Oxford: Oxford University Press.

Langlois, R. (1992). 'Transaction-cost economics in real time'. *Industrial and Corporate Change,* 1(1), 99-127. doi:10.1093/icc/1.1.99

Langlois, R., and Robertson, P. (1992). 'Networks and innovation in a modular system: Lessons from the microcomputer and stereo component industries'. *Research Policy,* 21(4), 297-313. doi:10.1016/0048-7333(92)90030-8

Lee, K., Szapiro, M., and Mao, Z. (2017). 'From global value chains (GVC) to innovation systems for local value chains and knowledge creation'. *European Journal of Development Research*doi:10.1057/s41287-017-0111-6

Locke, R., Rissing, B., and Pal, T. (2013). 'Complements or substitutes? Private codes, state regulation and the enforcement of labour standards in global supply chains'. *British Journal of Industrial Relations,* 51(3), 519- 552. doi:10.1111/bjir.12003

McIvor, R. (2009). 'How the transaction cost and resource-based theories of the firm inform outsourcing evaluation'. *Journal of Operations Management,* 27(1), 45-63. doi:10.1016/j.jom.2008.03.004

Nadvi, K. (2008). 'Global standards, global governance and the organisation of global value chains'. *Journal of Economic Geography,* 8(3), 323-343. doi:10.1093/jeg/lbn003

Negoro, T., and Ajiro, S. (2012). *An Outlook of Platform Theory Research in Business Studies* (Waseda Business & Economic Studies). Tokyo https://core.ac.uk/download/pdf/46888432.pdf

Perrons, R. (2009). 'The open kimono: How Intel balances trust and power to maintain platform leadership'. *Research Policy,* 38, 1300-1312. doi:10.1016/j.respol.2009.06.009

Pietrobelli, C., and Staritz, C. (2017). 'Upgrading, interactive learning, and innovation systems in value chain interventions'. *European Journal of Development Research*doi:10.1057/s41287-017-0112-5

Ponte, S., and Gibbon, P. (2005). 'Quality standards, conventions and the governance of global value chains'. *Economy and Society,* 34(1), 1-31. doi:10.1080/0308514042000329315

Sako, M. (2011). 'Technology strategy and management driving power in global supply chains'. *Communications of the ACM,* 54(7), 23-25. doi:10.1145/1965724.1965734

Sanchez, R., and Mahoney, J. (1996). 'Modularity, flexibility, and knowledge management in product and organization design'. *Strategic Management Journal,* 17(Winter Special Issue), 63-76. doi:10.1002/smj.4250171107

Schilling, M. (2009). 'Protecting or diffusing a technology platform: Trade-offs in appropriability, network externalities, and architectural control', in A. Gawer (Ed.), *Platforms, Markets and Innovation* (pp. 192-218). Cheltenham and Northampton: Elgar Publishing.

Schmitz, H. (1995). 'Small shoemakers and Fordist giants: Tale of a supercluster'. *World Development,* 23(1), 9-28. doi:10.1016/0305-750X(94)00110-K

Schmitz, H. (2007). 'Reducing complexity in the industrial policy debate'. *Development policy review,* 25(4), 417-428. doi:10.1111/j.1467-7679.2007.00378.x

Sturgeon, T. (2002). 'Modular production networks: A new American model of industrial organisation'. *Industrial and Corporate Change,* 11(3), 451-495. doi:10.1093/icc/11.3.451

Sturgeon, T. (2009). 'From Commodity Chains to Value Chains: Interdisciplinary Theory Building in an Age of Globalisation', in J. Bair (Ed.), *Frontiers of Commodity Chain Research* (pp. 110-135). Stanford CA: Stanford University Press.

Sturgeon, T., and Kawakami, M. (2011). 'Global value chains in the electronics industry: Characteristics, crisis and upgrading opportunities for firms from developing countries'. *International Journal of Technological Learning, Innovation and Development,* 4(1/2/3), 120-147. doi:10.1504/IJTLID.2011.041902

Tatsumoto, H., Ogawa, K., and Fujimoto, T. (2009). 'The effect of technological platforms on the international division of labour: A case study of Intel's platform business in the PC industry', in A. Gawer (Ed.), *Platforms, Markets and Innovation* (pp. 345-369). Cheltenham and Northampton: Elgar Publishing.

Tee, R., and Gawer, A. (2009). 'Industry architecture as a determinant of successful platform strategies: A case study of the i-mode mobile Internet service'. *European Management Review,* 6(4), 217-232. doi:l0.l057/emr.2009.22

Thun, E., and Sturgeon, T. (2017). *When Global Technology Meets Local Standards: Reassessing the China's Mobile Telecom Policy in the Age of Platform Innovation* (MIT-IPC Working Paper). Cambridge MA https://ipc.mit.edu/sites/default/files/documents/17-001.pdf

Tilson, D., Sorensen, C., and Lyytinen, K. (2012) *Change and Control Paradoxes in Mobile Infrastructure Innovation: The Android and iOS Mobile Operating Systems Cases.* Paper presented at the 45th Hawaii International Conference on System Science, Maui, HI. https://www.researchgate.net/publication/254051398_Change_and_Control_Paradoxes_in_Mobile_Infrastructure_Innovation_The_Android_and_iOS_Mobile_Operating_Systems_Cases

Tiwana, A., Konsynski, B., and Bush, A. (2010). 'Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics'. *Information Systems Research,* 21(4), 675-687. doi:10.1287/isre.1100.0323

Van Alstyne, M., Parker, G., and Choudary, S. P. (2016). 'Pipelines, platforms, and the new rules of strategy: Scale now trumps differentiation'. *Harvard business review*, 54-62.

Williamson, O. (1971). 'The vertical integration of production: Market failure considerations'. *American Economic Review,* 61(2), 112-123. doi:10.1179/102452907X166845

Williamson, O. (1983). 'Credible commitments: Using hostages to support exchange'. *American Economic Review,* 73(4), 519-540.

WTO. (2013). *World Trade Report 2013: Factors Shaping the Future of World Trade*). Geneva https://www.wto.org/english/res_e/publications_e/wtr13_e.htm

Yasumoto, M., and Shiu, J. M. (2007). 'An investigation into collaborative novel technology adoption in vertical disintegration: Interfirm development processes for system integration in the Japanese, Taiwanese and Chinese mobile phone handset industries'. *Annals of Business Administrative Science,* 6, 35-70. doi:10.7880/abas.6.3