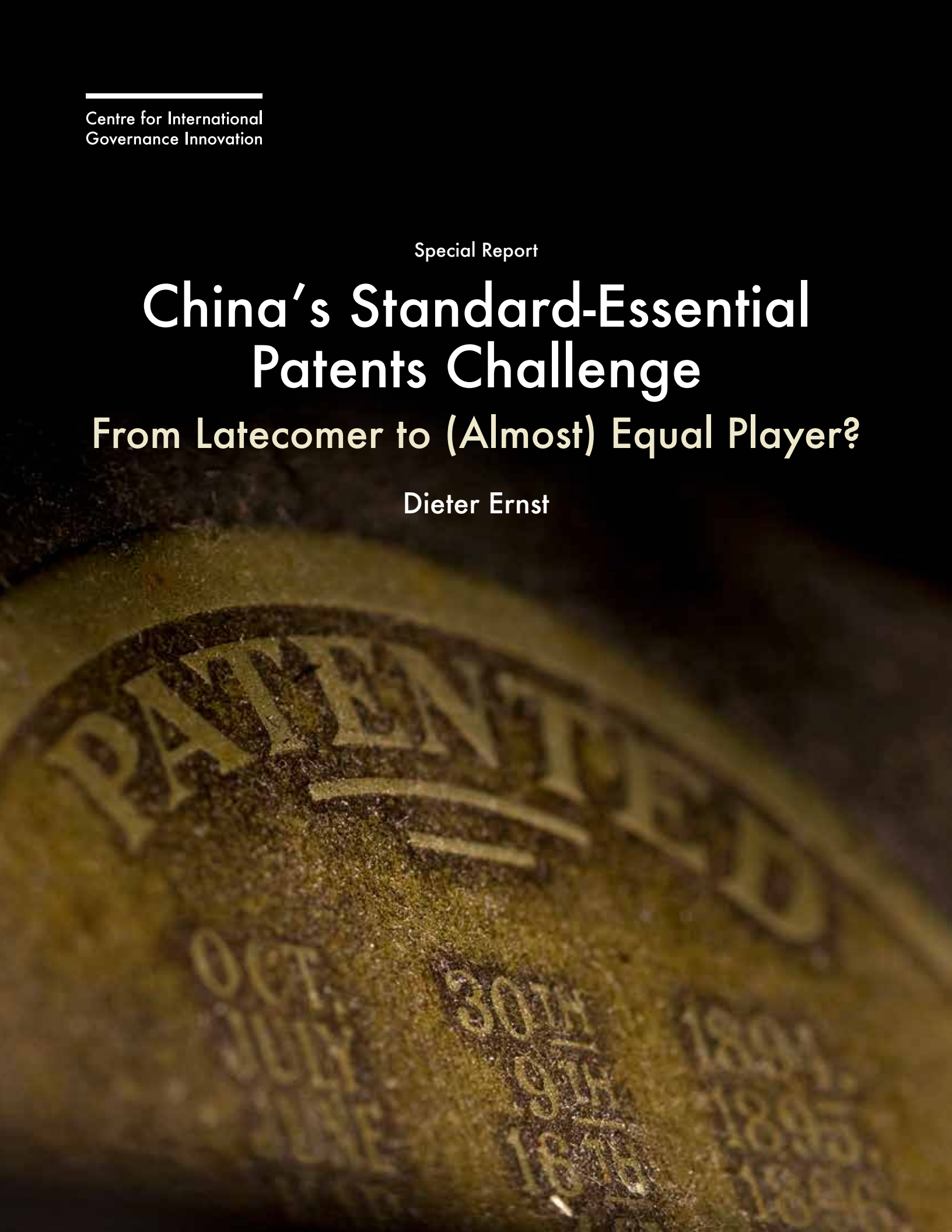
Centre for International
Governance Innovation

Special Report

China's Standard-Essential Patents Challenge

From Latecomer to (Almost) Equal Player?

Dieter Ernst



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About the Author

CIGI Senior Fellow Dieter Ernst joined the Global Economy Program in May 2016 as part of the program's innovation and trade research theme.

At CIGI, Dieter's research explores unresolved challenges for the global governance of trade, intellectual property (IP) and innovation, addressing two issues in particular: finding out what adjustments are needed in the development and use of IP, especially patents and trade secrets, to cope with the requirements of increasingly complex and diverse global corporate networks of production and innovation; and dealing with the effects of the proliferation of strategic patenting behaviour on the organization and governance of these global networks.

Based in Hawaii, Dieter is currently a senior fellow at the East-West Center. He has served as a member of the US National Academies' Committee on Global Approaches to Advanced Computing, as a senior adviser to the Organisation for Economic Co-operation and Development in Paris and as a research director of the Berkeley Roundtable on the International Economy at the University of California, Berkeley.

Previously, Dieter was a professor of international business at the Copenhagen Business School and served as a scientific adviser to governments, private companies and international institutions, including the World Bank, the UN Conference on Trade and Development and the UN Industrial Development Organization.

He holds a Ph.D. in economics from the University of Bremen.

About the Global Economy Program

Addressing limitations in the ways nations tackle shared economic challenges, the Global Economy Program at CIGI strives to inform and guide policy debates through world-leading research and sustained stakeholder engagement.

With experts from academia, national agencies, international institutions and the private sector, the Global Economy Program supports research in the following areas: management of severe sovereign debt crises; central banking and international financial regulation; China's role in the global economy; governance and policies of the Bretton Woods institutions; the Group of Twenty; global, plurilateral and regional trade agreements; and financing sustainable development. Each year, the Global Economy Program hosts, co-hosts and participates in many events worldwide, working with trusted international partners, which allows the program to disseminate policy recommendations to an international audience of policy makers.

Through its research, collaboration and publications, the Global Economy Program informs decision makers, fosters dialogue and debate on policy-relevant ideas and strengthens multilateral responses to the most pressing international governance issues.

Acronyms and Abbreviations

3GPP	3rd Generation Partnership Project
ATIS	Alliance for Telecommunications Industry Solutions
BITs	bilateral investment treaties
CCSA	Canadian Cable Systems Alliance
CDMA	code division multiple access
DoJ	Department of Justice
EPO	European Patent Office
ETSI	European Telecommunications Standards Institute
FDI	foreign direct investment
FRAND	fair, reasonable and non-discriminatory
FTC	Federal Trade Commission
GINs	global innovation networks
GPNs	global production networks
IDC	InterDigital Corporation
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
IP	intellectual property
IPR	intellectual property rights
IT	information technology
ITU	International Telecommunications Union
LOT	License on Transfer
LTE	Long Term Evolution
MEPs	market-essential patents
MOFCOM	Ministry of Commerce
NDRC	National Development and Reform Commission
NPEs	non-practising entities
OECD	Organisation for Economic Co-operation and Development
OMA	Open Mobile Allowance
PCT	Patent Cooperation Treaty
R&D	research and development
SAIC	State Administration for Industry and Commerce
SD	special and differential
SDOs	standards developing organizations
SEPs	standard-essential patents
SIPO	State Intellectual Property Office
SMEs	small and medium-sized enterprises
SOEs	state-owned enterprises
SPFs	sovereign patent funds
SSOs	standard-setting organizations
TPP	Trans-Pacific Partnership
TRIMS	Trade-Related Investment Measures
USPTO	United States Patent and Trademark Office
VITA	VMEBus International Trade Association
WCDMA	wide-band code division multiple access
WFA	Wi-Fi Alliance
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Executive Summary

Efficient licensing of standard-essential patents (SEPs) is crucial for achieving a rapid and broad-based diffusion of innovation. Owners of large SEP portfolios (and their supporters) argue that the governance of SEPs works reasonably well and that patent holdup and other negative effects are "purely theoretical" (Sidak 2008).

In reality, however, the governance of SEPs remains highly inefficient. As an exclusionary property right, patents invite their use as a strategic weapon to shape markets and to reap monopoly rents through patent monetization. SEPs are a particularly effective approach to such strategic patenting. Nobel laureate Jean Tirole as well as Carl Shapiro, Mark Lemley, Josh Lerner and many others have painstakingly documented that the licensing of SEPs is prone to market failures such as externalities (both positive and negative), information problems, market power and free riding, which can hinder the realization of the economic and societal benefits of the affected standards. There is no doubt that SEP-related market imperfections continue to constrain standard implementers both large and small, who are increasingly opposed to this form of "technology taxation."

Most of the existing SEP research has focused on advanced countries, primarily the United States. Yet fundamental changes in the geography of SEP markets give rise to the emergence of new players. It is time to move beyond a US-centric analysis. This report contributes new insights by broadening the geographic coverage of the research. Drawing on decades of research on China's innovation policy in information technology (IT), and on interviews with experts on China's policies on patents and standards, the study sheds light on a gradual process of concentrated geographic dispersion of SEP ownership in the IT industry, and presents indicators of China's ascent. While the United States remains the leading market for SEP licensing, litigation and transactions, China is now beginning to catch up. A handful of large Chinese IT companies are racing to increase their shares of declared SEPs, especially for new generations of mobile communication and networking technologies.

China's rapid growth of industrial manufacturing and exports has benefited from deep integration into global production networks (GPNs) and global innovation networks (GINs). A second novel contribution of the study is to combine insights from research on SEP-related market imperfections and from research on gains from trade through participation in global corporate networks. This unique approach is used to highlight the hierarchical nature of GPNs and GINs, distinguishing network flagships, higher-tier and lower-tier network suppliers. This report argues that participation in these global corporate networks raises new challenges for access to SEPs for lower-tier suppliers based in China, but it also may create new opportunities for China-based network flagships and higher-tier network suppliers.

This report assesses China's efforts to reduce SEP-related market imperfections in the IT industry. Despite major improvements in China's patent system and in its market for SEP licensing, China continues to lag substantially behind the United States, Europe and Japan in terms of SEP ownership, and it still struggles to improve the framework conditions for efficient licensing of SEPs. Based on a brief review of SEP policy benchmarks, the analysis presents China's new approach to SEP-related competition policy.

The report concludes with a brief discussion of three important unresolved policy issues: first, new challenges that Chinese IT firms face from non-practising entities (NPEs, the so-called patent trolls); next, adjustments in patenting strategies that result from the convergence of computer, communications and the Internet; and finally, pervasive uncertainty caused by the threat of trade and investment warfare inherent in the "Trump Trade Doctrine."

Introduction

A major policy issue in standard setting is that patents, by being included in a standard, may become SEPs. A company needs such patents to produce any product that meets the specifications defined in the standard. Patents are "essential" to a standard when it is not possible to comply with the standard without infringing that intellectual property right (Tapia 2009). Therefore, a company can make a standard-compliant product either by owning the SEPs or by licensing SEPs owned by others.

Suppose Chinese company C produces product A (say, a smartphone). Assume further that product A uses a specific standard X, and patent M is essential to the standard X. If patent M is not owned by company C, but by a foreign patent owner, then company C has to negotiate a licence for patent M to avoid infringement.

But the challenge is much bigger. Growing technological complexity implies that standard X requires not one but many SEPs, giving rise to "patent thickets." A smartphone today is typically covered by around 250,000 patents, up from "only" 70,000 in 2000 (Reidenberg et al. 2015). These patents are necessary to access a great variety of technologies — the LCD screen, antennas, Wi-Fi standards, processors, batteries, specific compound materials and so on. As a result, Company C now needs to negotiate licence agreements with leading SEP owners such as, for instance, Qualcomm, a company that dominates the critically important baseband chipset technologies.

Efficient licensing of SEPs is crucial for achieving a rapid and broad-based diffusion of innovation. Owners of large SEP portfolios (and their supporters) argue that the governance of SEPs works reasonably well and that patent holdup and other negative effects are "purely theoretical" (Sidak 2008).[1] In reality, however, the governance of SEPs remains highly inefficient.

SEP-related market failures constitute an important special case of the market failures that result from the exclusionary property rights attached to patents. According to the United States Patent and Trademark Office (USPTO), a patent is a negative right, granted by the US government to an inventor "to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States for a limited time in exchange for public disclosure of the invention when the patent is granted" (USPTO 2017). As an exclusionary property right, patents invite their use as a strategic weapon to shape markets and to reap monopoly rents through patent monetization.[2] SEPs are a particularly effective approach to such strategic patenting (Ernst 2015b).

Nobel laureate Jean Tirole, as well as Carl Shapiro, Mark Lemley, Josh Lerner and many others, has painstakingly documented that the licensing of SEPs is prone to market failures such as externalities (both positive and negative), information problems, market power and free riding, which can hinder the realization of the economic and societal benefits of the affected standards.[3] A rich body of research examines how standardization and hence innovation are fundamentally constrained by multiple sources of uncertainty that result, for instance, from lack of transparency whether an SEP is really essential (RPX 2014), and from lack of clarity of what the so-called fair, reasonable and non-discriminatory (FRAND) licensing conditions really mean (Contreras 2015b). SEP-related market failures also result from a variety of market-distorting patenting strategies, such as patent

1 During a 2016 conference organized by David Teece at the University of California, Berkeley, participants denied the existence of patent thickets and patent holdup and argued that SEP licensing policies have shifted too much in favour of implementers (Antitrust, Standard Essential Patents, and the Fallacy of the Anticommons Tragedy: Legal, and Industrial Policy Concerns conference co-hosted by Tusher Center for the Management of Intellectual Capital and Berkeley Technology Law Journal, October 29, 2016. http://businessinnovation.berkeley.edu/intellectual-capital/antitrust-october-2016/.

2 According to Michael Noel and Mark Schankerman (2006), "Strategic patenting is widely believed to raise the costs of innovating, especially in industries characterised by cumulative innovation." See also Galasso and Schankerman (2014); Feldman and Lemley (2015).

3 See Jean Tirole's Nobel Prize Lecture "Market Failures and Public Policy" (Tirole 2014), which argues that "competition is rarely perfect, markets fail, and market power – the firms' ability to raise price substantially above cost or to offer low quality – must be kept in check, highlighting SEPs as a prominent example. Pioneering contributions include Lerner and Tirole (2015), Shapiro (2001), Lemley (2002), Lemley and Shapiro (2007), Farrell et al. (2007).

ambush or holdup[4] and royalty stacking,[5] and from the increasing role that NPEs (the so-called patent trolls) and patent consolidators, are now playing as SEP licensors. There is no doubt that SEP-related market imperfections continue to constrain standard implementers both large and small, who are increasingly opposed to this form of "technology taxation," to quote Carl Cargill (2016), one of the pioneers in this discussion.

Most of the existing literature on SEPs has focused on advanced countries, primarily the United States. However, current changes in the geography of SEP markets give rise to the emergence of new players that signal the transition away from US dominance to a multipolar market for SEPs. It is time to move beyond a US-centric analysis. This report contributes new insights by broadening the geographic coverage of the research. Drawing on decades of research on China's innovation policy in information technologies, and on interviews with experts on China's policies on patents and standards, the report sheds light on a gradual process of concentrated geographic dispersion of SEP ownership in the IT industry, and presents indicators of China's ascent.

At the centre of analysis is the challenge that this large and still rapidly growing emerging economy is facing in the IT industry resulting from SEP-related market imperfections. After decades of rapid-fire growth, China has reached a level of development where catching up through an investment-driven "global factory" model is no longer sufficient to create long-term economic growth and prosperity. The closer China has moved to the technology frontier, the less scope there is for imitation and low-level incremental innovation. Of critical importance now is that Chinese firms adopt, absorb and develop advanced technologies to upgrade manufacturing and services through innovation (Ernst 2016; 2017). There are growing concerns in China that SEP-related market failures may create added uncertainty for their companies, generating unpredictable and often quite significant costs and delaying market entry of their products.

To set the stage for the analysis of China's SEP challenge, the first part of this report briefly summarizes what we know about SEP-related market failures and their impacts on standard implementers. Following that, a review of current changes in the geography of SEP markets sheds light on a gradual process of concentrated geographic dispersion of SEP ownership and presents indicators of China's ascent. While the United States remains the leading market for SEP licensing, litigation and transactions, China is now beginning to catch up. A handful of large Chinese IT companies are racing to increase their shares of declared SEPs, especially for new generations of mobile communication and networking technologies.

China's rapid growth of industrial manufacturing and exports has benefited from deep integration into GPNs and GINs. To address China's challenge with regard to SEPs within these global networks, the report makes a second novel contribution — it combines insights from research on SEP-related market imperfections with insights from research on gains from trade through participation in global corporate networks. This unique approach is used in the third part of this report to highlight the hierarchical nature of GPNs and GINs, distinguishing network flagships, higher-tier and lower-tier network suppliers. The report argues that participation in these global corporate networks raises new challenges for access to SEPs for lower-tier suppliers based in China, but it also may create new opportunities for China-based network flagships and higher-tier network suppliers.

The next part of the report assesses China's efforts to reduce SEP-related market imperfections, with a focus on examples from the IT industry. Major improvements in China's patent system and in its market for SEP licensing signal new opportunities. However, China continues to lag substantially behind the United States, Europe and Japan in terms of SEP ownership, and it still

4 Joseph Farrell provides the classical definition of a patent ambush or holdup: It "arises when a gap between economic commitments and subsequent commercial negotiations enables one party to capture part of the fruits of another's investment, broadly construed. Hold-up can arise, in particular, when one party makes investments specific to a relationship before all the terms and conditions of the relationship are agreed. Hold-up generally leads to economic inefficiency that contracting parties, and courts interpreting contracts, often try to avoid" (Farrell et al. 2007, 603-04).

5 Lemley and Shapiro (2007) show how holdup problems are magnified in the presence of royalty stacking, i.e., when multiple patents read on a single product. "Royalty stacking refers to situations in which a single product potentially infringes on many patents, and thus may bear multiple royalty burdens. The term 'royalty stacking' reflects the fact that, from the perspective of the firm making the product in question, all of the different claims for royalties must be added or 'stacked' together to determine the total royalty burden borne by the product if the firm is to sell that product free of patent litigation. As a matter of simple arithmetic, royalty stacking magnifies the problems associated with injunction threats and holdup, and greatly so if many patents read on the same product. In this key sense, the problems of injunction threats and royalty stacking are intertwined."

struggles to improve the framework conditions for efficient licensing of SEPs. In short, China still has quite some way to go to establish itself as an equal participant in the global markets for SEPs. Based on a brief review of SEP policy benchmarks, the analysis focuses on China's new approach to SEP-related competition policy.

The report concludes with a brief discussion of three important unresolved policy issues: first, new challenges that Chinese IT firms face from NPEs; next, adjustments in patenting strategies that result from increasing technological complexity, resulting from the convergence of computer, communications and the Internet; and finally, pervasive uncertainty caused by rising economic nationalism and the threat of trade and investment warfare inherent in the Trump Trade Doctrine.

SEP-related Market Failures and Impacts

Access to SEPs: A Simple Framework

A simple framework based on Jean Tirole's Noble Prize lecture (2014, 510, 511) is useful to lay out the issue of SEP-related market failures (see Figures 1 and 2).

There are two basic questions for assessing access to SEPs: does the SEP owner give equal or "fair" access to all technology implementers? Or, does the SEP owner foreclose access to all technology implementers but one, or to a couple of affiliated entities or allies? According to Tirole, if truly equal access were granted to the SEP (as in Figure 1), technology implementers would erode the SEP owner's market power. As a result, the SEP owner "often favors its downstream subsidiary (D_1 in Figure 2) in myriad of ways, for example by refusing to deal with rivals or to grant them a license, by charging prohibitive access prices, or by making its technology incompatible with the rivals'" (ibid., 511).

The Disclosure Boom of SEPs

To understand why SEP-related market failures matter, it is important to note the disclosure boom of SEPs. According to the 3rd Generation Partnership Project (3GPP) consortium, the number of SEP holders for 3G and 4G standards has grown from two in 1994 to 130 in 2013, and the number of SEPs rose from fewer than 150 in 1994 to more than 150,000 in 2013 (Galetovic and Gupta 2016). As a result, SEP-related market failures and the search for effective governance of SEP licensing have increased in importance.

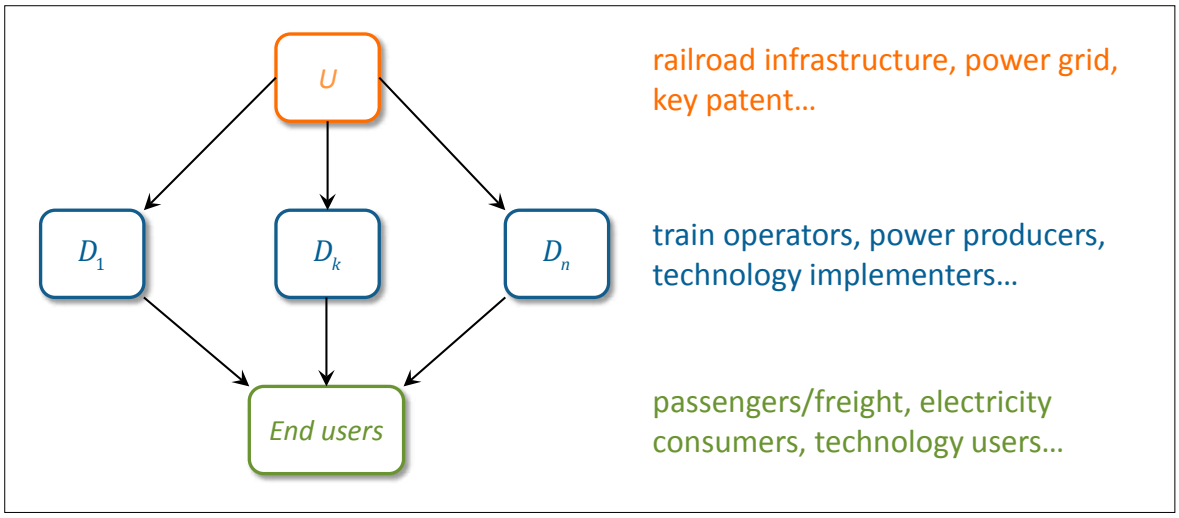
The increasing number of SEP declarations reflects a combination of factors, including the growth in patenting; the growing demand for standards (driven by the growth of shared platforms such as the Internet and cellular telephony); increased antitrust enforcement; a strategic "race" to own essential patents; and vertical specialization through GPNs and GINs (Bekkers et al. 2016; Ramel, von Laer and Blind 2017). Future technologies such as the Internet of Things (IoT), smart cars, smart homes and smart energy will increasingly rely on patented technology standards such as Long Term Evolution (LTE), Wi-Fi (for wireless local area networking), near field communication, radio-frequency identification and Bluetooth. The number of declared SEPs is constantly increasing, as companies seek to use them to enter new growth markets. SEPs are increasingly used as bargaining chips in licensing negotiations, to avoid costly court disputes.

Impacts

Patents provide an exclusionary property right, and thus can be used as a strategic weapon to shape markets and to reap monopoly rents through patent monetization. The use of SEPs as entry deterrents has emerged as a powerful tool for asset monetization. Especially in the mobile communications industry, the key to competitive success is a broad portfolio of "essential patents" necessary to produce any product that meets the specifications defined in the standard.

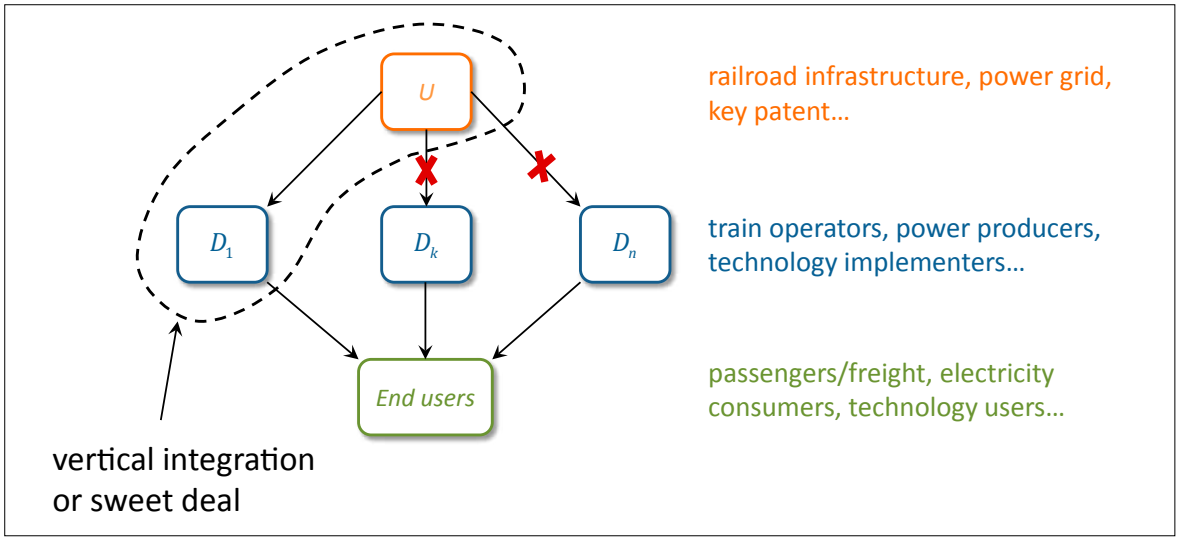
Companies license their SEPs to others to allow use — generating significant income. SEP holders are increasingly cross-licensing their SEP portfolios to one another, allowing each to manufacture standard-compliant products without infringing on the other's SEPs, and to receive compensation for its contributions to the standard. But

Figure 1



Source: Jean Tirole (2014, 510), "Market Failures and Public Policy," Nobel Prize lecture ©The Nobel Foundation. Used with permission.

Figure 2



Source: Jean Tirole (2014, 511), "Market Failures and Public Policy," Nobel Prize lecture ©The Nobel Foundation. Used with permission.

outside this privileged circle, things are much less harmonious. Research by Knut Blind and associates has documented the use of SEPs as a strategic weapon to prohibit, delay or obstruct standardization processes (Blind et al. 2004. This is the case, for instance, when incumbent market leaders pursue so-called "platform leadership strategies" through nominally open but de facto proprietary standards that are designed to block competitors and deter new entrants.[6]

Research by Lemley, Shapiro and others on the licensing and disclosure of private standard-setting organizations (SSOs) documents the

6 For example, Intel has sought to extend its control over microprocessors by creating widely accepted architectural designs that increase the processing requirements of electronic systems and, hence, the market for Intel's microprocessors (Gawer and Henderson 2007).

difficulties of finding FRAND compromises in private SSOs to reduce the negative impact of strategic patenting on innovation (Lemley 2002; Lemley and Shapiro 2007). According to the Federal Reserve Bank of Philadelphia, finding fair and non-discriminatory compromises is made even more difficult by "the potential for opportunistic behaviour by participants who own patents on a technology essential to the standard. There is a risk that without sufficient transparency and sufficiently strong mutual interests, network participants could make large investments to implement a standard only to be held up by a firm threatening to withhold a key piece of technology" (Hunt, Simojoki and Takalo 2007).

For standard implementers, multiple SEP-related market failures may well have negative effects, as highlighted in an in-depth study prepared for the European Commission (ECSIP Consortium, 2014). The study emphasizes that smaller firms in particular are struggling to cope with substantial and often unpredictable cost increases, delays in product commercialization and an increased risk of costly litigation. Of critical importance is the lack of clarity on what FRAND actually means (in terms of being *non-discriminatory* and *fair and reasonable*). This uncertainty gives rise to asymmetric information, and enables excess royalty rates or skewed cross-licensing agreements.

The combination of the disclosure boom of SEPs and the lack of transparency increases transaction costs for standard implementers, again primarily for small firms and new entrants from an emerging economy. The growing number of SEPs increases the likelihood of royalty stacking. Implementers thus may face cumulative payable royalties for SEPs that may rise more frequently above reasonable levels or may even become prohibitive for implementing products.

Of particular concern is over-inclusion of patented technologies in standards that are not really essential. Industry insiders estimate that only around 30 percent or less of declared SEPs are really needed for the implementation of a standard.[7] Over-inclusion is widespread, because patent owners have strong incentives to include them, and because this is made easier by the use of blanket disclosures in many standards developing organizations (SDOs). As the discussions about a standard under development evolve, companies file "opportunistic" patents relating to newly approved essential features in the standard. Inaccurate information is widespread in declaration lists.

The resultant uncertainty about exposure to licensing fees is a very significant deterrent for small and medium-sized enterprises (SMEs). This paper will demonstrate that this constraint is even more serious for newcomers from China who wish to export or develop new products. Of particular interest are "just-in-time" patents. In an important recent article, Byeongwoo Kang and Rudi Bekkers (2015) find that "companies … apply for patents of low technical merit just before a standardization meeting, and then send the patents' inventors to the meeting to negotiate this patented technology into the standard…. The inclusion of just-in-time patents may reduce competition and market entry, increase prices, and unnecessarily complicate the technological content of standards."

Another SEP-related market imperfection results from the increasingly frequent transfer of SEP ownership, thanks to the drastic increase in mergers and acquisitions, and fire sales of patent portfolios caused by downsizing. The new owner may not consider himself bound by an earlier FRAND licensing commitment, or SEP licensing commitments may no longer be in force after bankruptcy proceedings of the owner. Various SDOs stipulate that patent obligations should "run with the patent" when patent rights are assigned, and that RAND commitments should be construed as encumbrances that bind all successors-in-interest to the RAND declarant. In reality, however, "a transfer of SEPs to non-practicing entities often leads to increased royalty rates and more litigation" (European Commission 2015, 7).

Standard implementers face multiple challenges from the increasing use of patents for strategic purposes. According to the 2014 European Commission report, "Increasing competitive pressure forces firms to exploit all available opportunities for value creation. This implies a revaluation of IP portfolios to increase the monetization of IP assets. Non-core IP is more often sold to an NPE that seeks to cash in on royalties. Also as firms exit certain product lines or even the industry, IP portfolios are sold (sometimes by auction)" (ECSIP Consortium

7 Interviews with industry experts who have requested anonymity. According to RPX Corporation, alleged and declared SEPs are "relatively unlikely to succeed." Plaintiffs won only slightly more than a quarter of Alleged and Declared SEPs in litigation proceedings across district court and ITC proceedings (RPX 2014).

2014, 107). Thanks to the growing number of NPEs, standard implementers are exposed more often to patent holdup and patent ambush. Implementers are being disadvantaged in licensing negotiations (making excess payments or entering into skewed cross licences) because of information asymmetry regarding the extent and value of the SEP portfolio of licensors.

In the smart-phone industry, access to SEPs may be made conditional to an exchange for the licensing of non-SEPs, so-called market-essential patents (MEPs). These are patents that cover a functionality that the majority of end users expect on any phone in a given market segment. "They are claimed to be market essential because consumers highly value these designs and competitors feel they need to provide these as well, either by taking a licence or developing a work-around" (ECSIP Consortium 2014, 63). "Not being subject to any FRAND condition, market essential patents give considerable bargaining (or competitive) power" (ibid., 67). In short, MEPs pose even greater governance challenges than SEPs.[8]

Furthermore, selective and discriminatory licensing of SEPs may actually constitute one of the most serious challenges for SMEs and for new entrants from an emerging economy (International Telecommunications Union [ITU] 2014, 64–71; ECSIP Consortium 2014, 112 ff). Until a few years ago, SEP holders have charged SEP licensing fees primarily to the vendors of critical components within smartphones (Armstrong, Mueller and Syrett, 2014). However, large SEP owners now argue that patent holders should have the ability to select the appropriate level of the supply chain at which to license their intellectual property, and to refuse licences to companies at other levels. A SEP holder might restrict SEP licences to end-user product manufacturers only, and not directly license the suppliers of the standard-practising components that are incorporated into those products. In doing so, the SEP owners could tax a much larger royalty base than just the price of the component that is providing the patented performance features.

Some SEP holders seek to license only consumers who utilize devices practising the standard. For instance, "Some SEP holders — mostly patent-assertion entities — have recently attempted this tactic, sending out thousands of licensing letters and filing dozens of separate lawsuits against small businesses seeking direct payment for their use of standardized consumer products" (ITU 2014, 68). In a number of cases, SEP owners or their intermediaries are now demanding royalties from coffee shops, restaurants and hotels that offer Wi-Fi–based connectivity to their customers.

Recent attempts to address the international dimension of SEPs as entry deterrents indicate how much we still don't know about their impact on innovation gains, especially for latecomers to the global knowledge economy. Yogesh Pai (2014) explores impediments to an effective global governance of SEPs, but limits the discussion to the role that the World Trade Organization (WTO) regimes (through the Agreement on Trade-Related Aspects of Intellectual Property Rights and the Agreement on Technical Barriers to Trade) might play in providing solutions to the unresolved issues of SEPs. Li Xuan and An Baisheng (2009) argue that intellectual property rights (IPR) misuse in standards may cause great difficulties for manufacturers in emerging and developing countries who are implementing standards, but the study fails to provide an empirical analysis of the impacts on the international distribution of innovation gains.

An important recent National Academies study documents how China's standardization strategy leads to conflicts with foreign firms and governments, providing illustrative examples of such conflicts, and highlights how Chinese stakeholders respond to foreign complaints (Maskus and Merrill 2013). But the study focuses on a static assessment of China's compliance with existing approaches to patent management in standards, and fails to address the multiple implementation challenges that face countries like China, who are latecomers to the international patent and standardization systems.[9] It is thus time to address head-on the international dimension of SEPs.

8 This again supports our argument that SEPs constitute an important, special case of the market failures that result from the exclusionary property rights attached to patents.

9 For an analysis of China's standardization strategy, see Ernst (2011b).

The Changing Geography of SEP Markets

Catalysts

Powerful forces are changing the geography of SEP markets. Changes in regulations and new technologies have given rise to a gradual, yet concentrated geographic dispersion of SEP ownership, and the emergence of new players, especially China. Leading SEP owners retain their supremacy, but China, in particular, is beginning to narrow the gap.

Recent developments in the US patent system have acted as a catalyst of change. The first major patent statute in the United States in over 50 years, the 2011 America Invents Act changed the system from "first to invent" to "first to file," bringing it into line with most other patent regimes. The act also overhauled the review procedures at the USPTO, presenting defendants with a quicker, cheaper way of challenging patent validity than going through the courts. In the perception of owners of large patent portfolios, this has weakened the position of patent owners, especially since injunctive relief is no longer so readily available in the United States. In response, large owners of SEPs are increasingly opting to file infringement suits in Germany and other European jurisdictions instead. The launch of the Unified Patent Court and unitary patent, which, despite Brexit, is expected to come through during 2017 (Kluwer Patent Blog 2016), is further fueling interest in European forums.

As we will see below, China enters this equation because of the country's gradual move toward a more pro-patent court system. A gradual reform of the patent system and the leadership's concerted effort to upgrade the economy through innovation has prompted leading SEP owners to consider the world's most populous country as a new venue for SEP licensing and litigation. As intellectual property and patents in particular have moved centre stage, China now experiences a major boom in patent filings. According to the most recent data available, in 2014 the Chinese patent office, State Intellectual Property Office (SIPO), received more than 900,000 applications — more filings than the United States and Japan combined.

In turn, China now has become a hot patent litigation market. According to a recent report, "Patent litigation win rates in China are high, currently hovering around an average of 80 percent. Further, foreign plaintiffs fare better, statistically, than Chinese plaintiffs. While this is likely, in part, because foreign plaintiffs take great care before filing in China, it still indicates that as long as a foreign party does its homework, it will get a fair shake in the Chinese courts. The time from filing to judgment and injunction is short, ranging from six to 14 months. Legal costs are also low — in many cases one-tenth the cost of US patent litigation — due to the lack of significant discovery" (Robinson 2016; Love, Helmers and Eberhardt 2016).

But new technology also plays an important role as an enabler of changes in the geography of SEP markets. For instance, SEPs necessary for IoT technologies[10] are dominated by Asia-Pacific companies (for example, LG, Samsung, Panasonic, ZTE, Huawei, Haier and NEC), followed by US companies (such as Cisco, Microsoft, Google/Alphabet, Microsoft, Qualcomm, Apple and IBM) and European companies (Ericsson and Alcatel-Lucent). According to a recent report, "Asia-Pacific filings are dominated by ZTE, Huawei and Haier. Cisco's protection focuses on the United States; while others such as Intel and Microsoft take a more global view" (Cowan 2016).

Another example is 3D printing,[11] which is likely to add further to the geographic mobility of SEP ownership. 3D printing not only allows for decentralized manufacturing in any location with a suitable 3D printer. It also lowers entry barriers for copying by late entrants like Chinese firms: 3D scanners now allow products to be easily scanned to produce 3D computer-aided design files, which can be used to print knock-off products at the touch of a button. Both in advanced countries and in emerging economies (in particular, China), this has given rise to intense efforts to build up large and robust portfolios of 3D printing SEPs.

10 The trendy catchphrase "Internet of Things" refers to the convergence of the information and communication infrastructure for the Internet, wireless and mobile communications, smart sensors and cloud computing.

11 The economics of 3D printing (or additive manufacturing) is analyzed in Ford (2014). On 3D printing–related patenting challenges, see Bechtold (2015).

Concentrated Geographic Dispersion of SEP Ownership

Increasing diversity defines the new geography of SEP markets. Not only has the number of declared SEPs been increasing, but so too have the number and diversity of rights holders. As discussed below, this is reflected in the increasing geographical variety of rights holders, as well as the increasing variety of business models. A recent study finds that, while until the early 2000s most declared SEPs were filed in the United States, Europe and Japan, since then the Chinese, Korean and Taiwanese markets have been increasing in size and activity, and the number of declared SEPs in Germany, Japan and the United States has been falling.

According to Pohlmann (2016), the USPTO's share of declared SEPs has drastically declined from around 90 percent in 1992 to less than 30 percent in 2015. By contrast, in China, SIPO's share has increased to between 10 and 20 percent since 2011. While the United States remains the leading market for SEP licensing, litigation and transactions, China is now beginning to catch up. There is no doubt that we are witnessing a transition away from US dominance to a multipolar market for SEPs.

This transition reflects the rise of Asian markets. Especially in the IT industry, China has opened up its markets by accepting international standards, while Chinese rights holders increasingly contribute to the international standardization scene (for example, Huawei Technology, ZTE Corp and Datang Mobile Communications).[12]

According to industry insiders, leading multinationals with large SEP portfolios largely welcome the development of a multipolar SEP world, which in their view might help mitigate against the negative impacts of the aforementioned recent patent reform efforts in the United States.[13] There are signs, however, that, under the administration of President Donald Trump, legislators might move away from the Innovation Act in the House of Representatives and the Patent Act in the Senate — the two bills that have been the hallmarks of attempted patent reform in recent years (ibid.).

It is important, nonetheless, to emphasize that leading SEP owners retain their dominance. As the smart-phone patent war is coming to an end, owners of large SEP patent portfolios are the clear winners, especially Qualcomm, Apple, Microsoft,

12 See Pohlmann (2016). This report uses data on more than 200,000 patents declared as standard essential by a representative sample of major SSOs that includes the Advanced Television Systems Committee; the Alliance for Telecommunications Industry Solutions; the American National Standards Institute; the BluRay Disc Association; the Broadband Forum; the DVD Forum; the European Committee for Standardisation; the European Telecommunications Standards Institute; the International Electrotechnical Commission; the IEEE; the Internet Engineering Taskforce; the International Organisation for Standardisation; the ITU Radiocommunication Standardisation Sector; the ITU Telecommunication Standardisation Sector; the Open Mobile Alliance; the Organisation for the Advancement of Structured Information Standards; the Society of Motion Picture and Television Engineers; the Telecommunications Industry Association; and the Worldwide Web Consortium.

13 Author's interview with industry expert who requested anonymity.

IBM, Google, Nokia and Ericsson. Qualcomm, for instance, owns one of the largest SEP portfolios, especially for the cellular communication technology generations of 2G (code division multiple access [CDMA]), 3G (wide-band code division multiple access [WCDMA]) and G (LTE).[14] Microsoft has made a fortune from Android-related royalties. It now has more than 30 SEP licensing agreements in place, the majority of which involve the licensee paying it cash. The biggest of these agreements is with Samsung.[15] And Google, after its acquisition of Motorola Mobility's patent portfolio, has also become a major player in SEP markets.

To illustrate the persistent leadership of large SEP owners, consider SEPs for telecommunications-related technologies, the largest and most valuable SEP market. Recent data from the European Telecommunications Standards Institute (ETSI) document a significant concentration of SEP ownership. Five companies are responsible for roughly 60 percent of ETSI's total of 155,474 declared SEPs for telecommunications-related technologies (Sawant 2016). It is noteworthy, however, that Huawei, China's leading SEP owner, has moved up to join the three largest SEP owners, with a share of eight percent of ETSI's declared SEPs.

China's Ascent

There is clear evidence that China's role is on the rise in SEP markets, at least for its two leading telecommunications companies, Huawei and ZTE. Among the top 20 owners of declared SEPs at leading SSOs, Huawei now occupies position six, and ZTE is number 18 (Baron and Pohlmann 2015).[16] For 4G LTE and LTE Advanced standards, Huawei and ZTE are now the second and third top SEP owners, ahead of Nokia, LG and Samsung.[17] For 4G LTE standards, China is now the third most important application country for declared SEPs, after the USPTO and the World Intellectual Property Organization (WIPO) (ibid.).

China's ascent in SEP ownership is in line with China's widely reported patent boom. An important shift is underway in the international patent system; since 2011, more patents are filed at SIPO than at any other office in the world. In 2013, China (32.1 percent of world total) and the United States (22.3 percent) received more than half of global filings, while the European Patent Office (EPO) saw its share of the world total fall to 5.8 percent.[18] The latest patent data show the number of patents filed by Chinese inventors continued to rise in 2014, while filings under the Patent Cooperation Treaty by United States inventors declined (Organisation for Economic Co-operation and Development [OECD] 2017). Figure 3 graphically illustrates China's patent-filing boom since the early 2000s.

Important enabling factors have been government incentives for domestic companies to grow their patent portfolios, together with the low cost of patent application in China.[19]

According to a recent WIPO study, China's patent boom "is mainly driven by a greater activity and propensity of Chinese firms — as opposed to foreign firms or Chinese universities and public research institutions — to use the domestic patent system" (Kashcheeva, Wunsch-Vincent and Zhou 2014). In the context of slower economic growth and a more hostile international market, Chinese firms are refocusing their sales efforts on the domestic market, which forces them to increase their domestic patent applications. This change is borne out by the most recent SIPO data for 2016 domestic patent applications and 2015 patent recipients.[20] Huawei and ZTE continue to dominate in both filing and grants, as do a handful of state-owned enterprises (SOEs) such as Sinopec and the State Grid Corporation of China. For Chinese patent recipients, it is noteworthy that the gap between the first place and the tenth place has

14 Recently, Qualcomm has come under attack from multiple regulators (China's NDRC, Korea's Free Trade Commission and the US Federal Trade Commission), from its main customer (Apple) and from its own shareholders.

15 According to court documents that emerged in early 2016 as a result of a dispute between the two companies, in 2013 the Korean company has paid more than US$1 billion to Microsoft. The irony, of course, is that while Microsoft's PC-centred business model was in deep crisis, the revenue from Android-related SEPs has enabled the company to survive.

16 This study covers SEP declarations at ETSI, 3GPP, ISO, IEC, CEN, ITUT, ITUR, IEEE-SA, IETF, OMA, ANSI, SMPTE, ATSC, OASIS, TIA, Broadband Forum, ATIS, the BluRay Disc Association and the DVD Forum.

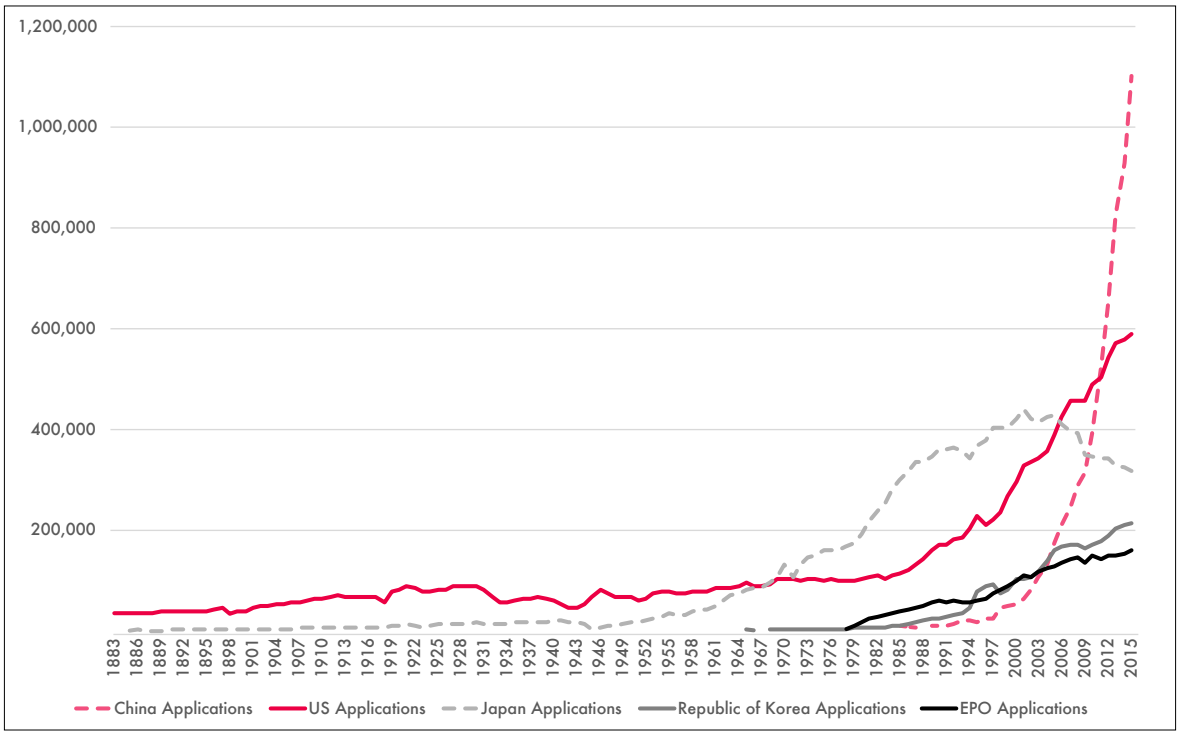
17 Author's interview with industry expert who requested anonymity.

18 China's patent boom is truly breathtaking: "In the 20 years from 1991 to 2011, the number of patent filings increased more than 46-fold – from around 10,000 to more than half a million.... From 2009 to 2011, China accounted for close to three-quarters of the...[patent application]...growth worldwide" (Fink 2013).

19 If an invention patent application is around 5,000 words long in English, the total cost of a patent application in China will be around US$6,000 from filing to grant, including official and attorneys' fees. A utility model or design application will cost between US$1,000 and US$1,500. (Author's interview with industry expert who requested anonymity.)

20 As reported in Ellis (2016).

Figure 3: Global Patent Filings, 1883–2015



Source: WIPO (2016a).

narrowed. This reflects the massive push by newcomers such as Oppo, Vivo and Xiaomi, who are seeking to catch up in applications but are still not on the list of the top 10 patent recipients. (It is unclear, however, whether applying for patents on such a scale will be sustainable. If a substantial number of those applications don't progress into grants and begin showing their value a few years down the line, then this recent patenting spree may end up as yet another example of mismanaged and misspent resources.)

In addition, China's IT industry is experiencing a massive patent acquisition push, including a significant number of declared SEPs. The box below (Ellis 2016) provides important recent examples.

As for the quality of China's patents, a useful indicator is the average citations per invention. At 1.17 citations in the IT industry, China continues to lag far behind the United States for the same metric (on average, 6.72 forward cites per invention) (Thomson Reuters 2014). But China's citation rate now compares favourably with Japan's (1.82 average forward cites) and Europe's (1.31 average forward cites), and it exceeds the South Korean rate (0.76 average forward cites).

It is certainly time to reassess earlier statements that Chinese patents are mostly "junk."

Yet China's gap in innovation capacity persists. China's leadership is very conscious that China continues to lag well behind the United States in research and development (R&D) on major breakthrough technologies, in critical capabilities (both management and technological), and in accumulated portfolios of high-impact invention patents. A recent study by the Industrial Research Institute (2016) finds that, while US and Chinese investments in R&D are equal, "the R&D quality, productivity, basic research, applied research, development activities and overall trends are considered to be vastly superior in the U.S. than in China by factors of two to eight."

At the same time, however, there is no doubt that China has succeeded in a very short period of time to increase its portfolio of valuable patents, and that some of its leading IT firms have established themselves as serious owners of SEPs.

Major Patent Acquisitions by Chinese IT Firms

Xiaomi

- Xiaomi buys a large portfolio of patents from Broadcom (October 2015).
- As part of wider licence and collaboration duels, Xiaomi buys 332 patents from Intel, relating to electronics, software and telecommunications, some of which were originally assigned to US chipmaker LSI (February 2016).
- As part of wider licence and collaboration duels, Xiaomi buys 1,500 patents from Microsoft. Anecdotal reports value the patent transaction at US$40 million (June 2016).

BOE

- BOE buys a patent portfolio including 425 US patents relevant to LCD technology from Seiko Epson (November 2014).
- From Casio, BOE acquires a portfolio that includes six US patents covering various display technologies (February 2015).
- BOE buys from GE at least 131 US patents relating mostly to LED technology (December 2015).

Alibaba

- From IBM, Alibaba buys a patent portfolio that includes 22 e-commerce-related US assets (September 2013).
- Alibaba disclosed in a regulatory filing that it had paid Yahoo US$70 million for patents during 2013 (October 2013).
- Alibaba acquired seven software-related US patents from Intel (April 2016).

Huawei

- Huawei buys seven US patents relating to telecommunications from Siemens (September 2012).
- A purchase from IBM includes 16 US patents (December 2012). IBM made further assignments to Huawei in July 2013, August 2014 and November 2014 — each covers a variety of technologies.
- From Sharp, Huawei buys 84 US patents covering telecommunications (May 2013). Sharp made further assignments to Huawei in October and December 2015.
- Buys from NCR include 14 US patents relating to software and wireless networking (June 2013).
- Huawei buys include 24 optics-related US patents from Hoya/Japan (September 2015).
- From Yahoo, Huawei acquisitions include 29 US patents relevant to digital media playback and storage (January 2016). Yahoo previously assigned two US patents to Huawei covering Internet telephony in May 2014.

Lenovo

- Lenovo paid Unwired Planet (NPE) US$100 million for 21 patent families covering 3G, LTE and other mobile communications technologies, alongside licences to Unwired Planet's patent portfolio (March 2014).
- Lenovo acquired from NEC more than 3,800 patent families covering 3G, LTE and various wireless device features (April 2014). NEC has made multiple assignments to Lenovo since March 2014, the most recent — consisting of 16 US patents — in June 2015.

China's SEP Challenge within Global Production and Innovation Networks

Much of China's patent boom has occurred in the IT industry. A defining characteristic of this industry in China is its deep integration into GPNs and GINs. To understand how global network integration affects China's access to SEPs, this paper takes a novel approach, combining insights from research on SEP-related market imperfections with insights from research on gains from trade through participation in global corporate networks.

China's Global Network Integration

China's progressive integration into GPNs and GINs, which was accelerated by China's WTO accession in 2001, has played an important enabling role in the development of its IT industry. Global network integration facilitated technology diffusion and absorption, and enhanced China's capacity to reap the potential gains from trade.

A proxy for China's high degree of GPN integration is that 44 percent of its exports are produced under so-called "processing trade" arrangements, in which imported inputs are assembled into exports (General Administration of Customs, People's Republic of China 2012). Another indicator is that two-thirds of China's production of goods and services are intermediates, which is substantially higher than the world average (Baldwin and Lopez-Gonzalez 2013).

As for integration into GINs, China is the largest "net importer" of R&D, and it is the third most important offshore R&D location (after the United States and the United Kingdom) of the 300 top R&D spending multinationals (Ernst 2011b). China is thus deeply integrated, albeit still unevenly, into the international circulation of technological and managerial knowledge needed to enhance its absorptive capacity. Most recent data show that China has caught up with the United States in attracting foreign investment in their R&D with a Greenfield investment of US$1.2 billion in 2014 compared to just US$300 million in the United States (Industrial Research Institute 2016, 23). In 2015, multinationals operated more than 1,500 R&D centres in China (up from around 200 in 2000) — and this number is poised to increase 20 percent by 2018 (Jolly, McKern and Yip 2015). Most importantly, the knowledge-intensity of these foreign R&D centres in China is increasing. Multinationals now seek to establish research partnerships with China's leading universities and public research centres; they also work with Chinese start-up companies.

What distinguishes China, however, is that global network integration was combined with well-funded and focused support policies for manufacturing and industrial innovation. Massive investments in the country's R&D infrastructure and higher education, on a scale never seen before, have been fast-tracking the speed of learning and capability development. Since 2000, China has increased R&D spending roughly 10 percent each year — a pace the country maintained during the 2008-2009 recession. Since then, China continued its steady increase in R&D intensity, reaching 2.1 percent in 2015 — only 0.3 of a percentage point below the OECD average. In volume terms, China's R&D spending was equivalent to 81 percent of the United States' level in 2015 and nine percent higher than that of the European Union (OECD 2017). This sustained commitment to a rapid expansion of R&D sets China apart from all other late entrants into the global SEP market.

As China's GDP growth declines, China's R&D investments are also bound to slow down. In addition, barriers to innovation in China remain substantial, ranging from severe quality problems in education to plagiarism in science; a fragmented innovation system, prone to rivalries among different government agencies and between the central government and local governments; and barriers to entrepreneurship and private R&D investment (Ernst 2011b, 2015a).

Even if one factors in massive inefficiencies of China's innovation system, China's pragmatic policy mix of combining global network integration with domestic capability development has produced results. As Peter Petri (2014) observes, "China is not averse to intervening, but it has done that against the background of a lot of liberalization. It's paying off."

Asymmetry: The Hierarchical Nature of Global Networks

The proliferation of GPNs gathered momentum during the 1970s. A lead firm (a network flagship) integrates its dispersed operations (intra-firm) and

inter-firm relationships worldwide, across both functions and locations. Integration enables the flagship to internalize and combine resources and capabilities without running into the constraints of excessive centralization (Ernst 1997; 2002; 2007).

The electronics industry has been in the vanguard of this transformation. Today, however, global corporate networks are driving production, R&D and trade in myriad goods and services sectors, from clothing, food processing, motor vehicles, construction equipment, aviation, energy (fossil fuel, wind and solar), medical technology and pharmaceuticals, to accounting, finance and legal services.

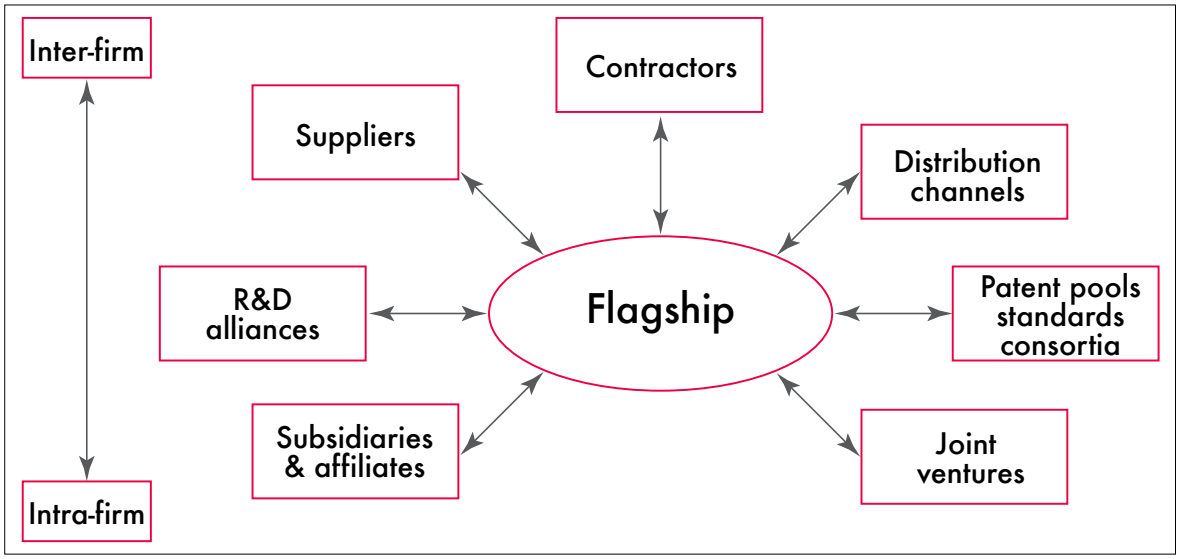
GPNs cover both intra-firm and inter-firm transactions and forms of coordination (see Figure 4): a GPN links together the flagship's own subsidiaries, affiliates and joint ventures with its subcontractors, suppliers and service providers, as well as partners in strategic alliances (Ernst and Kim 2002). A network flagship like Apple breaks down the value chain into a variety of discrete functions (by product or by production process) and relies heavily on first-tier subcontractors such as Foxconn's gigantic production complexes in Shenzhen, Chengdu and other major locations in China, Vietnam, Mexico and India. As a result, Apple can locate production and product development wherever they can be carried out most effectively, where they can improve the flagship's access to resources and capabilities, and where they are needed to penetrate important growth markets.

Over time, the focus of outsourcing is shifting from assembly-type manufacturing to knowledge-intensive support services, such as supply chain management, engineering services, the design of core components, and new product development. As knowledge intensity rises, this confronts network participants with new challenges for patenting and licensing strategy.

GPNs thus are a major organizational innovation that enables network flagships to reap the combined advantages of outsourcing (vertical disintegration) and integration. Outsourcing allows for the separation of labour-intensive processes (which move to low-cost locations) from capital- and knowledge-intensive processes and their dispersion across firm boundaries and national borders. Integration between the dispersed producers, suppliers and customers, and relevant R&D labs is necessary to reduce the high costs and risks of coordinating cross-border exchanges of products, people, information and knowledge. In short, network flagships increasingly rely on the skills and knowledge of specialized network suppliers to enhance their core competencies.

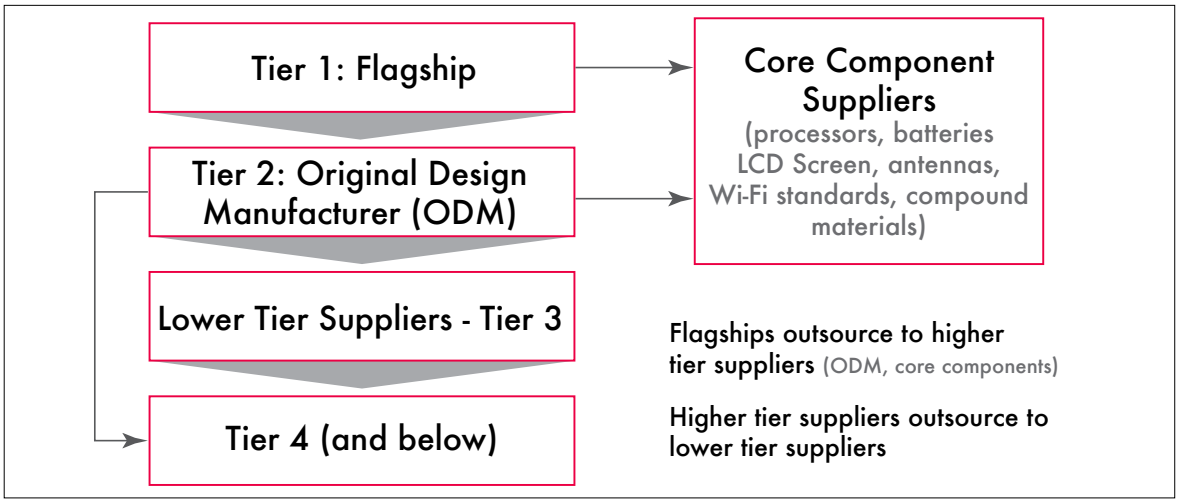
Asymmetry is a fundamental characteristic of these networks (see Figure 5 for smartphones). Network flagships dominate and define network organization and strategy (Ernst 2005). Control

Figure 4: The Nodes of a GPN



Source: Ernst and Kim (2002).

Figure 5: Inter-firm GPNs – Smartphones



Source: Author.

over and coordination of network resources and decision making enables the flagship to directly affect the growth, the strategic direction and network position of network suppliers. Flagships control distribution networks and brand names but, most important, they have technology, and they will go out of their way to protect this technology by filing patents. Moreover, flagships increasingly use SEPs as a strategic weapon to shape standards as well as markets, and to reap monopoly rents through monetization. For network flagships, SEPs have become an important currency in international trade and in the coordination of global networks (Ramel and Blind 2015).

While the exchange of SEPs through cross-licensing among network flagships can create a win-win outcome, this may not necessarily be the case for network suppliers. Ernst and Linsu Kim (2002) distinguish two types of network suppliers. Higher-tier suppliers like Foxconn play an intermediary role between flagships and lower-tier suppliers; they possess valuable proprietary assets (including patents); they have sufficient resources (including patents) to upgrade their capabilities; and they often are tasked with supply chain management. Their patent portfolios however are likely to be smaller than those of flagships.

Thousands of no-name, lower-tier suppliers are the weak links in the GPNs. Their main competitive advantage is low cost, speed and flexibility of delivery. They are often used as price breakers and "capacity buffers" and can be dropped at short notice. Lower-tier suppliers normally lack IP, and hence need to license technology both from higher-tier suppliers, the flagship and outside technology suppliers. However, their financial means are limited. Left on their own, these lower-tier suppliers are often hard-pressed to license SEPs and to invest in the training and complementary R&D needed to absorb the licensed technology and to comply with the relevant standards. The lower these companies are situated in GPNs, the less they can benefit from increased protection and enforcement of IPR. They might actually benefit from a weaker regime.[21]

A defining characteristic of GPNs is a two-way knowledge sharing among network participants. As Ernst and Kim (2002) demonstrate, network flagships transfer both explicit and tacit knowledge to local suppliers through formal and informal mechanisms. Apart from licensing agreements (including cross-licensing, if necessary), this may involve training and even sharing of intangible knowledge, such as trade secrets.

From the flagship's perspective, this knowledge sharing is necessary to upgrade the local suppliers' technical and managerial skills so that they can meet the flagships' specifications. Once a network supplier successfully upgrades its capabilities, this creates an incentive for flagships to transfer more sophisticated knowledge, including engineering, product and process development. This process,

21 For an excellent analysis, see the pioneering work of Keith Maskus, especially Maskus (2012).

however, is not automatic: to establish such two-way knowledge sharing, universally accepted and implemented interoperability standards must be in place (Palfrey and Gasser 2012). In turn, this requires mutually agreed rules for the licensing of SEPs. For the flagships, strong protection and enforcement of SEPs is the key to success.

The perspective of network suppliers is different, however. For them, what matters most is whether and how integration into these networks might foster or erode their absorptive capacity[22] and innovation capabilities. For upgrading to run its course for the networks suppliers, supportive industrial and innovation policies are required to foster the absorptive capacity of local suppliers. This highlights a fundamental tension between, on the one hand, global knowledge sourcing, which requires trade liberalization and compliance with international patent rules and standards, and, on the other hand, domestic capability development, which requires supporting industry and innovation policies. (For details, see A New "Gains from Trade" Doctrine, below.)

A more recent development is the emergence of GINs, driven by the relentless vertical disintegration of engineering, product development and research. A gradual opening of corporate innovations systems disperses R&D across firm boundaries and national borders (Ernst 2009).

By now, GINs have expanded well beyond the traditional high-tech regions in the United States, the European Union, and Japan. There are now multiple locations for innovation — even lower-order or less developed centres can still be sources of innovation (Cantwell 1995). Asia's role in these networks, formerly quite minor, is increasing, especially in China (Ernst 2011a). China is thus deeply integrated, albeit still unevenly, into the international circulation of technological and managerial knowledge needed to enhance its absorptive capacity.

Yet, the new geography of knowledge created by GINs is by no means a flatter world. A defining characteristic of GINs is a persistent inequality in the division of innovation tasks. A handful of established global centres of excellence in the United States, Japan, and the European Union retain their dominance in science and high-impact IP. In R&D, although China has improved quite significantly its position, the United States continues to be by far the largest single country in R&D investments with slightly more than a quarter of all global R&D spending (Industrial Research Institute 2016, 4).

A few examples must suffice to illustrate the systemic nature of the driving forces behind the spread of GINs; labour cost differentials matter, but they are only one force among a package of competitive pressures (Ernst 2009, chapter 2). GIN flagships expect China's integration into their GINs (either through their affiliates in China or through outsourcing to independent local suppliers) to:

- → increase the return-on-investment on R&D, despite the rising cost, complexity and uncertainty of R&D;
- → facilitate the penetration of China's high-growth emerging markets in compensation for the slow demand growth in core OECD countries;
- → gain access to lower-cost pools of knowledge workers; and
- → tap into the resources and innovative capabilities of new competitors and emerging new innovation hubs.

All of these considerations have shaped China's progressive integration into GINs. Today, however, as foreign flagships seek to retain and expand their penetration of the China market, they need to decide whether to upgrade their R&D in China, and if so, how. Such decisions increasingly focus on the existence of regulatory framework conditions, such as strong protection and enforcement of intellectual property rights, tax laws that facilitate transfer pricing, and business-friendly regulations and investor protection. And there's the rub for China. As we will see, these new requirements may create important additional impediments for Chinese companies and their efforts to improve the framework conditions for SEP licensing.

22 According to path-breaking research by Wesley M. Cohen and Daniel A. Levinthal (1990), absorptive capacity is "a firm's ability to recognize the value of new information, assimilate it, and apply it to commercial ends."

A New "Gains from Trade" Doctrine: Global Network Integration and Restrictions on National Policies

According to the OECD, the WTO and the World Bank, these global networks have opened up a new pathway to industrialization. Developing countries and especially emerging economies such as China no longer need to construct their own value chain from scratch, as Japan and South Korea had to do in the twentieth century. A new "gains from trade" doctrine for economic development has emerged that emphasizes the role of global network integration as "the 21st century's fast lane to industrial development" (Baldwin 2013; 2014). By joining GPNs, it is argued that "developing countries can benefit from foreign-originated intellectual property, trademarks, managerial and business practices, marketing expertise, and organizational models" (Taglioni and Winkler 2014).

Gains from Trade Are Not Automatic and Require Policies to Improve Access to SEPs

There is ample reason to doubt the validity of such sweeping and broad-brushed propositions. As stated by Susan Helper, the former chief economist of the US Commerce Department, "There is little reason to believe that participation in global value chains will automatically allow emerging economy firms to capture wealth" (Helper and Krueger 2016). In fact, the proponents of the new gains from trade doctrine are quite explicit that countries participating in these networks need to accept significant restrictions ("disciplines," in the parlance of trade diplomacy) on their national policies in support of innovation and industrial development.

Many trade agreements forbid such policies, especially local-content rules. For instance, the WTO Agreement on Trade-Related Investment Measures (TRIMs) prohibits local-content requirements because they might "restrict and distort trade" (WTO, n.d.(b)). And chapter 9 of the abortive Trans-Pacific Partnership (TPP) specifically prohibits "'performance requirements' such as local-content or technology localization requirements" (Office of the United States Trade Representative [USTR] 2015a).

Such restrictions, however, are creating new, yet little understood challenges for national policies that seek to foster economic growth, and prosperity through productivity-enhancing innovation. As we saw earlier in this report, SEP-related market imperfections may constrain innovation and technology diffusion. In order to reduce patent thickets, patent holdup, excessive licensing rates and other negative effects, proactive national policies are required to improve the framework conditions for the development, licensing and use of SEPs. To the degree that such policies are constrained by the new gains from trade doctrine, concerns are growing in China and other emerging economies that integration into GPNs and GINs may be a poisoned chalice.

It is now time to explore what economic theory has to say, first about the link between trade and innovation, and second about the role of public policy in securing benefits from global network integration. It is on this basis that the policies that might be needed to improve China's access to SEPs are discussed.

There is a broad consensus among development economists that, in principle, a country's integration into global networks may facilitate access to knowledge. Participation in GPNs and GINs might provide powerful mechanisms for global technology sourcing and learning for suppliers who are latecomers to these networks. In principle, integration into global networks thus could enable developing countries to overcome "barriers to exporting by accommodating specialization in narrow business functions and niche activities and [to] limit dependence on the degree of industrial development and broader skills set in the country" (OECD and World Bank 2015).

This is in line with important insights from Paul Romer's endogenous growth theory, which states that trade provides access to "new types of goods and new types of productive activities being introduced from abroad" and thus stimulates productivity and technology diffusion (Romer 1994, 6). However, Romer's proposition needs to be balanced with the "infant economy" argument, as formalized by Bruce C. Greenwald and Joseph E. Stiglitz (2006). Philippe Aghion (2014) summarizes the argument as follows: For developing countries with a nascent industrial sector, "full trade liberalization will make it very costly for domestic industrial sectors to invest in learning by doing … since domestic costs are initially higher than

foreign costs [and] the social benefits from learning by doing are not fully internalized."[23]

At the same time, innovation theory tells us that strengthening national innovation capabilities improves a country's ability to engage in and benefit from the international trading system" (Kim and Nelson 2000; Ernst, Ganiatsos and Mytelka 1998). In fact, the gains from trade through global network integration are contingent — or a country's capacity to capture those gains depends — "on the structure of specialization and the level of development" (Kowalski et al. 2015). In a recent report for the UK's Overseas Development Institute, Dani Rodrik (2015) argues that global network integration might erode absorptive capacity and innovation capabilities "because of disconnect to the rest of the economy." In a similar vein, a recent World Bank study observes that "foreign investors do not actively pursue — and sometimes resist — such integration for several reasons ranging from economic constraints to technological and quality gaps with domestic suppliers to shortages in specialized workers and skills" (Taglioni and Winkler 2014, 6).

In short, public policies are required to enable local companies (the network suppliers) to reap the potential gains for innovation from global network integration. The World Bank acknowledges that "GVC [global value chain] participation is a necessary but not a sufficient condition for development. While GVCs open doors, they are not magical. Most of the work still has to be done at home with domestic pro-investment, pro-skills, pro-jobs, and pro-growth reforms" (Taglioni and Winkler 2014, 3). For Rodrik, such policies need to include, for instance, "protection of home market, subsidisation of exports, managed currencies, local-content rules, development banking, special investment zones" (Rodrik 2015).[24]

But we need to move beyond these general observations, and examine the fundamental challenge for global network suppliers, as described earlier. On the one hand, they need access to best-practice technology and management approaches through global knowledge sourcing.[25] This requires trade liberalization and compliance with international patent rules and standards. On the other hand, network suppliers can absorb and use this knowledge only if they can tap into strong domestic technological and management capabilities, which requires supporting industry and innovation policies.[26] Lower-tier suppliers, in particular, need public policy support to benefit from global knowledge sourcing.

To address this fundamental challenge for network suppliers, policies to improve the governance of SEP markets play a critical role, which will be discussed in the section China's Efforts to Improve Framework Conditions for SEP Licensing.

New Restrictions Imposed by the New "Gains from Trade" Doctrine

However, such fairly comprehensive policies are anathema to the new gains from trade doctrine. In essence, the new gains from trade doctrine offers emerging economies and developing countries foreign direct investment (FDI) and integration into global networks. But there is a high price to pay. Proponents of this new doctrine emphasize a quid pro quo: if a country wants to reap the gains from global network integration, its policies need to comply with two types of restrictions:

- "Disciplines that assure the two-way flows of goods, information, capital and people that are necessary to run an international production network.
- Disciplines that guarantee tangible and intangible property rights, and a favourable business climate.

The former include liberalisation of infrastructure services, some financial services, capital flows, and barriers to trade in parts and components. The latter include assurances on movement of capital, IPR, investor rights, and competition policy or some other policies that guard against ill treatment of foreign-owned firms" (Baldwin 2012, 5).

For Baldwin, "the best strategy for the developing-nation government is to adopt strict disciplines — and this regardless of what the advanced technology firm decides to do.

23 Aghion (2014, 498) argues that "adequately targeted sectoral intervention, e.g. to more skill-intensive or to more competitive sectors, can enhance growth," especially for developing countries who seek to benefit from global network integration.

24 In contrast to Rodrik's argument, opportunity costs of local content requirements are highlighted in Hufbauer, Schott and Cimino (2013).

25 As defined in Ernst (2015a, 12-13).

26 For an in-depth analysis, see Ernst (2016).

If the investment happens, the government wins rapid industrialisation. If no engagement happens, the government loses little" (ibid.).

This bold assertion is doubly wrong. Such passive reliance on FDI will not bring "rapid industrialisation." Nor will voluntary compliance with strong protection and enforcement of IPR be in the interest of local companies. However, empirical research finds that the primary beneficiaries are large multinational corporations with large patent portfolios, while local innovation efforts are stifled.[27]

In fact, patents and standards are at the centre of the new gains from trade doctrine. Strong protection and enforcement of IPR everywhere within these global networks is considered to be a *sine qua non* for attracting FDI. Equally important in this view is compliance with the international rules of standardization, in line with the WTO Agreement on Technical Barriers to Trade, as well as the established procedures of SDOs and consortia. According to a report submitted to the Group of Twenty trade ministers in 2014, "standards and certifications previously played marginal roles in international trade, but they are now front and center" (OECD, WTO and World Bank 2014, 19).

It is important to understand the strategic rationale behind this new gains from trade doctrine. Fear is an important determinant. The United States, the European Union, Japan and Canada (known as the Quad) have lost their erstwhile unquestioned dominance — their share in world imports declined from two-thirds during the General Agreement on Tariffs and Trade period to less than half today, reflecting the rise of emerging economies, especially China. The growing number of WTO members from developing countries, and especially China's accession in 2001, dramatically increased the complexity of negotiations. For the United States, the decline of the Doha Round is definitive.[28] In its place, the United States has sponsored a massive expansion of regional trade agreements. (Under the new Trump Trade Doctrine, however, this is likely to change. See below.) Many of these new agreements went beyond tariff-cutting and included legally binding assurances aimed at making signatories more business-friendly to trade, foreign investment and the protection of IPR.

Combined with the proliferation of around 3,000 bilateral investment treaties (BITs),[29] this has left emerging economies and developing countries with little choice but to reduce trade barriers in order to attract industrial FDI and to upgrade their position in global networks. The underlying logic is straightforward: "Many developing nations sought and are still seeking to attract this offshoring activity. Firms in the high-income nations are interested in providing it — as long as they have assurances that host nations will respect their tangible and intangible property rights, and ensure that the necessary flows of goods, services, investment, capital, and people will be unimpeded" (Baldwin 2016, 111).

In short, for proponents of the new gains from trade doctrine, "world trade governance is heading towards a two-pillar system. The first pillar, the WTO, continues to govern traditional trade as it has done since it was founded in 1995. The second pillar is a system where disciplines on trade in intermediate goods and services, investment and intellectual property protection, capital flows, and the movement of key personnel are 'multilateralised' through regional and mega-regional trade agreements, like the TPP" (ibid., 114).

It is somewhat naive to assume that such a vision of world trade governance could ever be stable, when the stillborn TPP was to exclude major trading nations like China and India. And with the shift to crude economic nationalism in the United States, and the likely increase of trade warfare, there is even less reason to assume a stable regime of world trade governance.

Ironically, while restrictions imposed by the new gains from trade doctrine on national policies were meant to foster the proliferation of global networks, America's new get-tough approach to international trade and investment may now disrupt these networks. In the worst case, the world might get stuck with a full-blown trade war. Not only would this render the above restrictions obsolete, but it would also further roll back efforts to improve the governance of SEP markets.

27 For an extensive review of case studies, see Maskus (2012).

28 For former USTR Michael Froman, "moving beyond Doha… [and] freeing ourselves from the strictures of the Doha framework" was the main theme of his remarks to the 10th Ministerial Conference of the WTO in Nairobi, Kenya (USTR 2015b).

29 In essence, these BITs are "concessions of sovereignty undertaken to encourage inward investment. For example, signatories usually commit to resolve investor–state disputes in a forum based in Washington, DC, rather than in national courts" (Baldwin 2016, 107).

China's Efforts to Improve Framework Conditions for SEP Licensing

China's Patent System Needs to Move Beyond Pushing Numbers

Drawing on the German patent system, the Chinese patent system has its own unique characteristics, and it certainly differs substantially from the US patent system. A defining characteristic of China's patent system is its emphasis on public intervention in IPR, including an extensive administrative system, and other means of state intervention in the creation, exercise and enforcement of IPR (Cohen 2017). The focus is on the provision of public goods that would help to accelerate China's economic development.

Reflecting China's latecomer status, China's patent policies are still focused on pushing up numbers. This quantitative bias thus far has constrained efforts to improve the country's position in SEP markets. China's government has invested huge sums in patent portfolio development, targeting incentives to encourage the filing of patent applications, which has led to an exponential increase in the filings in China. This was done not to capture the value that can be generated from patents, but rather to increase the number of patents attributed to Chinese universities and companies, thus enhancing China's perceived capacity for indigenous innovation.

In essence, the Chinese government has provided significant incentives for domestic companies to grow their patent portfolios by underwriting innovation and invention, subsidizing patent prosecution fees and filing fees outside China, and underwriting some litigation expenses, including encouraging local lawyers to take cases on an alternate fee structure basis.

As for university R&D and patenting, the main focus has been to encourage senior researchers to file patent applications for their inventions (as this is one of the criteria under which researchers are evaluated) (Rotenberg 2016). The decision of how and where to register patents is left entirely up to them. "While researchers are encouraged to file applications for their inventions, they receive funding only up to the registration stage. Maintaining registered patents is not a priority and any necessary maintenance fees come from the specific department's research budget. This means that while researchers are encouraged to file patent applications and register patents (to push numbers and reputation up), no one seems to care what happens to these patents once they are registered and many are allowed to lapse. Additionally, no significant efforts are made to identify patents that might have commercial value and pursue this" (ibid., 6).

This numbers-driven approach is now running into constraints. Due to the slowdown of economic

growth, greater pressure on budgets has forced central and local governments to be more selective in their support for patent development. Government initiatives have already shifted from providing incentives for increasing patent applications to funding that promotes improved quality and commercial value of submitted patent applications, especially with regard to SEPs.

Leading Chinese IT companies seem to support this shift toward a more value-oriented patent policy. As for IP development in universities, it is too early to tell whether this new emphasis on nurturing the value and commercialization of patents can overcome the opposition from senior researchers, who might well be concerned of losing their erstwhile privileged position.

Major Improvements

Over the past few years, major improvements in China's patent system signal new opportunities for upgrading China's position in global SEP markets. The quality of the patents being issued by SIPO is improving, and policy makers inside the relevant government agencies are keenly aware of measures that might facilitate the growth of a thriving domestic market for SEP development and licensing.

Contrary to a widespread perception in the United States, China's government pursues an increasingly pro-patent policy, supported by Chinese owners of large patent portfolios, like Huawei, Lenovo, and the BATs (that is, Baidu, Alibaba and Tencent). Fostering SEP portfolios has become an important objective. As we will see below, competition policy is playing an increasing role in regulating the abuse of patent monopolies, especially for SEPs, and Chinese authorities are proactively enforcing these new rules.

At the same time, China's specialized IP courts have developed a reputation for professionalism and improved efficiency. As the growth of the economy continues to falter, the government is moving away from providing incentives for domestic companies to grow their patent portfolios to policies that seek to improve the quality, value and economic impact of those patents. For instance, the recently issued National Intellectual Property Development Strategy sets ambitious targets to stimulate valuable patents (alongside its target for every 10,000 people to own 14 invention patents by 2020) (WIPO, n.d.). According to this strategy, ¥2 trillion (US$291.4 billion) in technology contracts should be registered and US$8 billion in export income from royalties and franchising fees should be accrued from Chinese IP by 2020 (Prud'homme 2017).

As the world's largest market for major IT products such as semiconductors and mobile devices, China has become an attractive litigation market (Love, Helmers and Eberhardt 2016; Robinson 2016). Patent litigation win rates in China are high, currently hovering around an average of 80 percent. Foreign plaintiffs fare better, statistically, than Chinese plaintiffs. According to Erick Robinson (2016), while this may be due "in part to the fact that foreign plaintiffs take great care before filing in China, it still indicates that as long as a foreign party does its homework, it will get a fair shake in the Chinese courts." In addition, litigation in China is faster and cheaper than in the United States. In China, it takes between six to 14 months to get from filing to judgment and injunction. And legal costs in many cases are one-tenth the cost of US patent litigation.

To reduce the gap in patenting capabilities, China's leading IT companies are now recruiting top patent experts from global industry leaders. A few examples might illustrate the scope of improvements. Huawei, for instance, aggressively recruits leading patent experts in major overseas markets. The company's intellectual property team now has hundreds of members, working from branches in Shenzhen, Beijing, Shanghai, Munich, Stockholm, the Bay Area and Texas. Apart from generating new patent grants in Europe and the United States, the main purpose of these networks is to generate learning effects for Huawei's domestic IP team through systematic training and knowledge exchange.

Lenovo, another leading Chinese SEP owner, has recruited Ira Blumberg as its senior IP strategist, based in Raleigh-Durham, North Carolina. As a former senior executive of patent licensing for leading US NPEs (Intellectual Ventures, Rambus, and IPotential, LLC), Blumberg serves as a source of knowledge and as a talent scout for Lenovo's growing IP team. In addition, Lenovo recently recruited Laura Quatela, a top patent licensing attorney, as the company's chief legal officer and senior vice president. Lenovo thus has gained an important source of intelligence on the dynamics of competition in the global SEP market. Quatela previously held IP leadership positions at Alcatel-Lucent and Eastman Kodak,

and she is co-founder of RXP, a global consulting firm that helps clients monetize IP assets.

Few companies have invested as much in recruiting leading IP executives as Xiaomi, a Chinese smartphone and Internet service company. This erstwhile poster child of global investment funds initially avoided investing in developing a broad patent portfolio. But once this "patent-avoiding latecomer" strategy exposed Xiaomi to massive litigation (Ernst 2015b), Xiaomi changed tack and started to invest heavily in patent acquisition and licensing, drawing on the recruitment of experienced IP executives. For instance, Xiaomi recruited Xiang Wang, the former head of Qualcomm China, to serve as vice president of strategic cooperation. With 14 years of experience in Qualcomm, Xiang Wang knows Qualcomm's patent licensing model.

Not a patent specialist himself, Wang heads both the IP and supply chain teams. He has since recruited Bin Sun (a graduate of Santa Clara Law School and former head of IP Management Center at China's BOE Technology Group) as head of litigation and overseeing the company's absorption of patent fund operator Zhigu. Zhigu's CEO, Paul Lin, a former Intellectual Ventures executive, now leads Xiaomi's IP strategy. In addition to securing a licence from Qualcomm, Wang has been able to use licensing negotiations to help address the company's urgent need for more patents.

A deal announced in June 2016, which saw the Chinese company pick up 1,500 patents from Microsoft, illustrates how Xiaomi has leveraged its close relationship with Qualcomm, the global SEP leader for mobile device baseband chipsets. By tapping into Qualcomm's extensive alumni network in China, Xiaomi was able to purchase a large portfolio of 1,500 patents from Microsoft for an estimated US$40 million. According to Microsoft's head of patent licensing, Micky Minhas, the relationships between some of the key executives involved in the negotiations proved crucial in implementing this major patent acquisition. Minhas, Microsoft head of business development Peggy Johnson and Xiaomi head of strategic cooperation Wang Xiang all had previously worked at Qualcomm, so there was already a level of familiarity. A face-to-face meeting between the respective company CEOs in March 2016 resolved most of the outstanding issues and advanced the negotiations to a point where all that was left was to refine the contractual terms.

A Persistent Gap in SEP Ownership

Recent developments in China's IT industry indicate the magnitude of the challenges that lie ahead. But they also shed light on new opportunities. The leadership is under no illusion that China continues to lag substantially behind the United States, Europe and Japan in SEP ownership. A handful of leading companies have in place ambitious SEP strategies, with Huawei, Lenovo and ZTE in advanced manufacturing, and the BATs (Baidu, Alibaba and Tencent) in advanced network services the most prominent examples. In addition, a noisy but still tiny band of young start-up companies (such as Xiaomi, Vivo and Oppo in mobile communications) are now somewhat belatedly seeking to develop their own SEP portfolios.

Nevertheless, most Chinese firms in the IT industry continue to depend on SEP licensing from leading foreign SEP owners, and all are exposed to high licensing fees and litigation challenges. This remains a challenge even for the leading Chinese IT companies like Huawei. These companies are now involved in cross-licensing agreements as licensee and licensor. Yet the fees that they earn from those agreements are far lower than the fees that they have to pay. For Chinese start-ups, this challenge is existential. For instance, Xiaomi's IP strategy chief, Paul Lin, concisely describes the challenge that Chinese start-ups are facing when they seek to license SEPs: "(1) I pay but others don't pay (2) I pay a higher rate than others (3) the rate is too expensive to afford."[30]

Overall, this adds up to a significant and, thus far, growing gap between China's payments and its receipts for the use of IP. According to

30 Quoted in Wild (2017, 2).

SIPO, China's IP payments have increased from around US$7 billion in 2006 to around US$21 billion in 2013. China's IP receipts, however, have remained meagre: they were around US$2 billion in 2014, up from US$1.36 billion in 2013 and US$200 million in 2006.[31] It is fair to assume that Huawei received a significant portion of those US$2 billion licence revenues.

Huawei is, in fact, one of the few Chinese IT companies involved in cross-licensing agreements as both licensee and licensor. However, during a recent Forum on Standards and Patents at the China National Institute of Standardization in January 2017, Huawei complained that the licensing fees that it earns in those agreements are far lower than the fees it had to pay.[32]

A recent study from SIPO finds that revenues from patent licensing remain low by international standards, but that royalty payments are a larger burden for smaller Chinese companies. In 2011, 64 percent of the Chinese companies received less than ¥500,000 (US$77,400) of royalties from patent transfer or licensing; 76.6 percent paid royalties in this bracket. In both cases, most companies fell within the bracket below ¥50,000.

In short, China still has quite some way to go to establish itself as an equal participant in the global markets for SEPs. Change is on the way, however; China's National IP Strategy seeks to increase IP revenues from US$2 billion in 2014 to US$80 billion in 2020. Even if only a limited share of this ambitious target figure is achieved, this could change the dynamics of the global SEP market.

Patent Challenges for China's IT Firms

It is important to step back for a moment and to reflect on important challenges that Chinese IT firms face with regard to patents. On the one hand, they need to file patents in foreign markets to expand their exports. In fact, China's leading smartphone companies are all aggressively expanding into overseas markets, as domestic demand growth is slowing down (Lucas 2017, 13). On the other hand, Chinese IT firms need to defend themselves against both foreign and domestic competitors to maintain their market share within China.

To cope with this dual patent challenge, Chinese firms, with the help of various government-backed programs, have engaged in a massive patent-filing push, as well as in outright patent purchases. The government plays an active role: it funds IP consortia to acquire global patents. In many respects, these consortia act like sovereign patent funds (SPFs). In addition, China's National Development and Reform Commission (NDRC) and other government regulators are investigating unfair business practices involving anticompetitive patent licensing.

As for exports, Chinese firms have three strategic options. First, they could mimic Xiaomi's patent-avoiding latecomer strategy. Chinese firms thus can enter foreign markets with little to no patent portfolio, hoping that they can avoid at least for some time patent infringement litigation. While this strategy saves the time and cost of developing or acquiring patents, this strategy also carries a substantial risk of future litigation. Consider the Delhi High Court ruling in *Ericsson v Xiaomi*, which reminded Chinese companies that they need to own high-quality SEPs if they want to avoid litigation in foreign markets.[33]

Second, Chinese firms could expand their own patent portfolios through R&D. More Chinese entities are filing patents in offices worldwide. As the five IP offices (IP5) reported in 2014, the USPTO received more than 17,000 patent filings and the EPO more than 26,000 originating from Chinese entities — an increase on 2013 of 17.9 percent and 18.2 percent, respectively.[34] However, as most Chinese firms apply for USPTO or EPO patents simply by translating their Chinese patents into English, this massive filing push creates concerns about patent quality and, if challenged, allows for patents to be invalidated.

Companies such as Huawei, ZTE and Lenovo have nevertheless successfully expanded their patent portfolios based on their own R&D. Huawei, for instance, saw its USPTO patent grants increase year-on-year from 800 in 2015 to 1,202 in 2016 (Lloyd 2017).[35] As for WIPO's

31 Author's interview with industry expert who requested anonymity.

32 Author's interview with industry expert who requested anonymity.

33 Ericsson's litigation threat also halted Xiaomi's expansion plans for Russia and Brazil.

34 From www.fiveipoffices.org data, reported in Jou, Wu and Chan (2015). The members of IP5 are the EPO; the Japan Patent Office; the Korean Intellectual Property Office; SIPO; and the USPTO.

35 For details on Huawei's rapidly growing patent portfolio, see Network flagships, below.

Patent Cooperation Treaty (PCT) grants in 2016, Huawei was leading for the second consecutive year, with 3,898 published PCT applications, or an additional 456 applications over 2015, while China's ZTE Corporation ranked third with 2,155 PCT applications (WIPO 2016b). Of interest also is Alibaba's strategy, which was to actively strengthen its global patent portfolio several years before its initial public offering in the United States. According to Patentcloud, Alibaba has over 3,800 active patent grants and applications globally.[36]

A potential game changer could be Xiaomi's recent announcement that its affiliate Beijing Pinecone Electronics has designed its own processor for Xiaomi's mid- to low-priced smartphone model RedMi Note series.[37] Xiaomi has hired 200 to 300 engineers to work on smartphone chip design in cities including Nanjing, Shanghai and Beijing. This implies that Xiaomi is now seeking to replicate the model, from Apple, Samsung and Huawei, of designing processor chips in-house. It is, however, too early to judge whether this bold strategy will succeed.

A third option for Chinese exporters would be to purchase quality patent portfolios from well-established sources. A major example is the previously mentioned purchase by Xiaomi of 1,500 Microsoft patents. (See the list of recent Chinese patent acquisitions in the box below.) While this strategy may yield quick results, it can be costly. Although not as time consuming as applying for patents, purchasing patents requires time for patent portfolio evaluations. Note, however, that, through subsidies, the Chinese government has alleviated much of the cost for companies purchasing patent portfolios.

As the Chinese market becomes more fiercely competitive, maintaining a robust patent portfolio within China is becoming both a defensive and offensive strategy for companies. Chinese innovators continue to face patent litigation threats from operating entities, and increasingly from NPEs.[38]

36 See www.patentcloud.com/.

37 Yang and Liu 2017. Like most other smartphone makers, Xiaomi continues to rely on Qualcomm's baseband processors, but now it seems to be searching for ways to break the monopoly on chip technology by foreign companies and increase the value of its own patent portfolio.

38 For details, see New challenges from NPEs in the conclusion.

Unequal Distribution of SEP Ownership

Patenting by Chinese residents remains highly concentrated among a few Chinese firms and regions, and only in a handful of sectors. As China's large firms and research institutes are becoming increasingly sophisticated in the development, protection and use of patents, they are shifting to a more strategic approach to patenting. According to a recent SIPO study, motivations include occupying a technological space, averting litigation, increasing bargaining power in IP negotiations, improving their corporate image, and deriving revenues from royalty and licence fee income. SIPO emphasizes that "the strategic motives are becoming increasingly relevant" (WIPO 2014, 1).

The SIPO study also highlights the unequal distribution of SEP ownership. An important finding is that the percentage of large Chinese enterprises (including central SOEs) whose patented technologies are adopted as SEPs into standards or patent pools is notably higher than that of Chinese SMEs.

In order to better understand how SEP-related market failures give rise to the unequal distribution of SEP ownership and benefits, it is necessary to conduct empirical research that is based on the distinction, introduced in the third part of this report, between network flagships, higher-tier and lower-tier network suppliers.

Network Flagships

Huawei, the world's largest telecommunications equipment vendor and a rising force in smartphones, fits all the criteria of a network flagship. Huawei's own GIN now includes, in addition to at least eight R&D centres in China, five major overseas R&D centres in the United States and around 14 R&D centres in Europe.

Huawei's extensive experience in standards setting and its significant investments in IP are documented in the following data (Huawei, n.d.). With a team of over 400 experts in standardization (of which more than 300 are working on mobile communications standards), Huawei is active in 150 domestic and international industry standards bodies (including the 3GPP, Internet Engineering Task Force, Institute of Electrical and Electronics Engineers [IEEE], ITU, Broadband Forum, ETSI, Alliance for Telecommunications Industry Solutions

[ATIS], TM Forum, Wi-Fi Alliance [WFA], Canadian Cable Systems Alliance [CCSA] and OMA), and occupying 180 leadership positions (including chairpersons of the ETSI, ATIS, IEEE, OMA, CCSA, WFA and Wireless Gigabit Alliance and Organization for the Advancement of Structured Information Standards). In 2012, Huawei submitted more than 5,000 international standard proposals.

In mobile communications, the company has filed over 57,800 patent applications in China, the United States, Japan, the European Union, South Korea and Brazil, of which approximately 15,000 are in the sphere of wireless communications. Huawei has declared 2,137 SEPs in the field of wireless communications. In compliance with ETSI's IPR policy, Huawei has declared 865 SEPs for the LTE EPC (Evolved Packet Core) standard (3GPP, n.d.(a)), holding about 15 percent of all SEPs related to this standard; 778 SEPs in the UMTS (Universal Mobile Telecommunication System) standard (3GPP, n.d.(b)), holding six percent of all essential patents for this standard; and 145 essential patents for the GSM (Global System for Mobile communications) standard (ETSI, n.d.), holding two percent of all SEPs related to this standard. As we saw in the second part of this study, Huawei now is number six among the 20 top owners of declared SEPs at leading SSOs, and number two for declared SEPs for 4G LTE and LTE advanced standards.

These impressive achievements have enabled Huawei to sign cross-licensing agreements with all major IPR holders in the wireless industry, including Ericsson, Nokia-Siemens, Alcatel-Lucent, Qualcomm, Nokia, Sony-Ericsson, Sisvel and other leading players. As a global network flagship, Huawei does what all large SEP holders do — they cross-license their SEP portfolios to one another, allowing each to manufacture standard-compliant products without infringing on the other's SEPs, and to receive compensation for its contributions to the standard.

However, even among those privileged players, cross-licensing of SEPs may well give rise to an unequal distribution of rents. As China's leading SEP owner, Huawei complains that the licensing fees it earns in those agreements are far lower than the fees that it had to pay. At present, there are only tiny crumbs of data available in the public domain on this imbalance. And we do not know the underlying causes. It is, however, plausible to assume that Huawei's SEP portfolio may contribute less value to the relevant standards than the SEP portfolio of top owners of declared SEPs like Qualcomm, and therefore will pay the net-balancing royalty. (This assumes of course that the declared value of the patent is real — a somewhat heroic assumption.) In addition, companies such as Qualcomm and Interdigital are years ahead in developing best-practice management approaches to maximizing gains from such cross-licensing agreements.

It is time to conduct systematic empirical research to examine this unequal distribution of gains from cross-licensing that seems to affect even a successful Chinese global network flagship such as Huawei.

Higher-tier Suppliers

Next in line are higher-tier suppliers such as Foxconn. Although incorporated in Taiwan, Foxconn has played a critical role as higher-tier supplier for China's IT industry. In order to upgrade beyond low-margin contract manufacturing as a provider of original-design-manufacturing services, Foxconn is searching for ways to diversify into higher-value-added knowledge-intensive activities. The company claims that it has accumulated over 55,000 patents worldwide to achieve this objective (Foxconn, n.d.).

In their role as subcontractors, however, higher-tier suppliers like Foxconn are often stuck in a position of "passive innovators." That is, they innovate in collaboration with the flagships that are typically brand marketers of final goods and services, and hence "remain weak in making market-oriented innovations in the sense of putting together different technologies to independently create final products for consumers" (Chen 2016, 14). Tain-Jy Chen raises important and largely under-researched questions for the study of how SEP-related market failures may affect higher-tier suppliers in global networks: how does a firm's position in global networks affect their ability to cope with and benefit from SEP-related market failures? What are the specific challenges that these higher-tier suppliers might face when they seek to upgrade their position within these global networks?

A possible candidate for such a higher-tier supplier from China might be Spreadtrum Communications, a Shanghai-based chip design company that develops mobile chipset platforms for smartphones and other mobile devices supporting 2G, 3G and 4G wireless communications standards. Located at the centre of the global semiconductor value chain,

Spreadtrum depends on both requirements and specifications from the demand chain, as well as technology and capabilities from the supply chain. According to the company's CEO, the availability of integrated circuit (IC) design tools, semiconductor fab services, and open-source smart-phone software (Android) has enabled Spreadtrum to circumvent its weak spots and develop its strengths in hardware, IC design and integration.[39]

To enable knowledge exchange between Spreadtrum and its technology suppliers and customers, many different standards are needed, and many SEPs are included in these standards. It is time to conduct in-depth empirical research that traces important knowledge flows and the standards that overlay these knowledge flows, and to construct patenting landscapes for important SEPs. It is on that basis that it will become possible to assess the impacts of some of the aforementioned SEP-related market failures on higher-tier suppliers.

Lower-tier Suppliers Are Caught in an SEP Inferno

Lower-tier supply companies have to survive on razor-thin margins and lack the capacity to invest in R&D and the development of their own IP. Their position in global networks is the equivalent of Dante's in *The Inferno* — lost, with little hope to move up to the *purgatorio* of higher-tier suppliers or the *paradiso* of network flagships (Dante 1472, 172). Nor do they have the capacity to improve their lot through participation in SDOs or standard consortia.

However, lower-tier suppliers need to license technology from higher-tier suppliers, the flagship and from outside technology suppliers. These companies simply don't have the means to negotiate fair access to SEPs on their own. Nor do they have what it takes to comply with the relevant standards. In short, public policy support is essential to providing lower-tier suppliers with enough space to accumulate the means and capabilities to move up to the *Purgatorio* level.

One possible way to provide such focused support may be through the establishment of a SPF. But it would work only for lower-tier suppliers who are genuinely motivated to invest in IP development and management capabilities. If the companies are not the drivers, SPFs can achieve very little.

Critics argue that SPFs "could end up with a large number of valueless patents aggregated at high cost" (Expert Group on IPR Valorisation 2012). In addition, SPFs could have a disruptive impact on trade as a new type of technical barrier to trade. Some observers emphasize that the US government takes a negative view of SPFs as an unwarranted and inherently inefficient government intervention into the free market. Hence, "establishing an SPF could theoretically make the creator of such funds a target for US legal action in forum such as the WTO. More broadly, the establishment of such a fund could undermine relations with the US policy makers and expose the creating country to the risk of retaliatory action" (Clarke 2014, 10).

Probably the most significant impediment to the establishment of SPFs are under-researched implementation issues, especially with regard to obtaining sufficient financial and human capital and the organizational design and governance structure of such SPFs. In fact, despite the hype created in the media about the threat from SPFs as "state-sponsored patent trolls," SPFs are facing considerable birth pains. Nevertheless, three such SPFs seem to work with a clear strategic focus: France Brevets, IP Bridge Japan, and Intellectual Discovery Korea.[40]

In the end, SPFs seem to work only if their primary task is to support the efforts of lower-tier suppliers (especially young, small companies with new ideas) to develop a broad portfolio of capabilities for IP development and management. In addition, the industry structure and business culture must be conducive for this type of public-private dialogue and partnership. Furthermore, institutions and incentives in support of SPFs must be limited in duration — but we know how difficult it is to discontinue such support programs.

39 Author's interview with Leo Li, CEO of Spreadtrum, June 22, 2012.

40 For France Brevets, see www.francebrevets.com/en; for IP Bridge Japan, see www.jetro.go.jp/en/mjcompany/ip_bridge.html; and for Intellectual Discovery Korea, see www.i-discovery.com/site/eng/overview/about.jsp.

What Policies Might Enable China to Improve the Framework Conditions for SEP Licensing?

Structured Price Commitments

A good starting point for policies that China might consider is the concept of "structured price commitments" proposed by Jean Tirole and Josh Lerner.[41] For Tirole and Lerner, a licensing "price commitment made prior to standard selection can restore *ex ante* competition and efficiency ... [But] ... price commitments are unlikely to emerge in the absence of regulation" (Lerner and Tirole 2015, 550). As forum shopping enables IP owners to shun SSOs that force them to charge competitive prices, public policy is required to impose mandatory structured price commitments on SSOs.

The authors admit that structured price commitments may not be feasible or that they may produce unintended negative side effects. In fact, SEP owners and their supporters have largely ignored these suggestions, as they would erode their highly profitable royalty income.

Ex ante Disclosure

The structured price commitments proposal builds on the policy of *ex ante* disclosure, introduced a few years earlier by the VMEBus International Trade Association (VITA), which was supported by the US Department of Justice (DoJ) (Contreras 2011). VITA standards today are used primarily in embedded computing systems designed for demanding environments including military, avionics, industrial and communications applications.

VITA's approach may provide important lessons for China's evolving SEP policies. But it also displays important constraints. It has quite extensive requirements for *ex ante* disclosure. VITA's *ex ante* disclosure policies have been successfully implemented, however, only in the closed community of companies that are active in the defence and related industries. Ray Alderman, who was instrumental in pushing through VITA's *ex ante* policy, explains the difference to Jean Tirole's "Structured Price Commitments" as follows: "FRAND only works when there is competition, among the IP owners. If patent holders are forced to declare their SEPs up front with their fees and royalties, that inspires other IP owners to declare theirs with their financial and licensing conditions. I do not see how this recess [i.e., the structured price commitment] does that. Competition is the mechanism that negates ambush and exorbitant fees and royalties" (Alderman 2016).

IEEE's New Licensing Policy

China's efforts to improve the governance of SEP licensing can also now draw on the IEEE's amended licensing policy, supported again by the DoJ. The new IEEE policy states that IEEE members holding patents covering IEEE standards:

- "must offer to license those patents to all applicants requesting licences to implement the standard, and cannot pick and choose among licensees;
- may not seek, or threaten to seek, injunctions against potential licensees, until an enabling court decision, sustained in an appeal;
- may insist that licensees offer them reciprocal licenses for the same standard under their own patents;
- may arbitrate disputes over FRAND terms;
- may charge a reasonable royalty that is based on the value attributable to the patented invention, excluding the value of that SEP's inclusion in an IEEE standard; and
- should ensure that subsequent purchasers of these patents agree to abide by the same commitments."[42]

In essence, IEEE's amended policy seeks to reduce uncertainty about what constitutes a reasonable royalty rate under FRAND conditions. An optional factor to consider when determining the reasonable rate is the value of the relevant functionality of the smallest saleable compliant implementation that practises the essential patent claim.

41 See Lerner and Tirole (2014, 972-73); Lerner and Tirole (2015, 547–86). "Structured price commitments" is defined as follows: "Before the standard is finalized (and unlike today's practice), there is a recess, during which firms commit to a price cap at which they will grant nondiscriminatory licenses to their patents. Firms make commitments to the maximum price (and most restrictive terms) that they would charge before the patent is included in the standard" (Lerner and Tirole 2014, 972).

42 From the IEEE-SA website, http://standards.ieee.org/develop/policies/bylaws/sect6-7.html. See also Contreras (2015a).

Thus far, large SEP owners such as Qualcomm, Ericsson and Nokia, as well as NPEs such as InterDigital Corporation (IDC) and Intellectual Ventures, are still refusing to license their SEPs under the new IEEE rules. However, a larger group of IT companies, including Cisco and Intel, insist that the IEEE licensing rules are vital for establishing clearer guidelines to SEP licensing on FRAND terms. Large SEP owners and their supporters are fighting rearguard battles. The rising pressure from standard implementers and consumers will sooner or later shift the tide against the current SEP-related market failures. Take, for instance, the Fair Standards Alliance, whose members include large multinationals like Daimler, Volkswagen, Cisco, Dell and Google, as well as innovative SMEs and start-up companies (Fair Standards Alliance 2017).

All of the above policies emphasize a reform of rules and regulations within standard development organizations that would improve the governance of SEP licensing. For these reform efforts to succeed, a more active role for competition policy is required, as evidenced by the important supporting role that the DoJ played in bringing about the VITA and IEEE policies. In short, competition policy now needs to join patent and standards policies, as well as SDOs and courts to improve the governance of SEP markets.

China's Main Policy Response: Competition Policy

An assessment of China's policy responses needs to start with the government's approach to competition policy. China, together with Japan and Korea, is at the forefront of experimenting with new approaches to IP-related competition policy. This happens at the same time as competition policy is now under attack by the Trump administration in the United States.

Court Decisions Shape China's Policy on SEP Licensing

Judgments by the Guangdong High Court, published in April 2014 in two *Huawei Technologies v InterDigital Corporation* cases have played a catalytic role in shaping China's policy on SEP licensing. This gradual shift away from top-down, government-centred decision making to specialized higher courts is an important catalyst for the reform of China's SEP policy.

In the court's judgment, Huawei prevailed in its claims that IDC, a leading US NPE, has abused its dominant market position, and that IDC has failed to license its SEPs on FRAND terms. The court supported Huawei's claim that IDC had abused its dominant market position by:

- mandating a tying arrangement in its licence agreements, for example, by bundling essential patents with non-essential patents;
- requiring grant-backs, that is, requesting free licences back; and
- requesting a discriminatory and unreasonably high royalty rate for its Chinese SEPs and non-SEPs.

As for Huawei's second claim, the Guangdong High Court affirmed the Shenzhen Intermediate Court's ruling that IDC had imposed excessively high royalty rates for its SEPs relating to 2G, 3G and 4G wireless communications standards. Specifically, the court found that IDC's royalty rates were noticeably higher when compared to its licensing agreements with Apple and Samsung. The latter issue still remains undecided; the case is pending before the Supreme People's Court for review.

In addition, there are now signs that the government is considering introducing a national IP appeals court. This may be a further positive

development, and could support China's gradual move toward a more rule-based approach to SEP licensing. It is important, however, to highlight powerful countervailing developments. Most important, there has recently been a backlash against the independence of courts. In a stunning about-face, the president of China's Supreme People's Court (an erstwhile reformer) has recently denounced the idea of judicial independence — a move that jeopardizes far-ranging efforts to create impartial legal institutions in China (Hornby 2017).

China's New Role in Competition Policy

In any case, court decisions have created a framework for a more activist Chinese policy on SEP markets. Since Qualcomm's settlement with NDRC in February 2015, China has become the main frontier for SEP-related competition policy.

Three regulatory bodies overlap in their mandates (US-China Business Council 2014, 4).

The Ministry of Commerce (MOFCOM), through its Antimonopoly Bureau, is responsible for reviewing mergers and acquisitions transactions and other types of proposed business concentrations. It may approve or reject these transactions, with or without conditions. The NDRC, through its Price Supervision and Antimonopoly Bureau, manages enforcement of price-related conduct, including investigations of pricing practices by companies, price-related aspects of monopoly agreements and company abuse of dominant market position to set or control prices. Third, the State Administration for Industry and Commerce (SAIC), through its Antimonopoly and Anti-Unfair Competition Bureau, is in charge of investigating non-price-related monopolistic behaviour, including monopoly agreements, abuse of market dominance, and monopoly control.

All three enforcement agencies have considerably increased the number of enforcement staff to expand their role in enforcing competition law, including merger reviews and investigations of alleged anticompetitive behaviour related to pricing and monopolistic conduct.

MOFCOM has increased capacity and expanded its mission so that global transactions — even those between foreign companies that have little business in China — must be reviewed in China. The NDRC has also taken significant steps to increase its level of enforcement activity, particularly since early 2013. Of the three agencies charged with carrying out the enforcement of China's Anti-Monopoly Law, SAIC has received the least media attention. Yet, SAIC, like its counterpart agencies, continues to slowly build its enforcement capacity by increasing staffing and caseload. In April 2015, the SAIC released its own guidelines on what constitutes abuse of IP rights. Although the rules are not binding on other regulators or the judiciary, they are seen as an important step toward clarifying policy. However, "the broad and exceedingly vague and open-ended language…raises tremendous uncertainty and in general intrudes on the core exclusionary right of rights holders" (Schindler 2015, 4).

In its 2015 settlement with Qualcomm, NDRC has imposed important restrictions on that company's licensing practices: rates are fixed at between 3.5 and 5 percent from a royalty base of 65 percent of net selling price, and the company has been instructed to stop including expired patents in licensing packages and demanding grant-backs free of charge. As a result, the producer of a 4G-capable smartphone, for example, will now pay Qualcomm no more than 2.28 percent of the handset's wholesale price, down from the 3.5 percent rate Qualcomm previously demanded.[43]

The NDRC also made determinations in areas that are ostensibly part of the SAIC's remit, declaring as illegal both the tying of SEPs to non-SEPs and the conditioning of chip sales on licence agreements.

It is widely assumed in the United States that NDRC's decision on Qualcomm was a prime example of China's state-sponsored industrial policy. Yet, extensive interviews conducted with China-based industry experts show that the primary objective was to reduce antitrust violations in the market for SEPs for mobile communication technologies. Qualcomm's licensing policy matters for China. After all, Qualcomm holds the largest number of SEPs over the cellular communication generations of 2G (CDMA), 3G (WCDMA), and 4G (LTE).

NDRC's decision in the Qualcomm case has had quite dramatic implications, and not only for the SEP-related competition policy scene. Most important, the NDRC decision has cut loose a chain of events that is beginning to transform

43 Before the NDRC settlement, Qualcomm accounted for about 60 percent of China's market for mobile phone chipsets, charging the highest royalty rates in the smart-phone industry – at five percent of the wholesale price of a smartphone.

existing global SEP markets. Qualcomm now finds itself under attack from all sides:[44] from multiple regulators, in addition to NDRC, including Korea's Fair Trade Commission (KFTC) and the US Federal Trade Commission (FTC); from its main customer, Apple;[45] and from its own shareholders. In the end, Apple's lawsuits may turn out to be a game changer. In line with the Trump administration's withdrawal from an activist competition policy, the new head of the FTC is unlikely to further pursue the FTC ruling.[46] And neither NDRC nor KFTC are likely to change Qualcomm's cross-licensing business model. In the end, Apple's lawsuit may have a much more lasting impact, although it will take a while to materialize.

Should Patent Licensing Rates Differ?

An important new area of China's SEP-related competition policy are efforts to apply to patent licensing the WTO's special and differential (SD) treatment provisions for trade agreements, which give developing countries special rights (WTO, n.d.(a)). Chinese IT companies are now lobbying the government to adjust FRAND licensing conditions to the specific characteristics of the Chinese IP market, arguing that Chinese companies ought to get a discount relative to companies from advanced countries.

A vocal proponent for SD treatment of patent licensing in China is Xiaomi's chief IP strategist, Paul Lin. In his view, it is unfair and discriminatory to charge Chinese companies with royalty rates like those that are applicable to the United States or the European Union. "That argument might work for companies selling globally with sales across many countries, but it fails completely to resonate with Chinese companies that sell most of their products in China because there are simply not enough patent assets in the licensors' local portfolio to justify such rates.... The licensor needs to take into consideration a market's unique dynamics and develop a licensing programme that can be accepted in that marketplace accordingly."[47]

Lin and other Chinese IT industry executives argue that Chinese competition policy is called upon to correct this imbalance: "The heart of FRAND-related issues from the licensees' perspective is really fair competition (remember 'cost' is one major part of competition). No government will see their domestic companies being unfairly forced into less competitive positions without doing anything about it. That's why there are regulators" (ibid.).

China's competition authorities seem to be inclined to follow this suggestion. Ironically, they could quote recent statements in December 2015 by the US Court of Appeals for the Federal Circuit that the same patented technology may not necessarily be worth the same "fair and reasonable" value in all places and different jurisdictions, as well across all stages of the value chain (that is, chip versus final product) (Beeney 2016, 7). The new US FRAND doctrine holds that "non-discriminatory terms for all do not require identical terms for all. It thus may be reasonable, lawful and commercially acceptable to treat differently (within limits) licensees that are not similarly situated. This includes proportional 'better deals' for those which provide benefits to the licensor in forms other than cash royalties (eg, early adopters, high-volume producers, market leaders that drive technological adoption and those that provide valuable grant-backs or contribute valuable intellectual property to pool or joint licensing programs)" (ibid.).

It is safe to assume that China's competition authorities may exploit this new opening for a more targeted approach to SEP-related competition policy.

44 See, for instance, Mickle (2017), Fortune (2016), FTC (2017a) and Daniels (2017).

45 In addition to its lawsuit against Qualcomm in the United States, Apple has also filed a lawsuit against Qualcomm at Beijing's Intellectual Property Court, alleging the chip supplier abused its clout in the chip industry and seeking ¥1 billion (US$145.32 million) in damages. This indicates that China is becoming a serious contender in global SEP litigation battles.

46 On January 25, 2017, Maureen K. Ohlhausen, a Republican who favours a retreat from activist competition policy, was appointed acting chairman of the Federal Trade Commission (FTC) (FTC 2017b).

47 Paul Lin is quoted in Wild (2017): "Licensors must understand that what is FRAND in US and EU may not be in China, says Xiaomi IP strategy chief, Paul Lin."

Conclusion

This report documents how China has substantially improved its position in global SEP markets in the IT industry over the past few years. China still struggles, however, to reduce the impact of SEP-related market imperfections; most Chinese IT firms continue to depend on SEP licensing from leading foreign SEP owners, and they are exposed to high licensing fees and litigation challenges.

Looking ahead, three important unresolved issues will deserve particular attention: first, new challenges that Chinese IT firms face from NPEs; next, adjustments in patenting strategies that result from increasing technological complexity resulting from the convergence of computer, communications and the Internet; and finally, pervasive uncertainty caused by rising economic nationalism and the threat of trade and investment warfare inherent in the Trump Trade Doctrine.

New Challenges from NPEs

There is a growing concern in China that NPEs may increasingly target its IT firms, thus starting a new wave of patent wars. As leading multinationals with large patent portfolios have strengthened their defense against litigation attacks from NPEs, the NPEs appear to be turning their attention away from those defendants with the deepest pockets. According to RPX, a leading patent consolidator, there has been a significant drop-off in NPE litigation campaigns against large companies with revenues of US$50 billion or more. This suggests that NPEs may be shifting their focus toward more vulnerable targets. China is likely to be a primary target, given the growing attractiveness of its IP market.

Chinese companies are highly vulnerable against NPE attacks, because NPEs produce no goods and thus do not face the same risk of retaliatory patent infringement actions from Chinese companies. Even with a robust patent portfolio, Chinese companies still run a risk of litigation from NPEs if they expand into other countries. More of a company's funding must thus be spent filing costly invalidity actions against an NPE's patents or else settling an infringement case by giving in to the NPE's demands. Chinese companies are, in fact, increasingly concerned that NPEs from the United States may hinder their export and upgrading strategies.

Two recent examples that involve China's leading SEP owners illustrate what is at stake. Even with a global portfolio of 40,901 patents, ZTE, China's second-largest telecom equipment vendor, was unable to prevent Vringo, a US-based NPE, from obtaining injunctions against certain ZTE products in several jurisdictions. And Huawei is now under attack by Unwired Planet, another US NPE. Using its 2G, 3G and 4G SEPs that it acquired from Ericsson, Unwired Planet filed infringement lawsuits against Huawei in London and Dusseldorf in March 2014, with the final outcome still pending (Hodges 2016).[48]

In response to NPE attacks, Chinese, but also Japanese, Korean and Taiwanese companies are seeking to develop Sovereign Patent Funds. For instance, China's Ruichuan IPR Funds was established in April 2014 to protect Chinese companies from litigation within Greater China and abroad. It has already made patent acquisitions in the mobile and smart-phone industry; members include Xiaomi and TCL, which both stand to benefit from Ruichuan's patent pool as they expand into other countries. However, as NPEs have vastly superior financial and legal resources, Ruichuan may continue to encounter difficulties protecting Chinese companies.

Another possible response for Chinese companies would be to participate in defensive alliances such as the License on Transfer (LOT) Network, whose members pledge that any time they transfer a patent to an NPE, they will grant a licence to all of their fellow members (LOT Network 2017). Among Chinese IT companies, only Lenovo has joined thus far. Other Chinese IT companies prefer to keep their options open when it comes to transferring their IP assets — after all, these assets are still very young and vulnerable.

Technological Complexity

Chinese IT companies face serious challenges to develop a viable portfolio of SEPs that are essential to standards needed for emerging advanced networking technologies. With few exceptions, Chinese firms lack the capacity to cope with

48 In January 2017, the UK Patents Court heard the trial of the FRAND license royalty case in Unwired Planet v Huawei & Samsung, and a written decision is expected in early 2017, unless the case settles (TaylorWessing 2017).

increasing technological convergence. Take the smartphone, which requires a convergence of diverse technologies — telecommunications, semiconductors, displays, speakers and cameras. As mentioned at the beginning of this report, a smartphone today is typically covered by around 250,000 patents (Reidenberg et al. 2015). A viable SEP portfolio thus would need to balance operating system and application software, user interface, wireless, display, and semiconductors, as well as various other important technologies.

But technological complexity is a moving target. The convergence between the Internet and a broad array of information, communication, sensor, artificial intelligence, and robotics technologies into so-called IoT systems multiplies the requirements for useful and robust SEP portfolios.

To cope with these challenges, Chinese companies may consider participating in emerging specialized patent pools. One option may be to participate in a patent pool for IoT-related SEPs, called Avanci. This patent pool was established in April 2016 with the support of Ericsson, which seeks to provide an efficient, transparent platform to license essential wireless patents to the IoT (ReTHINK Wireless 2016). Avanci acts as a coordinator to ensure a fair deal for everyone involved while also simplifying patent licensing. The focus is on bringing together the big SEP holders, and providing predictability and convenience to them, with less litigation. In addition to Ericsson, Avanci participants include Qualcomm, IDC and Sony, as well as China's ZTE.

Another interesting approach is a patent pool for voice recognition technology, initiated by Baidu in late 2015, which claims that patents would be opened up to members for free. The group's membership reflects its focus on the IoT and other converged technologies: automaker BAIC, appliance manufacturer Haier, chipmaker BOE and e-commerce platform JD.com are members, while ZTE originally joined, but later left.

Baidu's voice recognition patent pool thus far has only Chinese members. Given the language issues involved in voice recognition technology, it might make sense to have a technology specifically designed for the Chinese market. This may also help to navigate China's tightly regulated online space. In the longer term, however, this narrow focus signals the danger of technological isolationism. Developing an IoT for China only would be a disastrous cul-de-sac. Both for IoT-related to advanced manufacturing, and for smart cars or smart grids, China can thrive only if it remains part of the international R&D circuit. The need for such openness is reflected in Baidu's decision to build a 100-person driverless car development team in Silicon Valley and to seek regulatory approval to test such vehicles in California.

While technological complexity raises immense new challenges for the development of viable SEP portfolios, China's leading IT firms are pursuing aggressive strategies to address these challenges. It is thus safe to assume that sooner or later some of these firms will come up with innovative solutions.

The Rise of Economic Nationalism — Uncertainty Due to a possible US-China Trade Conflict

Rising economic nationalism, especially in the United States, creates pervasive uncertainty with unknown consequences for China's efforts to improve the framework conditions for SEP licensing.

The so-called Trump Trade Doctrine signals a fundamental break with established US trade diplomacy. At his inauguration, Trump laid out a vision of unabashed protectionism: "We must protect our borders from the ravages of other countries making our products, stealing our companies and destroying our jobs. Protection will lead to great prosperity and strength." Moreover, "We will follow two simple rules: buy American and hire American." Success is measured by the following criteria: any trade deal "must increase the growth rate [of the economy], decrease the trade deficit and strengthen the US manufacturing base" (Wolf 2017a).

An official statement of the Trump Trade Doctrine is contained in a 336-page policy document that states categorically: "It is time for a new trade policy that defends American sovereignty, enforces US trade laws, uses American leverage to open markets abroad, and negotiates new trade agreements that are fairer and more effective both for the United States and for the world trading system, particularly those countries committed to a market-based economy" (USTR 2017).

To most observers, this "America First" doctrine is tantamount to a declaration of economic

warfare.[49] Specifically regarding China, the declared intention of the Trump administration is to impose an across-the-board 45 percent tariff on Chinese imports.[50] In addition, the Trump administration threatens to implement broad sanctions under the Section 301 of the US Trade Act, as well as aggressive screening of inward Chinese FDI.

The United States remains the predominant economic and military power, but it can no longer dictate the rules of international trade. The Trump Trade Doctrine faces significant legal and implementation risks. Across-the-board tariffs on Chinese imports at a higher level than the United States' most-favoured nation tariffs for other WTO members would prompt a WTO legal case from China, which the United States is almost certain to lose. The WTO has already declared parts of Section 301 of the US Trade Act illegal. In response, White House National Trade Council Director Peter Navarro reportedly has tasked staff at the Office of the USTR to outline ways in which the United States could move away from using the WTO dispute settlement system, with a shift to more unilateral actions against trading partners (World Trade Online 2017a; *Financial Times* 2017).

But, if the result were indeed open trade warfare, this would result in high risks for the global economy.[51] And both the United States and China would have to pay a heavy price. According to Martin Wolf (2017b), the damage to the US economy will be significant: "The policies proposed by Mr. Trump and the congressional Republicans — a combination of piecemeal protectionism with a large fiscal stimulus as well as elimination of much of the social safety net — is likely to impose large costs on unprotected sectors, while leaving supporters even more desperate." In fact, concern is building within the US Congress. For example, House Ways and Means Chairman Kevin Brady, a Republican, has said, "I strongly believe that our current trade agreements — including the WTO — have been successful for Americans" (World Trade Online 2017a).

Statements from the Chinese government leave little doubt that China can very effectively retaliate and can do considerable damage to US exports, targeting, in particular, agriculture, Boeing and semiconductors. Open trade warfare thus could cost the US millions of jobs (Noland et al. 2016).[52] China is prepared for a long battle of attrition, ranging from a campaign of silence and non-cooperation to retaliatory open trade warfare. To start with, China has re-emphasized its watertight commitment to the WTO system (World Trade Online 2017b). In addition, China could target critical Midwestern swing states that enabled Trump's victory, and thus hurt the companies in those states. In the open US political system, it is much harder to manage discontent and political blowback than in the authoritarian Chinese system. Trump's trade warfare against China therefore could really backfire on him.

All of this implies that the Trump Trade Doctrine will face tremendous implementation hurdles. There is no doubt that much damage can be done; existing and highly vulnerable global supply and demand chains will be disrupted, with far-reaching consequences for macroeconomic and social costs. But, in the end, significant changes would be unavoidable for the international systems

49 A bipartisan task force report of prominent China specialists, issued on February 7, 2017, expressed concern "about the increasingly antagonistic relationship," and argues that "the U.S. needs to up its game in terms of the effort it puts into high-level negotiations" (Task Force Report 2017).

50 According to Susan Shirk, chair of the Task Force Report 2017, "across-the-board tariffs or challenging the One China Policy is not the way to go.... We shouldn't undervalue what we've achieved over the years – a more or less peaceful Asia, a big market for exports and a key partner on global problems, like climate change. If this was to become unhinged, it's not just chaos in Asia but destabilizing for the global economy" (Barboza 2017).

51 A recent report by Fitch, the credit rating agency, states that the "aggressive tone" of the Trump Trade Doctrine poses global risks (Reuters 2017). And hedge fund managers are concerned about increasing uncertainty: "Not only is Trump shockingly unpredictable, he's apparently deliberately so; he says it's part of his plan" (Sorkin 2017).

52 If China switched from Boeing to Airbus, for example, the United States would lose some 179,000 jobs. Reduction in US business services would cost another 85,000 jobs. Soybean-producing regions – for example, in Missouri and Mississippi – could lose some 10 percent of local jobs if China halted imports (Noland et al. 2016).

of patents and standards. Basic parameters that so far have shaped the global markets for SEPs will now be challenged. And no one really knows how this might affect SEP-related corporate strategies and government policies.

In light of such pervasive uncertainty, China's government and its IT companies will find it difficult to determine what adjustments are needed in China's approach to SEP development and licensing. There is, however, little doubt that China will continue to upgrade its capacity to compete in global SEP markets.

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