Governing the Patent Commons

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Abstract:

Thousands of patents underpin the technologies that power the digital economy. Coordination among firms developing and implementing these novel technologies has notably been facilitated in large part by Standards Developing Organizations (SDOs). Despite the evident benefits of standardization in general and SDOs in particular, certain aspects of these processes have come under severe scrutiny from scholars, antitrust authorities and courts. These critics argue that the standardization space suffers from two crippling market failures, namely "patent holdup" and "royalty stacking". They thus conclude that opportunistic firms will squeeze their rivals' profits, harming consumers and stifling innovation in the process. However, recent empirical scholarship strongly suggests that patent holdup and royalty stacking rarely, if ever, occur in the standardization space.

Against this checkered backdrop, our paper argues that standardization is an emergent phenomenon, where parties have strong incentives to design institutions and contractual relationships that mitigate the scope for opportunistic behavior (including patent holdup and royalty stacking). The paper explores how these incentives have likely enabled firms to avoid severe market failures. We argue that ignoring these complex market dynamics may cause antitrust authorities and courts to do more harm than good (notably by exacerbating patent holdout behavior). The paper then reviews recent regulatory interventions and questions whether this has indeed been the case. Finally, we suggest that antitrust authorities and courts should draw inspiration from acclaimed scholarship regarding both the evolution of cooperation and the management of common-pool resources.

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I. Introduction

> "*The greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity, and judgement with which it is any where directed, or applied, seem to have been the effect of the division of labour.*"
>
> Adam Smith[1]

An estimated 5 Billion people around the globe currently own a mobile device, of which about half are smartphones.[2] It is worth taking a minute to reflect on this stunning figure. 5 Billion is roughly the same as the number of people with access to safe drinking water.[3] The widespread adoption of cellphones in general and smartphones in particular improves economic productivity and growth.[4] It has notably enabled swaths of previously unbanked adults to have access to essential financial services, thus allowing them to safely save money and receive payments for their services.[5] In industrialized economies, the ubiquity of smartphones has also led a proliferation of online platforms, spanning a large range of sectors, from transport, to payments and dining. These developments all have one important factor in common: they allow for an ever-greater division of labor. As Michael Munger observes in his book, *Tomorrow 3.0*, the platform economy is bringing about a tremendous reduction

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[1] A. SMITH, WEALTH OF NATIONS 9 (Cosimo Classics. 2007).

[2] GSMA, THE MOBILE ECONOMY 2018 4 (2018), http://www.pewglobal.org/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/. https://www.gsma.com/mobileeconomy/wp-content/uploads/2018/05/The-Mobile-Economy-2018.pdf.

[3] Fact sheets, World Health Organization, Drinking-water (Jun. 14, 2019), https://www.who.int/news-room/fact-sheets/detail/drinking-water

[4] DELOITTE, GSMA, CISCO, WHAT IS THE IMPACT OF MOBILE TELEPHONY ON ECONOMIC GROWTH? (2012), https://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf.

[5] JUNE ARUNGA & BILLY KAHORA, THE CELL PHONE REVOLUTION IN KENYA (2007), http://www.brunoleonimedia.it/public/Papers/IBL_Arunga_Kenya.pdf; https://www.telegraph.co.uk/technology/2017/02/28/mobile-phones-can-connect-unbanked-people-solve-indias-financial/.

in transaction costs that will ultimately increase specialization throughout the economy, and hopefully spur growth for decades to come.[6]

And smartphones (as well as the platform economy more generally) are not just a driving force behind improvements to the division of labor; they are themselves a triumph of specialization. Over 10,000 patent families are essential to 4G technology, while about 7000 are essential to 3G.[7] While some critics have posited that this makes it extremely difficult to effectively market 4G phones (though the proliferation of smartphones suggests otherwise), it is worth looking at this from another point of view: 4G technology marks the culmination of research efforts spanning the entire globe; the coordinated efforts of these numerous firms are not the result of government coercion, but the free play of competitive forces.

Coordination on such a vast scale is no simple task. And yet, of the vast array of options that are available to them, an increasing number of firms have settled on one particular paradigm to solve these coordination problems: the development of new technologies within Standards Developing Organizations (SDOs). These organizations and their members are responsible not only for wireless cellular technologies (*e.g.*, 3G, 4G) but also for such high-profile technologies as Wi-Fi, USB, and Blu-ray, among many others.

But despite the market's revealed preference for developing technologies within SDOs, and the numerous success stories that have emerged as a result, some scholars have argued that the standardization space is afflicted by two crippling market failures: patent holdup and royalty stacking.[8] Their central claim is that standardization puts patent holders in a position to opportunistically extract royalties for implementers, and that these anticompetitive effects are compounded by the large number of

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[6] *See* M.C. MUNGER, TOMORROW 3.0 xiv (Cambridge University Press. 2018).

[7] JORGE PADILLA, JOHN DAVIES, & ALEKSANDRA BOUTIN, ECONOMIC IMPACT OF TECHNOLOGY STANDARDS (2017), https://www.compasslexecon.com/wp-content/uploads/2018/04/CL_Economic_Impact_of_Technology_Standards_Report_FINAL.pdf; IRUNWAY, PATENT & LANDSCAPE ANALYSIS OF 4G-LTE TECHNOLOGY (2012), https://www.i-runway.com/images/pdf/iRunway%20-%20Patent%20&%20Landscape%20Analysis%20of%204G-LTE.pdf

[8] *See, e.g.,* Mark A Lemley & Carl Shapiro, *Patent holdup and royalty stacking*, 85 TEX. L. REV. 1991 (2006), *See also,* Joseph Farrell, John Hayes, Carl Shapiro & Theresa Sullivan, *Standard setting, patents, and hold-up*, 74 ANTITRUST LJ 603 (2007).

complementary patents that must be assembled in order to comply with most standards. In reaching these conclusions, critics also tend to overlook the flipside of the holdup coin: The asset-specific investments that regularly take place in the standardization space also raise the prospect of holdout, whereby implementers deploy various tactics in order to avoid paying licensing fees for a patent.[9]

Against this backdrop, our paper argues that, in the long run, patent holders and implementers have tremendous incentives to order their affairs in ways which minimize the occurrence of patent holdup, royalty stacking and patent holdout. We find that relying on these private incentives is, in many ways, preferable to heavy-handed policy interventions that, in an attempt to curb patent holdup and royalty stacking, may actually incentivize holdout behavior and reduce innovation.

The paper proceeds as follows: Section II documents the emergence of standards and standard-setting organizations. It notably shows that *de jure* standardization (through SDOs) is part of a long history of firms coordinating their behavior in order to produce interoperable technologies. SDOs have thus had to "outcompete" other methods of standardization. This has led them to adopt internal policies that balance the incentives of patent holders and implementers, in order to maximize their technological output. Section III outlines the case that critics have made against current standardization procedures. It then shows that these fears have not withstood empirical scrutiny. We outline various factors that might explain this empirical falsification, and argue that, even if holdup and royalty stacking does sometimes occur, the proposed solutions would likely do more harm than good (notably be reducing incentives to innovate and emboldening holdouts). Section IV looks at the responses of SDOs, courts and antitrust authorities to the holdup literature. One key finding is that, albeit to varying degrees, most policymakers, especially courts, have not fully endorsed the normative proposals put forward by patent holdup scholars. Finally, Section V concludes by arguing that policymakers should take a leaf out of the vast

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[9] *See* Colleen V Chien, *Holding up and holding out*, 21 MICH. TELECOMM. & TECH. L. REV. 1, 20 (2014). (Chien defines hold-out as "*the practice of companies ignoring patents and patent demands because the high costs of enforcing patents makes prosecution unlikely—or, in other words, because they can get away with it.*").

scholarship that deals with the evolution of cooperation[10], and the management of common-pool resources[11].

II. The emergence of standards and standards developing organizations

Throughout history, economic actors have sought to reap the benefits of specialization and interoperability. This has led to the emergence of various standardization practices, ranging from *de facto* standards and competition for the market, to complex standard-setting procedures within SDOs. This section offers a typology of these standardization practices. We ultimately show that, because interoperability standards hinge upon firms coordinating their behavior, standardization necessary implies a degree of incentive compatibility. That is, parties will only coordinate their behavior if they expect this to be mutually beneficial. In the world of *de jure* standardization, this implies that SDOs must design balanced internal rules which bring both implementers and patent holders to the table.

A. Interoperability standards v. quality standards

Standards play a crucial role in many industries. Standards may relate either to quality or interoperability, or both. Quality standards seek to establish minimum standards of quality for products and services. Interoperability standards seek to ensure that components of products are able to work together.

The need for quality standards emerged because of the difficulty and costs associated with identifying the quality of products. Often such standards have been imposed by governments. Beginning in the late 19th century, private organizations such as Good Housekeeping began developing their own standards for foods and other consumer

[10] *See, e.g.,* Robert Axelrod & William D Hamilton, *The evolution of cooperation*, 211 SCIENCE 1390 (1981).

[11] *See, e.g.,* ELINOR OSTROM, GOVERNING THE COMMONS (Cambridge university press. 2015).

products.[12] In 1906, the International Electrotechnical Commission introduced the first standards for electrical goods.[13]

Interoperability standards—the main subject of this study—began much earlier. Arguably the earliest such standards were measures of distance and time, which enabled more precise communication, calculation, and coordination.[14] Many of these standards persisted for centuries or even millennia—and some, such as the number of hours in a day, or minutes in an hour have become universal, in spite of occasional attempts to introduce alternatives.

In game theoretic terms, interoperability standards can be analogized to the well-know "Battle of the Sexes" game. The basic problem is the following. A man and a woman must choose a venue to go on a first date. The man prefers one venue while the woman prefers another. However, both would rather go anywhere together, rather go to their preferred venue alone:

		Woman	
		Venue 1	**Venue 2**
Man	**Venue 1**	**3,2**	0, 0
	Venue 2	0, 0	**2,3**

Figure 1: "Battle of the sexes" payoff matrix

[12] *About the GH Limited Warranty Seal*, GOOD HOUSEKEEPING (May 31, 2014), https://www.goodhousekeeping.com/institute/about-the-institute/a22148/about-good-housekeeping-seal/; *The History of the Good Housekeeping Seal*, GOOD HOUSEKEEPING (Oct. 1, 2011), https://www.goodhousekeeping.com/institute/about-the-institute/a16509/good-housekeeping-seal-history/

[13] ANSI: CELEBRATING 100 YEARS 1918-2018, https://www.ansi.org/about_ansi/introduction/history?menuid=1 (last visited Jul. 17, 2019).

[14] Michael A. Lombardi, *Why is a minute divided into 60 seconds, an hour into 60 minutes, yet there are only 24 hours in a day?,* SCIENTIFIC AMERICAN, https://www.scientificamerican.com/article/experts-time-division-days-hours-minutes/.

Though numerous implications have been derived from this game, the most relevant here is that the ability to coordinate decisions can generate significant value.[15] This type of coordination problem can notably be seen at play with traffic legislation. Though drivers may differ with respect to the side of the road on which they would prefer to drive, these minor preferences are dwarfed by the value that is generated if everyone can agree to drive on the same side (thereby avoiding accidents and a significantly higher probability of injury and death). Ultimately, what matters is that players coordinate their decisions on the same choice. As numerous authors have suggested, this problem is one of the most important drivers of interoperability standards.[16] In a nutshell, economic actors must agree on standards to ensure that technologies, components and people can seamlessly interact together. In doing so, they unlock significant economic benefits.

This type of standardization is nothing new. During the 18th and 19th Centuries, numerous standards emerged for such things as: the gauges used for railroads; the nuts, bolts, screws, metal sheets, drill bit sizes, and planks of wood used in construction and industry; and components used in weapons.[17] These standards were often developed by a single company but over time became widely used, thereby becoming *de facto* industry standards.

The QWERTY keyboard, patented in 1878 by Christopher Latham Sholes, was seemingly designed to enable rapid transcription of Morse code.[18] The design was licensed by Remington, who used it in its typewriters. By 1890, Remington had sold over 100,000 QWERTY-based typewriters (and also provided training on how to use them). In 1893, Remington merged with four other typewriter companies, Caligraph,

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[15] *See* Russell Cooper, Douglas V DeJong, Robert Forsythe & Thomas W Ross, *Communication in the battle of the sexes game: some experimental results*, THE RAND J. OF ECON. 568 (1989) (The authors notably show that communication, especially one-way communication, helps solve this type of coordination problem).

[16] *See* Stanley M Besen & Joseph Farrell, *Choosing how to compete: Strategies and tactics in standardization*, 8 J. OF ECON. PERSP. 117, 124 (1994). *See also*, Paul Belleflamme, *Coordination on formal vs. de facto standards: a dynamic approach*, 18 EUR. J. OF POL. ECON. 153, 158 (2002). *See also*, Jacques Pelkmans, *The GSM standard: explaining a success story*, 8 J. OF EUR. PUB. POL'Y 432, 434 (2001).

[17] ANSI: THROUGH HISTORY WITH STANDARDS, https://www.ansi.org/consumer_affairs/history_standards, (last visited Jul. 17, 2019).

[18] Jimmy Stamp, *Fact of Fiction? The Legend of the QWERTY Keyboard*, SMITHSONIAN.COM (May 3, 2013), https://www.smithsonianmag.com/arts-culture/fact-of-fiction-the-legend-of-the-qwerty-keyboard-49863249/

Yost, Densmore, and Smith-Premier, to form the Union Typewriter Company, and adopted QWERTY for all its typewriters. QWERTY thus became the *de facto* industry standard—and remains dominant (indeed, near universal) today.[19]

The use of interoperability standards really exploded during the 20th Century, along with the rise in innovation and trade. Examples of such standards include:

Electrical plugs and sockets. First developed in the 1880, with several patents for different designs being awarded, within a few years, many companies began producing plugs and sockets of similar designs, with components that made them interoperable. (One of the largest manufacturers of such plugs and sockets in the U.S., Henry Hubbell, brought an action against another large manufacturer, General Electric, claiming that the latter's plugs and sockets infringed his property rights. But the suit failed because it was shown that the essential elements of the interoperability of the components predated Hubbell's design.[20])

The standard phonograph, with discs sized 10" playing at 78 rpm, and then 12" and 7" playing at 33 1/3 rpm and 45 rpm, along with a standardized equalization response curve developed by the Recording Industry Association of America (which enabled more efficient and higher quality reproduction possible).[21]

The "von Neumann architecture". Arguably the single most important standard created in the past century was the computer architecture first proposed by John von Neumann in 1945 (building on earlier work by Alan Turing, J. Presper Eckert, John

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[19] *Id.* Some authors have cited the QWERTY keyboard design as an example of undesirable network effects. They argue that there are high switching costs associated with the QWERTY keyboard, and that this has inefficiently prevented allegedly superior designs from succeeding in the market, such as the DVORAK keyboard. *See, e.g.,* Paul A David, *Clio and the Economics of QWERTY*, 75 THE AM. ECON. REV. 332, 336 (1985). This version of history has been thoroughly rejected by Stan Liebowitz and Stephen Margolis. *See* Stan J Liebowitz & Stephen E Margolis, *The fable of the keys*, 33 THE J. OF L. & ECON. 1 (1990).

[20] 10 TRADEMARK REPORTER 164 (Arthur WM. Barber eds., 1920), https://books.google.co.uk/books?id=XOgsAAAAYAAJ&printsec=frontcover&dq=the+trademark+reporter+volume+10&hl=en&sa=X&ved=0ahUKEwjHgZr29YvXAhUCSRoKHWQaDOAQ6AEIJjAA#v=onepage&q&f=false

[21] Scott Hull, *What Is The RIAA Curve?*, SESSIONVILLE (Jan. 24, 2014), http://sessionville.com/articles/what-is-the-riaa-curve

Mauchly, and others).[22] This "von Neumann architecture", modified in various ways to improve efficiency and speed, became the basis for practically every computer built since.

In the past half century, standardization has further expanded, especially in response to the increasingly widespread use of digital devices for which interoperability is inherently desirable:

Internet protocols. Arguably the most significant interoperability standard of the past fifty years is TCP/IP, the set of protocols developed by Vint Cerf and Bob Kahn while at DARPA that enable communication between different devices over the Internet. This is closely followed by the hypertext transfer protocol (http) developed by Tim Berners Lee while at CERN, which enabled the creation of links on a graphical user interface, leading to the emergence of the world wide web.

Mobile communications standards. In order for mobile devices to communicate with one another, information must be transmitted and received via base stations that operate using compatible systems for coding that transmit/receive over the same frequency. To achieve compatibility, numerous standards have been developed, including those developed by the IEEE for WiFi (the 802.11 family) and those developed by various standards setting organizations and consortia for cellular networks, which include CDMA, WCDMA, LTE, etc.

Video and audio codecs. In order to transform analog video and audio signals into digital representations, various codecs have been developed by organizations such as Fraunhofer (MP3 audio codec), Apple (AAF, ALAC), Microsoft (WMA), and Xiph.org Foundation (FLAC).

Audio and video plugs and sockets. A whole slew of A/V connectors— 1/4" (phone jacks), 3.5 mm, "DIN", "RCA" (phono plugs), XLR, HDMI—have become *de facto* standards, enabling easy interoperable connections between analog and digital devices in a variety of contexts.

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[22] John von Neumann, First Draft of a Report on the EDVAC, Contract No. W–670–ORD–4926 Between the United States Army Ordnance Department and the University of Pennsylvania Moore School of Electrical Engineering, University of Pennsylvania June 30, 1945.

Computer interfaces. PCI, USB and other interfaces have become *de facto* standards within the computer industry, enabling widespread interconnectivity between devices.

The upshot is that interoperability standards are ubiquitous. Momentarily setting aside the question of how they are achieved, ensuring that market players can achieve this type of coordination is eminently desirable. It guarantees that new products can see the light of day and that new innovations can effectively be specified to function upon existing infrastructure.

B. *De facto* v. *de jure* standardization

In some cases, technologies have become *de facto* standards, i.e. without any explicit coordination by standards setting bodies. These can emerge with little or no competition. QWERTY is a good example. Adobe's PDF is another.

In other cases, technologies become *de facto* standards after a period of competition. For example, JVC's VHS format, first released in Japan in 1976 and the US in 1977, emerged as the *de facto* standard for video tapes due to its longer recording time and lower cost compared with Sony's Betamax, which had been released in 1975.

In yet other cases, competition leads to successive *de facto* standards. Word processing is a case in point. In the early- to mid-1980s, WordStar was the predominant word processing software—and *de facto* standard—for PCs. However, in the late 1980s, WordPerfect began to dominate and by the early 1990s had become a *de facto* standard. At that time, Microsoft introduced numerous improvements to its Word operating system, including interoperability with other Microsoft products, such as Excel and Outlook. As a result, Word became the dominant word processing software and *de facto* standard—a place which it still holds today, although some market share has now been taken by Google Docs.

1. Competition, network effects and de facto standards

De facto standards typically emerge due to the superiority of the technology that becomes dominant.[23] For example, VHS tapes, while similar in terms of quality of reproduction to Betamax, had the advantage that they could record 2 hours-worth of material in standard-play mode, sufficient for most movies of the era, and 4 hours-worth of material in long-play mode, which happens to be the length of a typical (American) football game. In addition, JVC freely licensed the VHS format, resulting in numerous companies competing to supply machines, which drove costs down. As a result of these advantages, VHS quickly became the dominant standard, in spite of being launched two years' after Betamax.

Some observers have suggested that "network externalities" also play a role.[24] For example, it has been suggested that the ability to share video cassettes with one's friends and family created an incentive to adopt players using the same format. That is no doubt true—up to a point. But if such network effects were the reason for dominance, then Betamax would have won the standards war simply by being first out of the gate. Ditto WordStar. It seems far more plausible that these network externalities work primarily to increase the value of existing standardized formats for people who have adopted them – they don't explain their adoption in the first place. After all, if you wanted to record a ball game (and happened to be living in 1980), you wouldn't buy a Betamax machine, even if all your friends had one, because it wouldn't do the job.

One important drawback with *de facto* standardization is that competition without cooperation may lead to multiple equilibria (notably the emergence of one winner, the coexistence of multiple technologies, no technology taking off, etc.). While the winner in a winner-takes-all standards race might prefer such an outcome; it is by no means inevitable and in many cases, market participants might prefer to determine

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[23] *Compare* Stan J Liebowitz & Stephen E Margolis, *The fable of the keys*, 33 THE J. OF L. & ECON. 1, 2 (1990) *with* Joseph Farrell & Garth Saloner, *Installed base and compatibility: Innovation, product preannouncements, and predation*, 76 THE AM. ECON. REV. 940 (1986) (The authors argue that, left to their own devices, markets may lead to both "*excess inertia*" and "*excess momentum*").

[24] *See, e.g.,* C. SHAPIRO, S. CARL, H.R. VARIAN & HARVARD BUSINESS PRESS, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY 229 (Harvard Business School Press. 1998).

the standard *ex ante*, thereby avoiding the risk of failure and the high costs of persuading others to adopt the *de facto* standard .[25] Agreeing upon a single interoperability standard may thus be eminently desirable. As Carl Shapiro and Hal Varian observe, this may notably lead to more valuable products for consumers (and potentially more profits for producers) because of expanded network effects, make users' adoption decisions less uncertain (and thus increase purchases), alleviate consumers' fears about lock-in, etc.[26] Hence de adoption of *de jure* standards.

2. *De jure standards*

De jure standards are established by legal agreement between different industry players, usually in the context of a standards developing organization (SDO—also often called a standards setting organization, SSO). There are numerous SDOs, including national and international industry-specific bodies, such as the International Electrotechnical Commission (IEC) and the International Telecommunications Union (ITU), the European Committee for Electrotechnical Standardization (CENELEC), the 3rd Generation Partnership Project (3GPP), as well as more general/over-arching national and international SDOs, such as the American National Standards Institute (ANSI), the International Organization for Standardization (ISO), and the European Committee for Standardization (CEN). In most cases, *de jure* standards are intentionally developed in a collaborative manner in order to pre-empt compatibility issues. Although this can occasionally result from a government mandate or benefit from some form of government recognition, spontaneous private coordination is likely a far more common source of *de jure* standardization.[27]

A good example of *de jure* standardization is the film speed standard, which—in the era of film photography—enabled firms to manufacture film of specific light sensitivity, photographers to use the correct exposure settings relevant to the sensitivity of the film, and processors to use the correct chemicals and processing time when developing the negatives. In the 1930s, the German SDO, DIN, developed a film-speed

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[25] *See* Michael L Katz & Carl Shapiro, *Network externalities, competition, and compatibility*, 75 AM. ECON. REV. 424, 425 (1985).

[26] *See* C. SHAPIRO, S. CARL, H.R. VARIAN & HARVARD BUSINESS PRESS, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY 229-230 (Harvard Business School Press. 1998).

[27] For instance, the European Union is currently deciding whether to mandate a wifi or 5G based technology as the standard for driverless cars. *See, e.g.,* Peter Teffer, *Wifi or 5G to connect EU cars? MEPs weigh in*, EUOBSERVER (Apr. 17, 2019), https://euobserver.com/science/144684.

standard that was quickly adopted by the German film industry, effectively enabling film manufactured according to DIN standards to be used in any camera by applying DIN-adjusted exposure settings. In the 1940s, the American Standards Association (the fore-runner of the ANSI) developed the ASA measure of film speed. In 1974, the ASA and DIN standards were subsequently incorporated into ISO standards, which became the internationally accepted standard—and remain dominant today for both analog and digital photography.

In some cases, however, *de jure* standards are established following the emergence of a *de facto* standard, either in whole or in part. In fact, the ASA film standard was based in part on previous *de facto* standards developed by Weston and Kodak.

Shipping containers offer another interesting example. A key element in the development of the standardized shipping container, which has revolutionized shipping by making it possible quickly and efficiently to load and unload cargo ships, was the specification of the corner fitting that enables lifting and locking of the containers. In the early 1960s, the first and then-largest container shipping company in the world, Malcolm Mclean's Sea-Land, used a corner fitting it had patented in 1956. When ISO came to develop an international standard, at the behest of the ASA, Mclean agreed to license his corner fitting patent royalty free to ISO (in no small part because his containers already had the fittings, giving him a competitive advantage, while any alternative design would have imposed considerable costs).[28]

Compact Discs are another example. Having lost the standards war over video tape, Sony teamed up with Phillips to develop an industry standard for digital audio recording. The result was a proprietary standard owned jointly by the two companies and licensed to other manufacturers. Over time, the CD became the basis of a series of IEC standards for digital recording and reproduction.[29]

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[28] MARC LEVINSON, THE BOX, (Princeton University Press, 2nd ed. 2016), McLean also had recent experience of being on the wrong side of a standard: In 1959, ASA had decided that standard shipping containers should be 10, 20, 30, or 40 foot, whereas Sea-Land's had been 35 feet, which meant that his company would have had to change its shipping fleet to accommodate the new standards.

[29] The original red Book specification for the CD was released by Sony and Phillips in 1980. The IEC adopted it as a standard (#60908) in 1987. IEC Webstore: International Electrotechnical Commission, https://webstore.iec.ch/publication/18347 (last visited Jul. 25, 2019).

The mobile communications standard CDMA is another good example. Qualcomm developed CDMA in the late 1980s and ran its first test in 1989. By 1993, Qualcomm had established CDMA as an industry standard, which was adopted by the Telecommunications Industry Association in 1995 as IS-95, following which it became a dominant standard for 2G and then 3G systems in the U.S. and Japan. A variant, WCDMA, was subsequently adopted for use with GSM phones in Europe.

However, since the early 1990s, most cellular communications standards have been adopted *de jure* through the work of standards setting organizations (SDOs) such as the European Telecommunications Standards Institute (ETSI), which developed the GSM standard, and 3GPP, which has coordinated the development of 3G, LTE, and 5G standards.

In some cases, technologies implementing *de jure* standards may be subject to government regulation that effectively mandates their use. GSM is a good example. In 1986, the European Commission proposed that European member states should reserve the 900Mhz spectrum band for GSM technology.[30] This essentially tipped the mobile technology race in favor GSM, making it the *de jure* standard for mobile communications in Europe.

C. Open v. closed standards

Another important distinction is that standards may be either "open" or "closed". Open standards are, first and foremost, readily accessible and usually incorporate patents that are available royalty free. Most open standards are developed collaboratively, although there are examples of standards that were initially developed by a single organization and subsequently offered royalty-free (such as the container ship corner fittings and VHS video standards discussed above, as well as PDF and PCI). Prominent examples of open standards include the von Neumann computer architecture, TCP/IP, USB, the Linux operating system, and the World Wide Web architecture (http etc.).

Closed standards (also referred to as proprietary standards) are typically developed by one or a small number of companies, and incorporate patented technology that is made available through licensing. Examples include various cellular standards (including CDMA, GSM, and LTE), the CD, and Microsoft Word. By enabling the

[30] GSMA: ABOUT US, https://www.gsma.com/aboutus/history (last visited Jul. 17, 2019).

owners of the underlying intellectual property to generate royalties, closed standards may often stimulate greater investment in research and development. In other words, closed standards increase the chance that innovators will earn a reasonable return on their technologies, thus boosting innovation. This is likely to be particularly important in areas where R&D costs are significant and the costs of copying low. One intuition is that open standards lead to competition *in the market*, while closed standards enhance competition *for the market*. As Katz and Shapiro argue, "[C]ompatibility relaxes competition early in the product life-cycle, because the threat of tipping [the tendency of one system to pull away in popularity from its rivals once it has gained an initial edge] is reduced. However, because compatibility prevents one firm from gaining control of the market, it tends to intensify competition later in the product life-cycle."[31] In other words, closed standards can reduce potential freeriding in the early stages of a technology's development – which boosts incentives to innovate. One potential downside is reduced intra-standard competition once a product/technology has been successfully launched. But this does not eliminate competition altogether. The threat of outside competition remains a powerful constraint. Competition and regulatory authorities on both sides of the Atlantic have thus been quick to embrace the emergence of closed standards.[32]

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[31] *See* Michael L Katz & Carl Shapiro, *Systems competition and network effects*, 8 J. OF ECON. PERSP. 93, 111 (1994).

[32] *See, e.g.*, European Commission, "Communication, Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements", OJ C 11, Jan. 14, 2011, ¶ 263 ("Standardisation agreements usually produce significant positive economic effects (102), for example by promoting economic interpenetration on the internal market and encouraging the development of new and improved products or markets and improved supply conditions. Standards thus normally increase competition and lower output and sales costs, benefiting economies as a whole. Standards may maintain and enhance quality, provide information and ensure interoperability and compatibility (thus increasing value for consumers)."). *See also*, Makan Delrahim, Assistant Attorney General, Speech, "Telegraph Road", at Incentivizing Innovation at the Intersection of Patent and Antitrust Law" (Dec. 7, 2018), https://www.justice.gov/opa/speech/assistant-attorney-general-makan-delrahim-delivers-remarks-19th-annual-berkeley-stanford ("I will discuss how standard-setting organizations have formed around innovators. When they work well, they translate ingenuity into usable, commercialized technologies.").

D. Incentive compatible institutions and the standard setting process

The establishment of a *de jure* standard by an SDO typically follows a process by which interested parties come together and identify technological problems which they might be able to solve cooperatively.[33] Firms then develop and submit technological contributions to address these problems. Finally, participants openly discuss and debate the proposed solutions until consensus is reached. This ultimately leads to a series of technical specifications upon which implementers can build products. Interested parties typically include both developers and implementers of technologies, and may also include various others, such as government agencies and user groups. Often multiple competing developers and implementers are involved.

On the one hand, such an inclusive process helps ensure that the standard will actually be adopted by the industry. On the other hand, delays in consensus-based collaborative standard setting may diminish potential gains from the process. The process by which standards were developed for shipping containers offers a cautionary tale: as Marc Levinson recounts in his fascinating history, it took over eight years and innumerable meetings on several continents to develop ISO standards for shipping containers.[34]

The members of SDOs include a wide-range of stakeholders, such as: companies that manufacture products, companies that market services that use the standards, companies that operate networks that practice the standards, technology owners who create technologies that are included in the standards, academic institutions, and government agencies. The SDO provides information to interested parties about the standard-setting project. Members attend standard setting meetings, vote on standardization decisions, and make technological contributions. Participation in standard setting can be subject to a substantial fee. There are policies and procedures ("bylaws") that govern the process of adoption and standard development. Participation in SDOs is voluntary and is subject to acceptance of the terms and conditions set out in the bylaws. These aim to allow the most appropriate technology to become standardized based on several factors. As mentioned earlier, this is a democratic and

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[33] *See* Kirti Gupta, *How SSOs Work: Unpacking the Mobile Industry's 3GPP Standards*, AVAILABLE AT SSRN 3063360, 7 (2017).

[34] Levinson, *supra* note 28.

consensus-based process designed to ensure that no single participant can manipulate it. Many SDOs allow for appeals by dissenting members post-adoption as well.

During the standard development process, participants submit contributions toward the development of standards. Some of these contributions incorporate patented technology and patent owners are asked to disclose the relevant patents that cover these technologies. These patents are deemed to be "standard essential". Often, a single standard will include multiple patented technologies, frequently from multiple different innovators.[35]

Throughout this process, a critical challenge for SDOs is to ensure that their internal regulations remain "*incentive compatible*". To maximize their technological output, SDOs must attract the right mix of implementers and innovators. They thus need to design internal procedures that strike a balance between the sometimes diverging interests of these stakeholders. This is no simple task. Although there are numerous ways in which these rules may favor a particular group of participants, allocating the profits of standardization is perhaps the most the most salient. To a first approximation, SEP holders will tend to favor internal rules that allow them to charge prices which are close to the monopoly benchmark (though not the double marginalization one[36]). Conversely, implementers will generally prefer policies that limit the returns of SEP holders (so long as this does not dry up the supply of inventions). However, these first order incentives may not always hold true in the real-world. Practical considerations may, for instance, urge SEP holders to accept a pricing structure that is not "profit maximizing" in the short-run, but which may incentivize further cooperation or the adoption of an underlying technology.[37] Unsurprisingly, SDOs' IPR policies have thus attracted the most attention from scholars and policymakers.

For instance, SDOs often specify the licensing terms for standard essential patents (SEPs). For various reasons (notably to because standardization involves tremendous uncertainty which makes concluding complete contracts relatively unattractive), these terms are usually kept relatively vague (see Section III.2 for a more detailed

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[35] *Ibid.*

[36] *See* Section III

[37] *See, e.g.,* Jonathan M Barnett, *The Host's Dilemma: Strategic Forfeiture in Platform Markets for Informational Foods*, 124 HARV. L. REV. 1861, 1883 (2010) (Jonathan Barnett shows that firms routinely forfeit their intellectual assets in order to boost the growth of the platform they operate).

discussion). SDOs commonly (though not always) require members to license standard essential patents on (F)RAND terms and disclose potentially relevant patents before a technology is adopted. This potentially limits patent owners' right to exclude implementers from the use of standard essential innovations.[38] However, it also enshrines the idea that SEP holders should be able to earn a return on their investments, thus rewarding their scientific contributions.

SDOs thus provide a framework that enables and incentivizes innovators to develop and share, at an early stage, new technologies that might become standard essential, while at the same time enabling and incentivizing innovators to contribute to the design of new standards incorporating these innovations, based on their own needs (often with the knowledge that they will be able to license any innovations protected by patents on (F)RAND term).

III. The case against patent holdup and royalty stacking

In spite of the evident benefits of de jure standards, they have been subject to numerus criticisms. These are usually predicated on two separate lines of argument: the theory of holdup and that of royalty stacking (though they are often confused with one another by critics of SEPs).

Patent hold-up

Contemporary academics have theorized that, under certain conditions, owners of standard essential patents might impede technological innovation by refusing to license their intellectual property on terms acceptable to implementers. This is referred to as patent "holdup." The underlying theory, which applies more broadly, is =that the conjunction of sunk, asset-specific, investments and incomplete contracts may

[38] *See, e.g.,* ETSI, RULES OF PROCEDURE, Annex 6: ETSI Intellectual Property Rights Policy, (Apr. 3, 2019) , Clause 3, available at https://www.etsi.org/images/files/IPR/etsi-ipr-policy.pdf ("ETSI shall take reasonable measures to ensure, as far as possible, that its activities which relate to the preparation, adoption and application of STANDARDS and TECHNICAL SPECIFICATIONS, enable STANDARDS and TECHNICAL SPECIFICATIONS to be available to potential users in accordance with the general principles of standardization").

give rise to opportunistic behavior, where one party to a transaction deceitfully extracts the other party's quasi-rents.[39] In the SDO space, this opportunism may lead SEP holders to charge seemingly extortionate royalties for an essential patent (hence, patent "holdup").

However, there is an important corollary to this patent "holdup" theory, namely that implementers may behave opportunistically, refusing to pay for an upstream asset that they are using. This is generally referred to as the "holdout" problem[40], "reverse holdup"[41] or "patent trespass."[42]

Royalty stacking

The theoretical underpinnings of royalty stacking have been formalized for almost as long as economic science has existed. As early as 1838, Antoine Cournot observed that the independent pricing of two complementary goods led to a higher price than if the same goods were priced by a single monopolist.[43] This double marginalization is notably said to affect the essential patents that make up a standard.[44] The basic implication is that the price of acquiring complimentary patents from separate innovators is potentially higher than if the patents were owned by a single firm (hence the formation of patent pools by their owners[45]). And because a patent's essentiality can

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[39] *See* Oliver E Williamson, *Transaction-cost economics: the governance of contractual relations*, 22 THE J. OF L. & ECON. 233, 241 (1979). *See also*, Armen A Alchian & Susan L Woodward, *The Firm is Dead; Long Live the Firm: A Review of Oliver E. Williamson's The Economic Institutions of Capitalism*, 26 J. OF ECON. LIT. 65 (1988) (The authors refer to this situation as "composite quasi-rents"). On opportunism, *see* O.E. WILLIAMSON, THE ECON. INST. OF CAPITALISM 47 (Free Press. 1985).

[40] *See, e.g.,* Richard A Epstein & Kayvan B Noroozi, *Why Incentives for Patent Holdout Threaten to Dismantle FRAND, and Why It Matters*, 32 BERKELEY TECH. LJ 1381 (2017).

[41] *See, e.g.,* F Scott Kieff & Anne Layne-Farrar, *Incentive Effects from Different Approaches to Holdup Mitigation Surrounding Patent Remedies and Standard-Setting Organizations*, 9 J. OF COMPETITION L. & ECON 1091 (2013).

[42] *See, e.g.,* Bowman Heiden & Nicolas Petit, *Patent" Trespass" and the Royalty Gap: Exploring the Nature and Impact of Patent Holdout*, 34 SANTA CLARA HIGH TECH. L.J. 179 (2018).

[43] *See* A.A. COURNOT, RECHERCHES SUR LES PRINCIPES MATHEMATIQUES DE LA THEORIE DES RICHESSES (chez L. Hachette. 1838).

[44] *See* Carl Shapiro, *Navigating the patent thicket: Cross licenses, patent pools, and standard setting*, 1 INNOVATION POL'Y & THE ECON. 119, 123 (2000).

[45] *Id.*

arguably be caused by the standardization process itself rather than the patent's intrinsic merits (notably when a standard chooses one of many competing technical solutions), it is argued that standardization process may exacerbate royalty stacking.[46]

From the outset, it is important to stress that, although both these stories have some superficial appeal, critics routinely miss one of their most salient implications. In both cases, the most important concern is not distributional (*i.e.* one party capturing another's quasi-rents) but relates to these practices' long-term effects on economic output. The threat of holdup may deter parties from investing in otherwise beneficial long-term relationships.[47] Similarly, royalty stacking may cause SEP holders to earn profits that are markedly below the monopoly benchmark (because double marginalization reduces each firm's profits), and may lead to the dissipation of implementers' quasi-rents (their rents are extracted by upstream firms). When this occurs, it drastically reduces output, investments and innovation.[48]

Both holdup and royalty stacking may often lead to mutually detrimental outcomes where no party is left better off. Parties thus have tremendous incentives to prevent them from occurring. Patent pools (one potential solution to royalty stacking issues) were widely used well before antitrust authorities began to encourage their formation.[49] Likewise, the economic literature is replete with well-established solutions to the holdup problem.[50]

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[46] *Compare* Fiona Scott Morton & Carl Shapiro, *Patent Assertions: Are We Any Closer to Aligning Reward to Contribution?*, 16 INNOVATION POL'Y & THE ECON. 89, 109 (2016) ("SSOs create or enhance market power by the joint action of their members in limiting competition among technologies and, instead, agreeing on a single standard, typically one in which several or many members hold IPRs.") *with* Alexander Galetovic & Stephen Haber, *The Fallacies of Patent-Holdup Theory*, 13 J. OF COMPETITION L. & ECON. 42 (2017).

[47] *See, e.g.,* Benjamin Klein, Robert G Crawford & Armen A Alchian, *Vertical integration, appropriable rents, and the competitive contracting process*, 21 THE J.OF L. & ECON. 297, 301 (1978) ("*This more subtle form of opportunistic behavior is likely to result in a loss of efficiency and not just a wealth-distribution effect*.").

[48] *See, e.g.,* Damien Geradin, Anne Layne-Farrar & A Jorge Padilla, *The Complements Problem within Standard Setting; Assessing the Evidence on Royalty Stacking*, 14 BUJ SCI. & TECH. L., 144, 157 (2008) ("[I]*f it were present stacking should discourage R&D investment*.").

[49] *See* Petra Moser, *Patents and innovation: evidence from economic history*, 27 J. OF ECON. PERSP. 23, 33 (2013).

[50] *See, e.g.,* Ronald H Coase, *The acquisition of fisher body by general motors*, 43 THE J. OF L. & ECON. 15 (2000). *See also*, Benjamin Klein, *Vertical integration as organizational ownership: The Fisher Body-General*

The evolution of standardization practices and the birth of SDOs can be thus be framed as an emergent phenomenon, which iteratively reduces the prospect of holdup and royalty stacking occurring. This is not to say that these risks have been definitively eliminated, but rather that (absent evidence of deceit, guile or opportunism[51]) authorities should operate under the rebuttable presumption that parties have ordered their affairs in ways which minimize holdup and royalty stacking.

With these critical caveats in mind, this section discusses and addresses the most important criticisms levelled against de jure standardization, especially as they relate to the institutional structure of SDOs and FRAND commitments. We start by showing that current literature on patent holdup marks a significant normative departure from early theories of holdup. We then show that numerous empirical studies have established that the occurrence patent holdup and royalty stacking is at most sporadic. We then offer potential explanations for these negative empirical findings, and show that the solutions put forward by critics could have significant detrimental effects.

A. Holdup theory: from positive to normative economics

The literature underpinning holdup theory can be traced back to the groundbreaking works of transaction cost economists, such as Oliver Williamson,[52] Armen Alchian[53]

Motors relationship revisited, 4 J. OF L., ECON., & ORG. 199 (1988). *See also*, Benjamin Klein, *Why hold-ups occur: the self-enforcing range of contractual relationships*, 34 ECONOMIC INQUIRY 444 (1996). *See also*, Philippe Aghion, Mathias Dewatripont & Patrick Rey, *Renegotiation Design with uUverifiable Iformation*, 62 ECONOMETRICA 257 (1994) (The authors show that contractual renegotiation procedures can be designed to mitigate to occurrence of holup). *More speculatively*, Richard Holden and Anup Malani suggest that parties could make use of blockchain technology and smart contracts to mitigate holdup. *See* Richard T Holden & Anup Malani, *Can Blockchain Solve the Hold-up Problem in Contracts?*, NATIONAL BUREAU OF ECONOMIC RESEARCH 29 (2019) (The authors that parties could use smart contracts as pre-commitment devices, thus reducing the scope for opportunistic behavior further down the line. In effect, parties would commit money to a smart contract, and this money could then be "burned" if the parties depart from a previously agreed course of conduct).

[51] *See* Williamson, *supra* note 39, 22 THE J. OF L. & ECON. at 234 (1979).

[52] *Id.* Williamson himself was heavily influenced by the writings of Alfred Marshal. *See* Alchian & Woodward, J. OF ECON. LIT. 67 (1988).

[53] *Id.*

and Harold Demsetz[54]. Although these economists are often cited in relation to holdup theory, their approach is mostly one of positive economics. One of their key findings is that capitalism has fostered numerous arrangements that are routinely used to mitigate the occurrence of holdup, such as vertical integration and long-term contracts.[55] However, these authors mostly stopped short of recommending top-down solutions to these problems, relying instead on firms' ability to deal with these matters privately, for instance through vertical integration (which was often misdiagnosed as anticompetitive behavior by courts at the time).[56]

The restraint which these early scholars exhibited is likely down to the fact that, in their minds at least, there is no top-down solution to these complex issues. They were acutely aware that policymakers can easily fall prey to the nirvana fallacy and prescribe medicine that is worse than the illness.[57] They thus recognized that the identification of market imperfections is a necessary but not a sufficient condition for regulatory intervention. Policymakers must also devise alternative institutional arrangements that lead to superior outcomes than the perceived harms they are seeking to address.

This *positive economics* approach stands in stark contrast to more recent scholarship on patent holdup. Foremost among these contemporary critics are Mark Lemley and Carl Shapiro.[58] According to them, policymakers should limit the extent to which holders of SEPs can seek injunctions (to prevent them from extracting excessive royalties from implementers).[59] They argue that this should, in particular, be the case

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[54] *See* Harold Demsetz, *The theory of the firm revisited*, 4 J. OF L., ECON., & ORG. 141, 150 (1988).

[55] *See* Klein, *supra* note 50, J. OF L., ECON., & ORGAN., at 199 (1988).

[56] *See, e.g.,* Klein et al., supra note 47, THE J.OF L. & ECON., at 325 (1978) ("[E]xplicitly recognizing that contracting costs are not zero, as they are often implicitly assumed to be in economic analysis, and explicitly considering the determinants of these costs (such as the presence of appropriable quasi rents) is the first step in explaining the large variety of contractual and ownership arrangements we observe in the real world."). *See also*, Oliver E Williamson, *Markets and hierarchies: some elementary considerations*, 63 THE AM. ECON. REV. 316 (1973) ("The principal purposes of this paper are to examine the factors which induce a shift of transactions from market to internal organization and, within internal organization, to explain the types of hierarchical relations that predictably emerge.").

[57] *See* Harold Demsetz, *Information and efficiency: another viewpoint*, 12 THE J. OF L. & ECON. 1 (1969).

[58] *See* Lemley & Shapiro, *supra* note 8, at 2036.

[59] *Id.*

when the underlying product contains multiple components, only one of which is covered by the plaintiff's patents.[60]

Lemley and Shapiro conclude that courts should refuse to grant injunctions when, to redesign their technology around a patent, the infringing party would bear costs in excess of the patent's marginal contribution to the underlying product.[61] Accordingly, they urge courts to calculate a reasonable royalty rate based this marginal value. And if redesign is not prohibitively expensive, then courts should stay injunctions until infringers have been able to redesign their products around the litigated patent (paying reasonable royalties in the interval).

Under this approach, SEP holders would be unable to obtain royalties that are above what courts believe to be their patents' marginal contribution to a technology. Framed differently, judges would be tasked with restoring the *ex ante* price that parties *would* have agreed upon before a patent was incorporated in a standard. As Farrel et al. put it:

> Restoring a competitive outcome may be possible, however, by limiting royalties and other license terms to those that would have resulted had the patents been disclosed and licensing terms been bindingly negotiated *ex ante*.[62]

The following sections evaluate these theories and the proposed remedies.

B. Empirical evidence of holdup and royalty stacking?

The theories of holdup and royalty stacking in SEP-reliant industries create several testable hypotheses:

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[60] *Id.*

[61] *Id.* at 2037

[62] *See* Joseph Farrell, John Hayes, Carl Shapiro & Theresa Sullivan, *Standard setting, patents, and hold-up*, 74 ANTITRUST L.J. 603, 660 (2007).

First, if they were valid, we would expect to see lower investments in innovation, higher quality adjusted prices and lower innovation rates in SEP-reliant industries relative to other industries.[63] Is that what we find?

In a seminal paper, Galetovic, Haber & Levine show that quality-adjusted prices decreased *more rapidly* for a selection of SEP-reliant products than any other good in the Consumer Price Index. [64] Quality-adjusted prices notably decreased far more significantly in SEP-reliant industries than in the electricity industry, which *is* subject to holdup.[65]

Looking at the period of 1997-2013, the authors notably found that:

> [R]ates of technological progress in SEP-intensive industries (phone equipment, video equipment, audio equipment, televisions and laptop computers) were very fast relative to technological progress in the overall economy and almost any other industry. For example, the overall rate of innovation in phone equipment (which includes such low tech items as fax machines and landline phones, as well as wireless phones) was 10 percent per annum faster than the economy-wide average. The rate of innovation in portable and laptop computers was faster still, 31 percent per annum faster than the economy-wide average.[66]

These findings are echoed by Keith Mallinson, who focuses more specifically on mobile communications technology. Mallinson notes that successive generations of mobile technology have resulted in dramatic and on-going improvements to the performance of mobile devices. For instance, data transfer rates for end-users have increased more than 1,000-fold since 1991.[67]

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[63] *See* Alexander Galetovic, Stephen Haber & Ross Levine, *AN EMPIRICAL EXAMINATION OF PATENT HOLDUP*, 11 J. OF COMPETITION L. & ECON. 549, 551 (2015).

[64] *Id.* at 554.

[65] *Id.* at 565.

[66] *See* Galetovic & Haber, *supra* note 63, 11 J. OF COMPETITION L. & ECON., at 7 (2017).

[67] *See* Keith Mallinson, *Don't Fix What Isn't Broken: The Extraordinary Record of Innovation and Success in the Cellular Industry under Exiting Licensing Practices*, 23 GEO. MASON L. REV. 969 (2015). With the first commercial services of GPRS in 2000, this 2G GSM technology initially provided users with data speeds of up to 56 kilobits per second. By around 2005 in most developed nations, 3G UMTS with WCDMA

Second, proponents of the theories of patent holdup and royalty stacking in SEP-reliant industries assert that the availability of injunctions to SEP holders multiplies , holdup and royalty stacking in those industries.[68] They thus urge policymakers to limit the availability of injunctions, to grant stays while defendants reorganize, and mandate reasonable royalties below the level that SEP holders charge with the threat of an injunction. If these theories are correct, then applying the remedy they propose should reduce the price of SEP-intensive products.

But the evidence identified by Galetovic and his co-authors (using a difference-in-difference methodology) clearly shows that limiting the availability of injunctions did not lead to price decreases in SEP-reliant industries.[69] The authors obtain this result by looking at the effect of the US Supreme Court's *eBay Inc. v. MercExchange* case.[70] The case overruled years of existing precedent under which patent holders could automatically obtain an injunction against an infringing defendant, introducing a four-factor test in its place. There is little question that the case made it harder to patent holders to obtain injunctions. In its aftermath, courts refused to grant injunctions in roughly a third of cases (which was impossible previously).[71] And recent scholarship

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provided users up to 384 kbps. Technology enhancements to WCDMA with HSDPA and HSPA+ then provided ever-increasing speeds from megabits per second to tens of megabits per second. Today, 4G Long-Term-Evolution ("LTE") networks are providing users in excess of 100,000 kbps (100 Mbps).

[68] *See* Lemley & Shapiro, *supra* note 8, at 2036.

[69] *See* Galetovic, et al., *supra* note 63, 11 J. OF COMPETITION L. & ECON., at 571 (2015).

[70] *eBay Inc. v. MercExchange, L. L. C.*, 547 U.S. 388 (2006).

[71] *See* Benjamin Petersen, *Injunctive relief in the post-eBay world*, 23 BERKELEY TECH. LJ 193, 196 (2008) ("In the two years after the Supreme Court's ruling in eBay, there were thirty-three district court decisions that interpreted *eBay* when determining whether to grant injunctive relief to a patent holder. Of these decisions, twenty-four have granted permanent injunctions and ten have denied injunctions."). *See* Bernard H Chao, *After eBay, Inc. v. MercExchange: The Changing Landscape for Patent Remedies*, 9 MINN. JL SCI. & TECH. 543, 572 (2008) ("For the first time, courts are not granting permanent injunctions to many successful patent plaintiffs."). *See* Lemley & Shapiro, *supra* note 8, at 2036 ("a number of district courts have responded by denying injunctions to nonmanufacturing patent owners."). *See also*, Rachel M Janutis, *The Supreme Court's Unremarkable Decision in eBay Inc. v. MercExchange, LLC*, 14 LEWIS & CLARK L. REV. 597 (2010) ("However, the first few district courts deciding patent cases following that decision granted injunctions to patent owners in the majority of cases, at a rate of approximately two-to-one."). *See also*, Christopher B Seaman, *Permanent Injunctions in Patent Litigation After eBay: An Empirical Study*, 101 IOWA L. REV., 1953 (2015) ("This Article also evaluates the impact of other considerations on permanent injunction decisions after eBay. It finds that grant rates vary significantly by field of technology, with injunctions nearly always granted in cases involving patented drugs and biotechnology, but much less often for disputes involving computer software.").

suggests that the case's effect might be even more drastic (previous studies ignore the fact that *eBay* may have had important sample effects).[72]

Third, the theory of patent holdup implies that profit margins of implementers would be low, as a result of SEP holders capturing their quasi-rents. Yet the profit margins of top mobile device manufacturers (one of the most important SEP-reliant industries) typically range from 20 to 40%, which implies that their quasi-rents are not being captured.[73]

Fourth, various scholars have argued that royalty stacking in SEP-reliant industries was leading to cumulative royalties in excess of 20% of a mobile device's final price.[74] Yet, empirical examinations of the cumulative royalty rates earned by SEP holders in the mobile device industry are within the 3% to 5% range, which is much lower than royalty stacking would predict. [75]

Available evidence thus contradicts the idea that, under the current legal landscape, holders of SEPs inevitably or routinely hold up implementers or set royalty rates above the monopoly benchmark. If one were to adopt a strictly Popperian view, then it would be "case closed" on holdup and royalty stacking.[76] Alternatively, taking a more nuanced approach, such as that favored by Hillary Putnam[77], would call for scholars and policymakers to reassess the contested theories in light of their failed

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[72] *See* Kirti Gupta & Jay P Kesan, *Studying the impact of ebay on injunctive relief in patent cases* (Univ. of Illinois College of L. Legal Studies Research Paper 2016).

[73] *See* Kirti Gupta, *The patent policy debate in the high-tech world*, 9 J. OF COMPETITION L. & ECON. 827, 845 (2013).

[74] *See* Lemley & Shapiro, *supra* note 8, at 2026. *See also*, RNA Bekkers & J West, *The effect of strategic patenting on cumulative innovation in UMTS standardization* 22 (9 DIME WORKING PAPERS ON INTELLECTUAL PROPERTY RIGHTS 2006). *See also*, Ann Armstrong, Joseph Mueller & Tim Syrett, *The smartphone royalty stack: Surveying royalty demands for the components within modern smartphones*, AVAILABLE AT SSRN 2443848 (2014) (The authors argue that the total royalties for a Windows or Android phone range from $121 to $124).

[75] *See* Alexander Galetovic, Stephen Haber & Lew Zaretzki, *An estimate of the average cumulative royalty yield in the world mobile phone industry: Theory, measurement and results*, 42 TELECOMM. POL'Y 263, 271 (2018). *See also*, J Gregory Sidak, *What Aggregate Royalty do Manufacturers of Mobile Phones Pay to License Standard-Essential Patents*, 1 CRITERION J. ON INNOVATION 701 (2016), *See also,* Mallinson, GEO. MASON L. REV., 997 (2015).

[76] *See* K. POPPER, THE LOGIC OF SCIENTIFIC DISCOVERY (Taylor & Francis. Eds. 1959).

[77] *See* Hilary Putnam, *The "corroboration" of theories*, THE PHIL. OF SCI. 121, 129 (1991).

predictions. One important question is why Lemley and Shapiro's theory of patent hold up and royalty stacking failed to predict market outcomes in SEP-reliant industries. In other words, is there something about de jure standardization which critics failed to capture? Some scholars have already started to fill in this scholarly void[78] and this is what we pursue in the following sections.

C. Potential explanations

It is important to understand why the theories of holdup and royalty stacking fail to apply in the case of standardization and SEP holders. As detailed below, factors that plausibly explain this include:

1) Several features of current standardization processes that tend to limit various parties' scope for opportunism, despite the absence of complete contracts. This is notably the case of FRAND pledges and patent disclosure obligations, which place some limits on the behavior which parties can adopt *ex* post.

2) These various backstops have not appeared out of thin air. Instead, they are the fruit of iterative improvements to standardization processes, notably brought about by competition between SDOs.

3) Parties to the standardization process often face the prospect of repeat interactions.

4) Finally, traditional solutions to holdup and double marginalization issues, such a mergers and agreements which internalize these affects, might also be playing a role.

Of course, we cannot be sure that these factors systematically eliminate all opportunistic behavior from members of a standard developing organization. However, when combined with the negative empirical findings of the previous section, there is a strong sense that they at least mitigate its occurrence.

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[78] *See, e.g.*, Gerard Llobet & Jorge Padilla, *The Inverse Cournot Effect in Royalty Negotiations with Complementary Patents* (2017).

1. SDOs limit the scope for opportunism

A first hypothesis is that SDOs design their internal rules in ways which minimize the occurrence of holdup and royalty stacking. Readers will recall that the early literature on holdup identified three essential conditions for it to occur.[79] First, there must be a sunk investment in a relationship-specific asset (sometimes referred to as composite quasi-rents). Second, the affected parties cannot have concluded complete contracts (or else the risk of holdup would either be priced into their relationship or its occurrence would be contractually precluded). Third and finally, one party must behave opportunistically, which entails some element of surprise.

In the context of SEPs, the first two conditions very often pertain. Implementers undertake investments in products that rely on SEPs, which are, inherently, very relationship-specific assets. Likewise, SEP holders probably design their technologies with a given set of implementers in mind. Meanwhile, the (FRAND) contracts pertaining to SEPs are, by design, incomplete.[80] For instance, it is exceptionally rare for parties to agree on licensing prices before a technology has been adopted (it is also uncommon for SEP holders to make precise price commitments or to submit sealed bids *ex* ante).[81]

However, except in unusual circumstances, there is only limited scope for opportunistic surprise for SEPs licensed according to the policies of an SDO and subject to FRAND. SDO policies are specifically designed to ensure that the right mix of firms will partake in the standardization process.[82] These organizations have thus come up with a series of tools that weed out the most egregious forms of opportunism (which might otherwise deter firms from participating in the SSO's activities). For instance,

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[79] *See* Williamson, *supra* note 39, 22 THE J.OF L. & ECON., at 241 (1979). *See also*, Alchian & Woodward, *supra* note 52, J. OF ECON. LIT. (1988) (The authors refer to this situation as "composite quasi-rents"). On opportunism, *see* OLIVER WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM 47 (Simon and Schuster 1985).

[80] *See* Section III.2 for a more detailed discussion.

[81] Some scholars have called for the introduction of such procedures. *See, e.g.,* Josh Lerner & Jean Tirole, *Standard-essential patents*, 123 J. OF POL. ECON. 547 (2015).

[82] *See, e.g.* Benjamin Chiao, Josh Lerner & Jean Tirole, *The rules of standard-setting organizations: an empirical analysis*, 38 THE RAND J. OF ECON. 905 (2007).

some SDOs require SEP holders to disclose their patent-protected technologies and make FRAND pledges before a standard is adopted.[83]

Although these might seem like relatively loose commitments, they often rule out the most harmful forms of conduct. Take patent disclosure obligations. Many SDOs either mandate or encourage such disclosures in order to make the standardization process more transparent.[84] The basic intuition is that the members of an SDO would rather avoid patent-protected technologies when public domain substitutes are available.[85] Making firms disclose their relevant IP can help achieve this goal. In turn, these disclosures may reduce the prevalence of royalty stacking (by reducing the number of firms that can claim licenses on a product) and holdup (because technologies that are not patent-protected are less susceptible to holdup).

But such obligations are not without costs. Mandated disclosures may force firms to reveal their long-term strategy and enable competitors to invent around the patents.[86] When these are realistic prospects, strict disclosure obligations may ultimately encourage firms with strong technology portfolios to move towards a competing SDO or to bypass de jure standardization altogether. Similarly, it has been claimed that *generic* disclosures (which do not cite the *specific* patents that are relevant to a contemplated technology) may impose search costs on other firms within an SDO.[87]

These design choices thus reflect complex tradeoffs, where there is no one-size-fits-all solution. Sectors where patent ambush is a realistic threat (for instance because a standard incorporates numerous technologies from different and lesser-known sources) might be more tempted to mandate the specific disclosure of IP rights. [88]

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[83] *See, e.g.*, Justus Baron & Daniel F Spulber, *Technology standards and standard setting organizations: Introduction to the searle center database*, 27 J. OF ECON. & MGMT STRATEGY 462, 466 (2018).

[84] *See* Josh Lerner, Haris Tabakovic & Jean Tirole, *Patent Disclosures and Standard-Setting* 3 (NBER WORKING PAPERS, WORKING PAPER NO. 22768, 2016).

[85] *Id.* ("The SSO indeed does not know which patents are major or minor. To this purpose, it can require disclosure of essential patents, and then conduct its own investigation to confirm that the patent is a major one, or to find a substitute to the disclosed patent.").

[86] *See* Chiao, et al., *supra* note 82, 38 THE RAND J. OF ECON., at 911 (2007).

[87] *See* Lerner, et al., *supra* note 84, at 6.

[88] *See* Chiao, et al., *supra* note 82, 38 THE RAND J, OF ECON., at 927 (2007) ("Empirically, we find that the presence of a provision mandating royalty-free licensing is negatively associated with the presence of a

Conversely, SDOs that already impose strict patent licensing policies have much less reason to burden firms with disclosure obligations.[89]

The upshot is that SDOs will constantly seek to refine their rules in order solve potential incentive-compatibility problems and thus attract the best possible firms to their organization. In doing so, they have a large incentive to design the standardization process in ways which prevent one party from extracting the others' quasi-rents. Otherwise, there would be no incentive for firms to join the SDO in the first place. Through their internal policies, SDOs may thus weed out low-hanging opportunism while preserving the overall attractiveness of their organizations.

2. Competition between standard developing platforms

The findings of the previous subsection are reinforced by the fact that standard developing organizations are constantly competing against each other to promote the most successful technologies. They thus need to convince the best technology firms to join their organizations. And because firms are unlikely to participate if they expect that their quasi-rents will be dissipated, SDOs have an incentive to design the standardization process in ways which mitigate the possibility of holdout, holdup, and royalty stacking.

From a more theoretical standpoint, standard developing organizations are multi-sided platforms (or two-sided markets) that seek to attract both innovators and implementers.[90] This has important policy ramifications. The central finding from the economic literature on two-sided markets is that a platform's output is not just affected by the overall price which it charges, but also by the allocation of prices between firms on both sides of the market.[91] This is because platforms need to get both sides "on board". As a result, they often adopt slanted pricing structures or impose

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disclosure requirement, whereas weaker "reasonable" licensing provisions are strongly associated with such a requirement.").

[89] *Id.*

[90] *See* Jean-Charles Rochet & Jean Tirole, *Two-sided markets: a progress report*, 37 THE RAND J. OF ECON. 645 (2006).

[91] *Id.*

internal rules which favor one particular class of agents over another, and the side with the most elastic demand tend to pay less.[92]

This dynamic surely plays an important role in the field of standard developing organizations. It potentially explains why SDOs have so far refused to impose "socially desirable" pricing obligations on SEP holders, notably in the form of *ex ante* price commitments (because imposing such measures might cause some SEP holders to join rival SDOs with more inventor-friendly policies).[93] More generally, the two-sided markets literature tells us that optimal SDO policies will tend to favor those agents that have the strongest outside options. This might, for instance, be the case for owners of strong IP portfolios who may be in a position to bypass the standardization process altogether and vertically integrate, if SDO policies do not meet their requirements. As US Assistant Attorney General Makan Delrahim observed:

> Patent policies affect the incentives for innovation. If an SSO's policy is too restrictive for one side or the other, it also risks deterring participation in procompetitive standard setting.
>
> Just as competition in the marketplace results in better outcomes for the consumers of goods and services, competition among standard-setting organizations to adopt better patent policies can result in better outcomes for the consumers of standard-setting activities (that is, for the participants themselves).[94]

Although competition might not always lead to perfect outcomes, it goes a long way towards reducing the hypothetical occurrence of patent holdup and royalty stacking.

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[92] *Id.* at 658-659. *See also,* Mark Armstrong, *Competition in two-sided markets*, 37 THE RAND J. OF ECON. 668, 670 (2006) (The author shows that multi-homing users tend to pay higher fees, while platforms compete aggressively to attract single-homing users).

[93] Josh Lerner and Jean Tirole have argued that this "forum shopping" might be detrimental to social welfare (because it prevents SSOs from adopting socially optimal rules). They thus call for regulators to regulate SSOs, requiring SEP holders to make *ex ante* price commitments. *See* Lerner & Tirole, *supra* note 81, 123 J.OF POL. ECON., at 575 (2015). *See also*, Josh Lerner & Jean Tirole, *A better route to tech standards*, 343 SCIENCE 972, 973 (2014).

[94] *See* Makan Delrahim, Assistant Attorney General , Speech, Telegraph Road: Incentivizing Innovation at the Intersection of Patent and Antitrust Law (Dec. 7, 2018), https://www.justice.gov/opa/speech/assistant-attorney-general-makan-delrahim-delivers-remarks-19th-annual-berkeley-stanford.

For instance, as discussed above, Josh Lerner and Jean Tirole have argued competition prevents SDOs from adopting socially optimal internal rules (because SEP holders shop around to find the most IP-friendly SDO). [95] But there is a flipside to this story. If we think that SEP holders will refuse to join an SDO that offers them subpar returns on their IP, then *a fortiori* they will also turn down SDOs where holdup and royalty stacking are likely prospects.

Moreover, even if SDO's internal rules currently inflate royalty rates compared to some idealized competitive benchmark, it is not entirely clear why this should be a cause for concern. The fact that some SEP holders may generate higher returns than they would if royalties had been agreed *ex ante* might still increase overall incentives to innovate.[96] This is because innovation is a risky activity, with some SEPs being more widely implemented than others, so the potential to earn higher returns on inventions that are more widely implemented creates stronger incentives to innovate across the board. In other words, so long as aggregate royalty rates remain at or below the monopoly benchmark there is no clear reason to believe that innovation is being harmed. There is nothing in the SDO competition literature to suggest that SDOs' rules are not achieving this.

3. Frequency of interactions

Another important limit to *ex post* opportunism lies in the fact that parties to the standardization process are often involved in repeat transactions. Repeat interactions are generally considered to limit the scope for opportunistic behavior. There are two important for reasons for this. First, the fact that firms routinely perform the same transactions reduces the per transaction cost of setting up a mutually beneficial governance structure. Second, firms' behavior may have reputational consequences which keep potential opportunism in check. Both of these might be at play in the SDO space, as we elaborate below.

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[95] *Id.*

[96] *See, e.g.,* Douglas H Ginsburg & Koren Wong-Ervin, *The Department of Justice's Long-Awaited and Much Needed Course-Correction on FRAND-Assured Standard-Essential Patents*, COMPETITION POL'Y INT'L (Nov. 19, 2017) ("*These outcomes, however, depend upon private SDOs and their members striking the right balance between the interests of innovators and those of implementers. If innovation is not sufficiently rewarded, this model ceases to work and standards will be established by other means*.").

In his early writings on holdup, Oliver Williamson wrote that:

> The cost of specialized governance structures will be easier to recover for large transactions of a recurring kind. Hence the frequency of transactions is a relevant dimension.[97]

The intuition is straightforward. If a single governance structure can be designed to manage multiple transactions, then its costs are spread across these various dealings. Other things being equal, the benefits of this governance structure are thus more likely to outweigh its costs.

These economies of scale seem particularly relevant to the world of standardization, where SDOs are often involved in dozens, sometimes hundreds, of standards per year. For instance, the website of the Institute of Electrical and Electronics Engineers (IEEE) lists 8912 standards, dating back to its inception in 1922. This includes 566 entries for the year 2018 alone.[98] Similarly, the European Telecommunications Standards Institute (ETSI) lists 46,088 results, dating back to 1988.[99] Of those, 2036 are "major" standard versions for the year 2018. Accordingly, the cost of setting up these SDOs is spread across a vast number of transactions. It is thus unlikely that these costs are somehow impeding the emergence of optimal governance mechanisms within these SDOs. Instead, because establishing an effective governance structure incentivizes many firms to use an SDO for standard development, low average costs stem from good governance structures, thereby incentivizing their adoption.

Similarly, it is well-established that the prospect of repeat transactions (and the potential reputational consequences which opportunistic behavior may entail) often suffice to ensure compliance with the "spirit" of an otherwise incomplete contract.[100] In the words of Benjamin Klein:

> Each transacting party compares the potential hold-up gain from breaching the contractual understanding with the capital loss from the private

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[97] *See* OLIVER WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM, 60 (Simon and Schuster 1985).

[98] *See* IEEE Website, https://ieeexplore.ieee.org/xpl/opacstd.jsp (last visited Feb. 02, 2019).

[99] *See* ETSI SEARCH & BROWSE STANDARDS, https://www.etsi.org/standards (last visited Jul. 21, 2019).

[100] *See, e.g.*, Benjamin Klein & Keith B Leffler, *The role of market forces in assuring contractual performance*, 89 J. OF POL. ECON. 615, 616 (1981).

> sanction. If the hold-up gain is less than the capital cost, then the transactor cannot credibly threaten breach of the contractual understanding. Therefore, although transactors could take advantage of the fact that all the elements of a contractual understanding are not perfectly specified in the written contract, they will not do so and will instead perform in a manner that is consistent with the mutually understood contractual intent.[101]

Reputation might thus play an important role in the field of *de jure* standardization.[102] Most SDOs only require SEP holders to make relatively loose commitments (if any) before a technology is adopted.[103] Some scholars have been quick to conclude that these lax obligations are insufficient to prevent opportunistic behavior. In doing so, they only focus on wording of contracts rather than the overall context in which they take place. Many highly publicized works almost entirely ignore this possibility (notably those of Lemley & Shapiro or Farrell et al.).[104]

And yet, the firms that are central to these debates often interact repeatedly, and in multiple standard developing organizations.[105] Although hard data on the regularity

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[101] *See* Klein, *supra* note 50, 34 ECONOMIC INQUIRY, bar449 (1996).

[102] *See* Pierre Larouche & Florian Schuett, *Repeated interaction in standard setting*, J. OF ECON. & MGMT. STRATEGY 488 (2019) (The authors show that repeated standard-setting games may significantly reduce the occurrence of opportunistic behavior). *See also*, Gastón Llanes, *Ex-ante Agreements and FRAND Commitments in a Repeated Game of Standard-Setting Organizations*, 54 REV. OF INDUS. ORG.159 (2019) ("*When firms interact repeatedly to develop standards, a commitment to set fair, reasonable and non-discriminatory (FRAND) royalty fees may lead to more efficient technologies and higher surplus for all parties. This result can explain why standard-setting organizations favor FRAND commitments over more structured licensing commitments–such as price caps–and why there are been relatively few cases of hold-up in practice, even though such opportunistic behavior has been a primary cause of concern for innovation economists*.").

[103] *See* Baron & Spulber, *supra* note 83, 27 J. OF ECON. & MGMT STRATEGY, at 466 (2018) ("*Many SSOs have rules regarding the licensing of SEPs. The most common rule is that SEP holders shall commit to making licenses available on a RAND basis. In most cases, the SSO bylaws do not themselves grant implementers of the standard a right to use the patented technology described in the standard. This right must be negotiated in private agreements that take place outside of the SSO. No SSO in our sample organizes or supervises licensing negotiations*.").

[104] *See* Lemley & Shapiro, *supra* note 8, at 1991. *See also,* Farrell, et al., *supra* note 62, 74 ANTITRUST L.J. 603 (2007).

[105] For instance, Samsung, Qualcomm, Ericsson, Nokia and LG have all been involved in 2G, 3G and 4G mobile technologies. iRunway, *supra* note 7, https://www.i-runway.com/images/pdf/iRunway%20-%202G%20and%203G%20Mobile%20Communication.pdf. https://www.i-runway.com/images/pdf/iRunway%20-%20Patent%20&%20Landscape%20Analysis%20of%204G-LTE.pdf.

of these interactions is hard to come by, it is difficult to imagine that bad apples would not, at some point, be made to pay for repeatedly applying "extortionate" royalty rates.

Critics may retort that most standardization organizations have committed to select technologies purely on merit[106], which arguably precludes retaliation. Plausible as this may be, it is important to stress that, in most cases, technologies are not selected on an anonymous basis. It is thus hard to exclude the possibility that, at least when they are faced with roughly equivalent technologies, members of an SDO may favor the technical solution of the firm that enjoys a superior reputation.

But even if members of an SDOs do select technologies based solely on their intrinsic merits, this still does not exclude retaliation. Just as firms may not wish to join SDOs with poor governance structures, they might also be hesitant to enter an organization that will tie them to firms with a track-record of extortionate royalty demands.

4. Patent pools and mergers

Finally, other institutional arrangements, such as patent pools and mergers, may also limit the scope for opportunistic behavior, even if the SDO only requires SEPS holders to make "loose" FRAND pledges.

In these cases, firms remain free to join patent pools which, when formed, alleviate most of the concerns associated with opportunism (cross-licensing is another solution). Patent pools set a joint royalty rate for all patents in the pool. Licensing complementary technologies as a single package greatly reduces the hypothetical risk of royalty stacking and holdup.[107] Of course, this solution is not perfect. Some firms will be tempted to free-ride on the efforts of the patent pool by staying out (though this type of behavior might also be caused by implementer monopsony power, which

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[106] *See* Marc Rysman & Timothy Simcoe, *Patents and the performance of voluntary standard-setting organizations*, 54 MGMT SCI. 1920, 1932 (2008).

[107] *See* Shapiro, *supra* note 44, 1 INNOVATION POL'Y & THE ECON., at 127 (2000). *See also,* Josh Lerner & Jean Tirole, *Public policy toward patent pools*, 8 INNOVATION POL'Y & THE ECON. 157, 162 (2007).

could lead to inefficiently low prices, from a dynamic perspective[108]).[109] And the formation of patent pools raises its own set of competitive issues. This is notably due to inflated prices if substitute patents are included in the pool (though the availability of independent licensing greatly reduces the likelihood of these harms).[110] Despite this, patent pools are yet another market force which might significantly reduce *ex post* opportunism that might otherwise have been left unchecked during the standardization process.

The same can be said about mergers. Both holdup and royalty stacking are, by definition, eliminated once firms merge (in both cases firms impose an externality on their partners which is internalized by the merger). Though it is highly unlikely that all firms within a standard could merge to solve the above issues, it is at least plausible that firms with a reputation for poor *ex post* behavior would constitute targets for other firms within the standard. It has also been argued that vertically integrated firms have superior incentives to join patent pools, thus improving consumer welfare.[111]

D. Regulatory failure

Responding to the empirical literature on patent holdup and royalty stacking (which shows that they are not widespread), some authors have argued that it is not because they are rare that authorities should not do anything about these phenomena. Jorge Contreras, for instance, posits that:

> The absence of systemic hold-up actually tells us little about individual firm behavior that can and should be sanctioned by the law, and it may

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[108] *See, e.g.,* Jonathan M Barnett, *From Patent Thickets to Patent Networks: The Legal Infrastructure of the Digital Economy*, 55 JURIMETRICS 1, 34 (2014) ("*The risk of this monopsonistic outcome would appear to be limited in the case of markets populated by the highest-value technology suppliers. Any technology supplier always has the option to elect not to participate in a pool that does not appropriately compensate the supplier for its technological contribution. For lower-value suppliers, this may not be a meaningful option because failing to participate in the pool may mean being dropped from the relevant standard.*"). *See also*, J Gregory Sidak, *Patent holdup and oligopsonistic collusion in standard-setting organizations*, 5 J. OF COMPETITION L. & ECON. 123, 149 (2009) (Sidak argues that standard setting may facilitate monopsonistic collusion among patent licensees).

[109] *See* Anne Layne-Farrar & Josh Lerner, *To join or not to join: Examining patent pool participation and rent sharing rules*, 29 INT'L J. OF INDUS. ORG. 294 (2011).

[110] *See* Josh Lerner & Jean Tirole, *Efficient patent pools*, 94 AM. ECON. REV. 691, 699 (2004).

[111] *See* Layne-Farrar & Lerner, *supra* note 109, 29 INT'L J. OF INDUS. ORG., at 296 (2011).

> thus be time to close the debate over the systemic prevalence of this form of behavior.[112]

On some basic level, this is indeed true. If public intervention was costless, did not deter socially beneficial behavior, and effective remedies could easily be devised, then authorities would have every reason to tackle all instances where market prices depart from some idealized competitive benchmark. But this is rarely, if ever, the case. There are usually important downsides to government intervention in the economy. Actions to remediate patent holdup and royalty stacking are no exception. This explains why comparative institutional analysis is so important.[113] The challenge is not merely one of addressing perceived market imperfections. It is about ensuring that intervention actually leads to overall social benefits.

The question before us is whether the fixes that have been proposed to limit to occurrence of patent holdup would generate social benefits that outweigh their costs. To determine whether this is the case, it is first necessary to identify the most salient features of these purported solutions.

As has already been discussed, one of the most publicized proposals is the one put forward by Mark Lemley and Carl Shapiro.[114] Their proposition hinges on two critical elements that have been echoed by other scholars.[115]

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[112] *See* Jorge L Contreras, *Much Ado About Holdup*, 26 (Univ. of Utah College of Law, Research Paper No. 269, 2018).

[113] *See* Demsetz, *supra* note 57, 4 THE J. OF L. & ECON. 1 (1969).

[114] This is not to say that there have not been any other proposed solutions, but none of the alternatives has gained as much traction in policy circles. Some authors have suggested that policymakers should require patent holders to make *ex ante* price commitments before their technology is selected in a standard. *See* Lerner & Tirole, *supra* note 81, 123 J. OF POL. ECON., at 547 (2015). Likewise, some SSOs have prevented SEP holders from earning royalties that exceed the value of the "smallest saleable patent practicing unit" (or "SSPPU").

[115] *See, e.g.*, George S Cary, Mark W Nelson, Steven J Kaiser & Alex R Sistla, *The Case for Antitrust Law to Police the Patent Holdup Problem in Standard Setting*, 77 ANTITRUST LJ 913, 916 (2010). *See also,* Timothy S Simcoe, *Private and public approaches to patent hold-up in industry standard setting*, 57 THE ANTITRUST BULLETIN 59, 71 (2012). *See also,* Colleen V Chien & Mark A Lemley, *Patent holdup, the ITC, and the public interest*, 98 CORNELL L. REV. 1 (2012). *See also,* Joseph Kattan, *FRAND Wars and Section 2*, 27 ANTITRUST 30 (2012). *See also*, Kai-Uwe Kuhn, Fiona Scott Morton & Howard Shelanski, *Standard setting organizations can help solve the standard essential patents licensing problem*, 3 ANTITRUST CHRONICLE 1, 4 (2013).

First, patent holders should only be able to earn "reasonable" royalties that do not exceed the incremental value of their innovation.[116] Because this value is hard to determine, scholars use the royalties that firms could have commanded *ex ante* (before the standardization process has taken place) as a benchmark. This is notably down to the assertion that standardization increases the market power of SEP holders.[117] Under this proposal, decisionmakers would thus be tasked with constructing a counterfactual world where parties have not yet made sunk asset-specific investments. As Carl Shapiro and Fiona Scott Morton put it:

> "The basic idea behind reasonable royalties is straightforward: they are meant to measure the royalties that would be negotiated ex ante between the patent holder and the infringing party, assuming that the patents involved are valid and infringed. In this context, "ex ante" is interpreted to mean the date just before the infringement began although an economically more precise statement would be the date just before the infringing party made significant investments specific to the use of the patented technology."[118]

Second, these authors argue that SEP holders should be prevented from obtaining injunctions in a wide array of circumstances where this would allow them to earn royalties that are "unreasonable" (under the definition of the previous paragraph).[119] This would notably preclude SEP holders from seeking injunctions against willing licensees.[120]

The following sections show that this approach, and others like it, would likely generate significant social costs that far outstrip its limited competition-related benefits.

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[116] *See* Lemley & Shapiro, *supra* note 8, at 2037. *See also,* Carl Shapiro, *Patent reform: Aligning reward and contribution*, 8 INNOVATION POLICY AND THE ECONOMY 111, 139 (2007). See also, Dennis W Carlton & Allan L Shampine, *An economic interpretation of FRAND*, 9 J. OF COMPETITION L. & ECON. 550 (2013). ("*The threat of an exclusion order places at risk the investment and ongoing profits of firms using the standard, allowing the patent holder to engage in hold-up and ask for payment in excess of the ex ante value of the patent.*").

[117] *See* Farrell, et al., *supra* note 62, 74 ANTITRUST L.J., at 660 (2007).

[118] *See* Scott Morton & Shapiro, *supra* note 46, 16 INNOVATION POL'Y & THE ECON., at 94 (2016).

[119] *See* Lemley & Shapiro, *supra* note 8, at 2037 .

[120] *See* Mark A Lemley & Carl Shapiro, *A simple approach to setting reasonable royalties for standard-essential patents*, 28 BERKELEY TECH. LJ 1135, 1143 (2013).

This is especially true given the, at best, sporadic occurrence of patent holdup and royalty stacking).

1. Ex ante royalty rates and the "veil of ignorance"

Under the aforementioned proposals, authorities would have to reconstruct the hypothetical royalty rates that firms could have commanded before the standardization process took place. This would likely prove to be a daunting task.

Critics fear that *de jure* standardization increases the market power of participating firms, whose patents can potentially become "essential" via this process. This effect is more pronounced for "weak" patents that face *ex ante* competition and/or have a low probability of being found valid (rather than "strong" patents for which there are no *ex ante* substitutes).[121] Accordingly, proponents have urged authorities to prevent SEP holders from earning higher royalties *ex post* than those they could have charged *ex ante*. This is notably said to prevent firms from exploiting "weak" patents.

Taken literally, this approach is highly flawed. It assumes that all market power created *during* the standardization process is also *caused* by this process. This is not the case.

Innovation involves significant risks and uncertainty. While these must be priced in to *ex ante* licensing terms (including royalty rates), they mostly disappear *ex post*. *Ex ante* terms are thus likely to appear be more favorable than *ex post* ones, even when one ignores the effect of the standardization process itself.

Imagine an idealized setting where some implementers licensed a technology before it was incorporated into a standard, and where others held out and sought to obtain equivalent terms after the technology prospered in the marketplace. Imagine further that SEP holders only charge lump-sum licensing fees (per unit fees and percentage-based royalties would involve more complex risk-sharing mechanisms).[122] Forcing

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[121] *See* Lemley & Shapiro, *supra* note 8, at 1993.

[122] Lump sum licensing agreements are relatively uncommon in reality. *See, e.g.,* Mariko Sakakibara, *An empirical analysis of pricing in patent licensing contracts*, 19 INDUS. & CORP. CHANGE 927, 934 (2010) (The authors find the 95.99% of licensing agreements include royalty payments). *See also,* Preet S Aulakh, S Tamer Cavusgil & MB Sarkar, *Compensation in international licensing agreements*, 29 J. OF INT'L BUS. STUD.409, 414 (1998) (The authors survey of 110 license agreements found that 29 relied solely on lump-

technology firms to offer the same lump-sum licensing terms to both sets of firms would be analytically equivalent to requiring insurance companies to conclude equivalent contracts for a house that is standing and one that has already burned down.

For instance, numerous standardized technologies exhibit significant network externalities. This is notably the case for communications technologies (such as 4G, Wifi) and video storage devices (such as Blu-Ray). In these markets, firms routinely offer more favorably terms to early adopters in order to establish an installed base of users.[123] Early adopters not only take on more risk than later arrivers (who know whether a technology has succeeded in the market). They also produce critical network externalities in the early stages of a technology, where the market might not have settled on a winning standard.[124] In the realm of communication technologies, for example, there may be important benefits to getting key implementers on-board early (think of firms like Apple or Samsung). A similar story occurs in the market for video game consoles, where firms seek to retain key develops before they launch a console.[125] In short, getting these key players to adopt a technology may signal that it will prosper in the market, which in tun drives purchases. It is thus perfectly reasonable for early adopters to obtain what are ostensibly more favorable license terms.

What precedes remains true even in cases where firms agree on licensing terms that involve a more nuanced allocation of risk than lump-sum payments. Take the example of fixed, per unit royalties. The optimal fee, *ex post*, is likely to be lower when there turns out to be little demand for a technology (or when the product faces strong

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sum royalties). Older literature suggests that this was the case for roughly 10% of licensing contracts. *See* Nancy T Gallini & Ralph A Winter, *Licensing in the theory of innovation*, THE RAND J. OF ECON. 237, 242 (1985).

[123] *See* Michael L Katz & Carl Shapiro, *Technology adoption in the presence of network externalities*, 94 J. OF POL. ECON. 822, 834 (1986). *See also*, Hongju Liu, *Dynamics of pricing in the video game console market: skimming or penetration?*, 47 J. OF MKTING RES. 429 (2010). *See also*, Charles WL Hill, *Establishing a standard: Competitive strategy and technological standards in winner-take-all industries*, 11 THE ACAD OF MGMT EXECUTIVE 7, 16-17 (1997).

[124] *See* Katz & Shapiro, *supra* note 123, at 834.

[125] *See* Andrei Hagiu, *Pricing and commitment by two-sided platforms*, 37 THE RAND J. OF ECON. 720, 721 (2006) ("[I]t *is common for video game console manufacturers to announce (attractive) price tags for their upcoming consoles well in advance of their actual release, in order to attract the support of independent game developers (and justify charging them around $8 royalties per game sold*)."). *See also,* Rochet & Tirole, *supra* note 90, 37 THE RAND J. OF ECON., at 664 (2006).

competition), and vice versa. When they are negotiating *ex ante*, firms must price-in this *uncertainty*.[126] If implementers can obtain identical terms *ex post*, then settling on *ex ante* terms can only leave them worse off. This ability to push back negotiations has a knock-on effect on SEP holders who will have to shoulder more of the initial risk.

The upshot is that it will prove exceedingly difficult to authorities to satisfactorily reconstruct hypothetical *ex ante* royalty rates. They will not only have to establish what the competitive landscape looked like before the standardization process took place, but also what type of risk allocating mechanisms parties would have chosen *ex ante* and how *ex post* developments would have affected these prices. Reconstructing hypothetical *ex ante* prices is thus no substitute for actual *ex ante* agreements (where parties factor in all these risks and uncertainties). Moreover, systematically allowing late-arrivers to obtain equivalent terms to early adopters reduces their incentive to conclude deals *ex ante*. Finally, as the following section will clarify, the numerous factors that must be accounted for during *ex* ante negotiations probably explain why firms so rarely conclude complete contracts in the first place.

2. There is a reason why firms conclude incomplete contracts

One way to avoid holdup problems is for parties to entirely specify their relationship – that is to write a complete contract. A contract is incomplete when it "has gaps, missing provisions, and ambiguities and has to be completed (by renegotiation or by the courts) with strictly positive probability in some states of the world."[127]

As numerous commentators have observed, FRAND commitments which are prevalent in the world of *de jure* standardization, are a form of incomplete contract. By agreeing on the loose concept of FRAND royalties, rather than a precise number,

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[126] *See* FRANK H KNIGHT, RISK, UNCERTAINTY AND PROFIT 197 (Courier Corporation, 2012 reprint. 1921). In a nutshell, Knight draws a distinction between risk and uncertainty (which Knight also refers to as unmeasurable risk). The first involves a probabilistic situation with known payoffs and probabilities. In the case of the latter, the payoffs and/or the probability of a given outcome are also unknown.

[127] *See* OLIVER HART, FIRMS, CONTRACTS, AND FINANCIAL STRUCTURE (Clarendon Press. 1995).

parties leave at least part of their arrangement unspecified. And when these arrangements also involve specific assets, this renders parties vulnerable to their counterparts' (and courts') interpretation of FRAND.

But if writing a complete contract can weed out patent holdup, why do parties they routinely forgo this opportunity? The simple answer is that the incompleteness of the FRAND commitment is a feature, not a bug. Incompleteness results in flexibility.[128] The patent policies of the major SDOs allow the SEP holder and the implementer to set licensing terms for an SEP, including the ultimate royalty rate, through voluntary negotiations. That mechanism permits a range of FRAND royalties for a given SEP.[129]

This *ex post* contractual flexibility helps parties address inherent uncertainty concerning the ultimate value of a technology. This might explain why some SDOs have deliberately declined proposals to narrow down their policies pertaining to FRAND.[130] As Epstein and Noorozi observe:

> The incomplete nature of the FRAND contract is therefore neither an oversight by SDOs [i.e. standard settings organizations] nor an invitation for courts to fill in the gaps or clarify the boundaries, but rather an architectural design feature of the FRAND framework that has been critical to its success.[131]

Loose FRAND commitments thus ensure that standards can be adopted and disseminated rapidly, unhindered by complex and time-consuming price negotiations. For instance, ETSI's Guide on IPR provides that:

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[128] *See, e.g.*, Holden & Malani, *supra* note 50, at 29. ("*So the parties should not construct a penalty that locks in the original contract unless the expected cost of hold-up is greater than the expected cost of inflexibility*").

[129] *See* J Gregory Sidak, *Is a FRAND Royalty a Point Or a Range*, 2 CRITERION J. ON INNOVATION 401 (2017).

[130] Since its inception, ETSI has explicitly turned down proposals to narrow its IPR policy framework (notably by introducing Smallest Saleable Unit pricing, or by forcing SEP holders to license their technology to all willing licensees). *See* Bertram Huber, *Why the ETSI IPR Policy Does Not and Has Never Required Compulsory 'License to All': A Rebuttal to Karl Heinz Rosenbrock*, 4-9 (2017), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3038447.

[131] *See* Epstein & Noroozi, *supra* note 40, at 1396.

> [S]pecific licensing terms and negotiations are commercial issues between the companies and shall not be addressed within ETSI [...] Members attending ETSI Technical Bodies are often technical experts who do not have legal or business responsibilities with regard to licensing issues. Discussion on licensing issues among competitors in a standards making process can significantly complicate, delay or derail this process.[132]

The upshot is that the level of precision contained in "FRAND" is a choice made by sophisticated parties informed by a number of tradeoffs.[133] It verges on the fanciful to believe that authorities will not face significant difficulties in establishing the exact royalty rates which parties would have agreed upon *ex ante*. Extending the instances in which authorities are tasked with making these determinations will further entrench their role as price regulators of last resort.

And the risk is not just that authorities might strike the wrong balance between the interests of SEP holders and implementers (with the potential consequence that firms will underinvest in innovation). It is well-established that enabling regulatory and judicial authorities to act as price regulators increases firms' incentive to partake in rent-seeking activities.[134] Giving courts more power to determine whether royalties are FRAND will further encourage firms to misuse the court system to their advantage (or, as discussed in the following section, avoid private negotiations under the knowledge that courts will systematically rule in their favor). It is thus eminently desirable that, as much as possible, parties be left to sort out their affairs privately.

3. The suggested approach may exacerbate holdout behavior

This brings us to one of the most important objections to the Lemley & Shapiro line of reasoning. Guaranteeing that implementers will, in most cases, receive extremely favorable terms, as well as shielding them from injunctions, obviates any incentive which they may have to join the negotiating table. It thus raises the prospect that

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[132] *See* ETSI Guide on IPR, Section 4.1.

[133] *See* Joanna Tsai & Joshua D Wright, *Standard setting, intellectual property rights, and the role of antitrust in regulating incomplete contracts*, 80 ANTITRUST L.J. 157, 163 (2015).

[134] *See* Robert D Tollison, *Rent seeking: A survey*, 35 KYKLOS 575, 578 (1982) ("*Rent seeking is the expenditure of scarce resources to capture an artificially created transfer.*"). *See also*, Gordon Tullock, *The welfare costs of tariffs, monopolies, and theft*, 5 ECONOMIC INQUIRY 224 (1967).

implementers may practice a patented technology and deliberately refuse to take a license. This behavior is generally referred to "patent holdout"[135], "reverse holdup"[136] or "patent trespass"[137].

Particularly relevant here is the contention that SEP holders should be barred from seeking injunctions. This is one of the central claims made in Lemley & Shapiro's paper and subsequent literature.[138] These authors argue that the threat of injunctions forces implementers to accept royalties that depart form the *ex ante* benchmark. The basic intuition is that contested patents often cover only a small piece of underlying products. Because injunctions usually prevent the entire product from being sold, they impose a particularly high cost on infringing implementers.[139] This, in turn, is said to significantly weaken their bargaining position *vis à vis* SEP holders.

These fears rest on the critical assumption that SEP holders enjoy a particularly strong bargaining position against implementers. Authors support this claim by arguing that implementers cannot avoid the negotiating table, as doing so raises the prospect of willful patent infringement and, with it, severe punitive damages.[140]

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[135] *See* Epstein & Noroozi, *supra* note 40, at 1381. *See also* Colleen V Chien, *Holding up and holding out*, 21 MICH. TELECOMM. & TECH. L. REV. 1, 2 (2014). *Contra* Douglas Lichtman, *Patent holdouts and the standard-setting process* (U CHICAGO L. & ECONOMICS, OLIN WORKING PAPER, 2006)(The author uses holdout in a different context, referring to firms dampened incentives to sue for infringements when multiple patents cover a same infringing product).

[136] *See* Kieff & Layne-Farrar, *supra* note 41, 9 J. OF COMPETITION L. & ECON., at 1092 (2013). *See also*, Joshua D Wright, *SSOs, FRAND, and antitrust: lessons from the economics of incomplete Contracts*, 21 GEO. MASON L. REV. 791, 807 (2013).

[137] *See* Heiden & Petit, *supra* note 42, 34 SANTA CLARA HIGH TECH. L.J., at 179 (2018).

[138] *See* Lemley & Shapiro, *supra* note 8 at 2009. *See also*, Kuhn, et al., 3 ANTITRUST CHRONICLE 3, (2013)("*For example, threatening to engage in expensive litigation, or pursuing an injunction or an exclusion order if the licensee does not pay the requested royalties, creates a powerful incentive for the licensee to settle, even on poor terms. Thus the SEP owner can obtain payment far in excess of the ex ante value of the technology, and appropriate the profits due to the later investments of others.*").

[139] See Farrell, et al., *supra* note 62, 74 ANTITRUST LJ, at 638 (2007) ("*An injunction would prevent a user from practicing the standard, whose value is by no means all attributable to this one patent holder's patents-because of specific investments by the user, because of innovations by the user, because of coordination, and because of the other inventions (patented or not) incorporated in the standard.*").

[140] *Id.* at 203. ("*Under current law, the willfulness doctrine serves to deter such conduct* [...]"). On willful infringement, *see* Kimberly A Moore, *Empirical statistics on willful patent infringement*, 14 FED. CIR. BJ, 227 (2004).

But such a conjecture does not hold water. Over the last years, a growing body of scholarship has shown that implementers can, and do, forgo patent negotiations in the knowledge that it will be hard for them to be brought to justice. For instance, Nicolas Petit and Bowman Heiden provide survey data which notably suggests that smartphone SEP license coverage decreased from 73% to 36% between 2006 and 2016.[141] They also find that – at least according to SEP holders – potential holdout behavior ranges from dilatory tactics to outright infringement.[142] Although this data was largely obtained from SEP holders – and should thus be taken with a pinch of salt – it does tend to exclude the idea that the specter of willful patent infringement systematically deters holdout behavior.[143]

On a more theoretical level, Richard Epstein and Kayvan Noroozi argue that moving from a system supported by injunctions to one of liability rules may significantly raise the scope for holdout behavior.[144] The authors notably cite the example of *Apple v. Motorola*[145], where the United States Court of Appeals for the Federal Circuit refused to grant an injunction against Apple. It did so on grounds that there were ongoing negotiations between both parties and that there was no evidence Apple would unilaterally refuse to deal with Motorola.[146]

This conclusion is in line with a long-standing law & economics literature that discusses the relative merits of liability rules versus property rules (the latter are generally

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[141] *See* Heiden & Petit, supra note 42, 34 SANTA CLARA HIGH TECH. L. J., at 235 (2018).

[142] *Id.* at 232.

[143] For instance, in *Unwired Planet*, Judge Birss concluded that "Overall I find that there is clear potential on theoretical grounds for hold-out to occur." *See Unwired Planet International Ltd & Anor v Huawei Technologies Co Ltd & Anor* [2018] EWCA Civ 2344 (23 October 2018), para. 665, https://www.bailii.org/ew/cases/EWCA/Civ/2018/2344.html.

[144] *See* Epstein & Noroozi, *supra* note 40, at 1413. *See also*, Jonathan M Barnett, *Has the Academy Led Patent Law Astray*, 32 BERKELEY TECH. LJ 1313, 1363 (2017) (The author argues that removing the threat of injunctive relief weakens patent holders' bargaining position, thus diminishing their incentives to innovate).

[145] *Apple*, 757 F.3d at 1332.

[146] *See* Epstein & Noroozi, *supra* note 40, at 1414.

associated with the ability to obtain an injunction).[147] At a highly abstract level, liability rules are said to compensate victims, deter injurers and spread risk.[148] In theory, liability rules thus appear sufficiently robust to handle almost every externality problem, including the potential damages caused to SEP holders by patent infringers. However, numerous practical intricacies may cause this intuition to fail, thus shifting the optimal policy from one liability rule to one of property rights.

In their seminal paper on the topic, Guido Calabresi and Douglas Melamed identify two main reasons that may cause liability rules to achieve a suboptimal allocation of resources.[149] First, under a liability rule courts, rather than market participants, set the price of a good.[150] Since courts do not have access to all the relevant knowledge that would be available to market participants, there is a strong likelihood that this price will deviate from the market clearing level (i.e. it will be either too high or too low). In other words, the price set by courts under a liability rule is unlikely to maximize the joint welfare of the parties (*i.e.* will not be welfare maximising). This risk is particularly acute when courts must deal with highly idiosyncratic goods, such as patents.

Second, even if courts could perfectly compute the damage suffered by the victim, liability rules may still be suboptimal.[151] For instance, liability rules may lead to underdeterrence when the person who causes the harm does not have sufficient resources to compensate the original entitlement holder (whereas injunctions are effective regardless of potential insolvency).

Richard Epstein and Kayvan Noroozi aptly show that both of these outcomes are real prospects when courts prevent patent holders from obtaining injunctions (thus veering too far on the "liability" end of the spectrum).[152] Because patent litigation often

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[147] *See* Guido Calabresi & A Douglas Melamed, *Property rules, liability rules, and inalienability: one view of the cathedral*, 85 HARVARD L. REV. 1089 (1972).

[148] *See, e.g.*, Robert D Cooter, *Economic theories of legal liability*, 5 J. OF ECON. PERSP. 11 (1991).

[149] *See* Calabresi & Melamed, *supra* note 147, 85 HARVARD L. REV. 1125 (1972).

[150] *Id.*

[151] *Id.*

[152] *See* Richard A Epstein & Kayvan B Noroozi, *Why Incentives for Patent Holdout Threaten to Dismantle FRAND, and Why It Matters*, 32 BERKELEY TECH. LJ 1381, 1407 (2017).

spans numerous years, they observe that both the patent holder and infringer may have gone bankrupt by the time courts reach a final decision on liability.[153] When this is the case, liability rules may be ineffective. Epstein and Noroozi also argue that allowing one potential licensee to get away with holdout behavior will encourage others to follow suit. This is especially true when there is strong competition between implementers. In these cases, agreeing upon a license fee may weaken their competitive position compared to rivals that are holding out.[154]

To make matters worse, regulatory interventions that increase the incentive for implementers to hold out will prove hard or impossible-to-correct- for market participants. As we have argued throughout this paper, parties to the standardization process have strong incentives to avert situations where one party is in a position to behave opportunistically. But this ability to construct mutually advantageous arrangements is not without limits. By preventing courts from granting injunctions or by imposing antitrust liability on SEP holders who seek them,[155] policymakers effectively foist their distributional preferences upon market participants. For instance, private arrangements that incentivize implementers to join the negotiating table (one example could be an SDO policy that excludes repeat infringers) may suffer the same regulatory fate as injunctions (under the premise that they achieve the same effect). As a result, firms may find it impossible to modify the allocation of rights decided by regulators, and economic welfare may suffer.

In short, both the survey evidence regarding patent holdout and its theoretical foundations should dispel the myth that SEP holders systematically enjoy a better bargaining position than implementers. Calls to limit injunctions are thus just as likely to harm the innovation process (by enabling holdout behavior) as they are to improve it (by preventing patent holdup). And given the empirical literature which suggests

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[153] *Id.*

[154] *Id.*

[155] This was notably the case in the EU Commission's *Motorola* decision. *See* Commission Decision No. COMP. AT. 39985 (*Motorola – Enforcement of GPRS Standard Essential Patents*), C(2014) 2892 final, slip. op. (April 29, 2014), para. 280. ("*In the exceptional circumstances of this case, set out in section 8.2.1 below, Motorola's seeking and enforcement of an injunction against Apple in Germany on the basis of the Cudak GPRS SEP amounts to an abuse of a dominant position under Article 102 TFEU as of Apple's Second Orange Book Offer of 4 October 2011, which constituted a clear indication that Apple was not unwilling to enter into a licence agreement on FRAND terms and conditions.*").

that holdup and royalty stacking are not widespread, there is little cause for policymakers to blunt SEP holders' ability to seek injunctions.

4. The problem with incremental value pricing

A final important objection concerns the assumption that SEP returns (be they royalties, per unit fees or lump sum payments) should be limited to the *ex ante* incremental value which a technology contributes to a standard.[156] This approach is sometimes referred to as the "Efficient Component Pricing Rule" ("ECPR").[157] The ultimate goal is to ensure that firms (especially those with so-called weak patents) earn the revenues that they could hypothetically have negotiated *ex ante*, rather than those which they can extract once asset-specific investments have been made. Proponents thus urge policymakers to interpret FRAND pledges along these lines.[158] As Denis Carlton and Allan Shampine put it:

> A "reasonable" royalty paid by a firm in the context of FRAND and a SSO is a royalty that does not include any hold-up value: the royalty that would have been negotiated *ex ante*, before the patented technology at issue had been adopted into the standard and prior to the licensee incurring sunk costs. The maximum royalty ex ante is based on the incremental value that the technology brings to the licensee compared with the next-best alternative available.[159]

But technologies that make up a standard are often perfect complements. As a result, the sum of their incremental values may exceed the total value of the standard. For instance, a left shoe is usually worthless without a right shoe, so that each shoe contributes 100% to the value of a pair. Some scholars thus add that each firm's returns

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[156] *See, e.g.* Scott Morton & Shapiro, *supra* note 46, 16 INNOVATION POL'Y & THE ECON., at 101 (2016). *See also,* Carlton & Shampine, *supra* note 116, 9 J. OF COMPETITION L. & ECON. 545 (2013).

[157] *See* Daniel G Swanson & William J Baumol, *Reasonable and nondiscriminatory (RAND) royalties, standards selection, and control of market power*, 73 ANTITRUST LJ 1, 29 (2005). *See also*, William J Baumol, *Some subtle pricing issues in railroad regulation*, INT'L J. OF TRANSPORT ECONOMICS/RIVISTA INTERNAZIONALE DI ECONOMIA DEI TRASPORTI, 341 (1983).

[158] *See, e.g.*, Scott Morton & Shapiro, *supra* note 46, 16 INNOVATION POL'Y & THE ECON., at 101 (2016). *See also*, Swanson & Baumol, *supra* note 157, 73 ANTITRUST LJ, at 29 (2005).

[159] *See* Carlton & Shampine, *supra* note 116, J. OF COMPETITION L. & ECON., at 545 (2013).

should be limited to account for the value of other essential technologies/components that make up a standard.[160]

Enacting these strict approaches to FRAND pricing (and especially the latter) is not without issues. Doing so may place an unduly high importance on the demand for technologies, ignoring the supply-side of the equation. Indeed, it is widely accepted that FRAND royalties should seek to achieve a balance between the dissemination of innovations (ensuring that prices are not excessive) and the incentives to produce them (by ensuring that firms' contributions are rewarded).[161] For instance, ETSI's IPR policy finds that:

> IPR holders whether members of ETSI and their AFFILIATES or third parties, should be adequately and fairly rewarded for the use of their IPRs in the implementation of STANDARDS and TECHNICAL SPECIFICATIONS.[162]

Along similar lines, Douglas Ginsburg and Koren Wong-Erwin point out that:

> These outcomes, however, depend upon private SSOs and their members striking the right balance between the interests of innovators and those of implementers. If innovation is not sufficiently rewarded, this

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[160] *See, e.g.,* Farrell, et al., *supra* note 62, ANTITRUST LJ, at 642 (2007) ("[T]*he sum of the royalty rates for any group of essential patents cannot exceed the combined value of all of these patented technologies to the standard, measured in comparison with an alternative standard that infringes none of these patents*."). *See also*, Lemley & Shapiro, *supra* note 8, at 2007.

[161] *See* Epstein & Noroozi, *supra* note 40, at 1424. *See also*, Damien Geradin, *Standardization and technological innovation: Some reflections on ex-ante licensing, FRAND, and the proper means to reward innovators*, 29 WORLD COMPETITION 511 (2006). *See also*, Yann Ménière, *Fair, Reasonable and Non-discriminatory (FRAND) Licensing Terms. Research Analysis of a Controversial Concept*, 3 (JRC Science and Policy Report No. 27333, 2015) ("[FRAND] *commitments are meant to protect technology implementers while ensuring that patent holders receive an appropriate reward for their investments in research and development.*"). *See also*, Mario Mariniello, *Fair, Reasonable and Non-Discriminatory (FRAND) terms: a challenge for competition authorities*, 7 J. OF COMPETITION L. & ECON. 523, 524 (2011) ("*The magnitude of such returns can be instrumental to encourage innovation, as returns on successful innovations need to compensate, not only for the cost of developing the innovation itself, but also for the cost of developing other projects which ultimately fail.*").

[162] See ., ETSI, RULES OF PROCEDURE , *supra* note 38, para. 3.2, *available at* https://www.etsi.org/images/files/IPR/etsi-ipr-policy.pdf.

> model ceases to work and standards will be established by other means.[163]

On the one hand, scholars rightly observe that a strict pursuit of incremental value pricing (as with ECPR) may lead to ostensibly excessive royalties. But there is a flip-side to this finding. Just as focusing on the incremental contribution of a technology may produce surprisingly high returns in some cases, it can also lead to zero returns when technologies are *ex ante* perfect substitutes.[164] This radical outcome, though theoretically justified, is not without problems.

For a start, it would be inconsistent for policymakers to depart from ECPR when it leads to "excessive" royalties (as some authors have suggested) but not when it leaves SEP holders with zero returns. If recreating the state of *ex ante* competition is what truly matters, then authorities should tolerate both outcomes. Just as there are situations where perfect competition would have led to very low royalties, in other cases SEP holders would have been in a position to extract significant returns due to the absence of *ex ante* substitutes. Not that they would necessarily have chosen to do so. Instead, they might have opted for mutually beneficial arrangements (such as patent pools, or simply charging a "fair" price) which avoid the distributional and reputational consequences of non-cooperative behavior.

A second, more fundamental, objection is that ECPR raises the old economic question of allocative efficiency versus *ex ante* incentives to innovate. It is well-established that innovation raises a time consistency problem. In a nutshell, the *ex post* market power required to spur innovation also implies allocations of resources that depart from the competitive benchmark.[165] The upshot is that, in innovation-intensive industries such as the standardization space, optimizing the *ex post* allocation of resources is probably not the sole goal that authorities should pursue.[166] Mandating that technologies with *ex ante* substitutes should earn zero royalties may well increase

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[163] *See* Ginsburg & Wong-Ervin, *supra* note 96, COMPETITION POL'Y INT'L, at 7 (2017).

[164] *See* Anne Layne-Farrar, A Jorge Padilla & Richard Schmalensee, *Pricing patents for licensing in standard-setting organizations: Making sense of FRAND commitments*, 74 ANTITRUST LJ 671, 701 (2007).

[165] *See* Kenneth Arrow, *Economic welfare and the allocation of resources for invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609 (1962). *Contra* Demsetz, *supra* note 57, 4 THE J. OF L. & ECON. 1 (1969).

[166] For a more detailed discussion, *see, e.g.*, Dirk Auer, *Structuralist Innovation: A Shaky Legal Presumption in Need of an Overhaul*, CPI ANTITRUST CHRONICLE, DECEMBER, 4 (2018).

the diffusion of existing technologies, but it has ambiguous effects on firms' incentives to produce them. Such an approach might, for instance, reduce these firms' incentives to contribute to the development of standards (notably by solving interoperability issues that crop up during a standard's development phase).

Due to these potentially unattractive features of ECPR, if is not surprising that other alternatives have been put forward. For instance, some scholars have suggested that the "Shapley value" should be used to determine whether returns can be deemed FRAND.[167] Although this also tracks each contribution's marginal value, it leads to less extreme results (notably in the case of *ex ante* substitutes).[168] Another alternative would be to stick with the *Georgia Pacific*[169] case law which outlines a multifactor test to determine whether rates are FRAND.[170]

This raises a critical question: who should decide on the allocation of rents between firms participating in the standardization process? As discussed in the previous paragraphs, there are a whole range of arrangements which firms might agree upon to split the profits of standardization. As things stand, firms and SDOs have mostly seen fit to use open-ended FRAND pledges and the *Georgia Pacific* case law as a backstop. With few exceptions, they have thus declined to move towards the ECPR or other approaches that implement strict incremental value pricing (even though they could easily include these in their patent licensing policies).[171]

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[167] *See* Layne-Farrar, et al., *supra* note 164, 74 ANTITRUST LJ, at 674 (2007). *See* Lloyd S Shapley, *A value for n-person games*, 2 CONTRIBUTIONS TO THE THEORY OF GAMES 307 (1953).

[168] *See* Layne-Farrar, Padilla & Schmalensee, *Id.* at 697. ("*Here, even though it might make technical sense for the standard to be based on only one of the two component b patents, both* b_1, *and* b_2 *are entitled to royalties according to the Shapley value. In contrast, under the efficiency-based approach of the previous section, company a would obtain all rents,* $za = 1$, *since it faced no competition, while companies* b_1, *and* b_2 *would obtain zero since perfect competition would drive their auction bids to that level. The Shapley value is still affected by competition, but less drastically*.").

[169] *Georgia-Pacific Corp. v. U.S. Plywood Corp*., 318 F. Supp. 1116 (S.D.N.Y. 1970).

[170] For a discussion of this framework, *see. e.g.*, Damien Geradin, *The Meaning of Fair and Reasonable in the Context of Third-Party Determination of Frand Terms*, 21 GEO. MASON L. REV. 919, 948 (2013). *See also*, Anne Layne-Farrar & Koren W Wong-Ervin, *Methodologies for calculating FRAND damages: an economic and comparative analysis of the case law from China, the European Union, India, and the United States*, 8 JINDAL GLOBAL L. REV. 139 (2017).

[171] This is, for instance, the case of IEEE's licensing policy. The policy is available on IEEE's website: https://standards.ieee.org/about/policies/bylaws/sect6-7.html. *See also*, Scott Morton & Shapiro, supra note 46, 16 INNOVATION POL'Y & THE ECON., at 111 (2016).

This choice could be down to any number of reasons. For a start, firms might prefer less radical pricing mechanisms than ECPR, which preserve incentives to participate in the standardization process when a technology faces *ex ante* substitutes. It is also possible that firms believe it would be challenging for decisionmakers to reconstruct the *ex ante* state of competition. Doing so would notably entail a daunting assessment of alternatives that were available at the time of a technology's inclusion in a standard. Clearly the cost of false positives (i.e. wrongly concluding that rates are not FRAND) is particularly large in these cases. SEP holders would effectively be expropriated if a decisionmaker wrongly concluded that there was *ex ante* competition for their technology.

Critics may retort that, in the long run, ECPR pricing would benefit SEP holders because their losses in cases of *ex ante* competition would be outweighed by improved earnings in those instances where they contribute unique technologies (presumably because holdup and royalty stacking would be averted). This may indeed be the case. But, barring evidence of systematic royalty stacking and holdup, it would be prudent to leave this determination to the firms involved in the process. These are sophisticated players who are well-placed to assess the various pros and cons of given arrangements.

In short, though it is widely recognized that SEP holders' rewards should, to some extent at least, be tethered to the quality of their contribution to an end-product, there has been little enthusiasm from the market to move towards strict pricing rules, such as ECPR. This market response is important because, when they decide on profit allocation mechanisms, parties to the standardization process are effectively sharing a common pool resource (see Section V). Absent a finding that there are significant obstacles which prevent them from achieving collectively beneficial outcomes, their revealed preferences should carry significant weight. Viewed from this perspective, it is not clear that proposed pricing mechanisms significantly improve on the current state of affairs.

E. Summary and conclusion of part III.

The previous sections have shown that there is a strong case against the theories of patent holdup and royalty stacking. For a start, empirical studies tend to indicate that neither holdup nor royalty stacking are currently endemic in SEP-intensive industries. Most notably, these studies do not show any pro-innovative benefits resulting

from legal rules (namely the *eBay* case law) that restrict SEP holders' ability to obtain injunctions against infringers.

We have identified numerous factors which might explain why these real-world outcomes fail to match the predictions of critics. To begin with, SDOs have an incentive to design their standardization policies in ways which minimize opportunistic behavior of this kind. This incentive is compounded by competition between SDOs. Because firms are unlikely to join an SDO which allows rivals to capture their rents – and SDOs must get both implementers and innovators on board to thrive – competition between SDOs is likely to produce arrangements which weed out the most egregious forms of opportunism. Moreover, the prospect of repeat interactions generates both economies of scale, which reduce the cost of setting up mutually beneficial arrangements, and reputational costs for firms who depart from accepted norms. Finally, as with all other externalities, firms may internalize the detrimental effects of opportunism through a variety of actions that take place outside of SDOs. This notably includes mergers and the formation of patent pools.

Given the, at best, sparse occurrence of patent holdup and royalty stacking in SEP industries, regulations seeking to limit these (largely hypothetical) problems – for example by limiting the availability of injunctive relief to SEP holders – may well generate social costs that far outweigh their limited benefits. For example, if such regulations effectively granted favorable terms to late adopters, more firms would likely wait until the last minute to conclude deals with SEP holders, placing added risk on the shoulders of those SEP holders and thereby undermining incentives to innovate. Such regulations would likely also raise enforcement costs, as authorities attempt to reverse engineer the terms that would have been agreed upon by parties *ex ante*. To make matters worse, reducing SEP holders' ability to obtain injunctions may not only exacerbate dilatory tactics by implementers, but might also lead to increased patent-infringing behavior. Finally, a strict implementation of incremental value pricing may ultimately reduce firms' incentives to innovate.

IV. Responses by SDOs, courts and antitrust authorities

Over the past couple of years, SDOs, courts and antitrust authorities have begun to grapple with the potential ramifications of the growing literature on patent holdup

and royalty stacking. The following sections look at some of the most high-profile developments to emerge in this area.

A. IEEE's updated IPR policy

One of the most high-profile changes to come out of the patent holdup debate has been the Institute of Electrical and Electronics Engineers' ("IEEE") decision to amend its intellectual property rights policy.

On February 8, 2015, IEEE announced that its board of directors had approved a series wide-reaching change to its patent policy, asserting that: "*The policy must balance several concerns, including respect for the rights of patent-holders and assurance that licenses to standards-essential patents are available on reasonable and nondiscriminatory terms to all implementers.*."[172] In order to achieve this "balance," IEEE effectively redefined the meaning of FRAND for patent-protected technologies incorporated into its standards. This new patent policy notably included changes to both the way FRAND rates may be computed and the rights of SEP holders (notably their ability to seek injunctions). The policy is reproduced here in full (emphasis added):

> "Reasonable Rate" shall mean appropriate compensation to the patent holder for the practice of an Essential Patent Claim **excluding the value, if any, resulting from the inclusion of that Essential Patent Claim's technology in the IEEE Standard**. In addition, determination of such Reasonable Rates should include, but need not be limited to, the consideration of:
>
> > The value that the functionality of the claimed invention or inventive feature within the Essential Patent Claim **contributes to the value of the relevant functionality of the smallest saleable Compliant Implementation** that practices the Essential Patent Claim.
> >
> > The value that the Essential Patent Claim contributes to the smallest saleable Compliant Implementation that practices that claim, **in light of the value contributed by all Essential Patent Claims for the same IEEE Standard** practiced in that Compliant Implementation.

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[172] *See* News Release, IEEE Statement Regarding Updating of its Standards-Related Patent Policy" (Feb. 8, 2015), available at https://www.ieee.org/about/news/2015/patent-policy.html.

> Existing licenses covering use of the Essential Patent Claim, **where such licenses were not obtained under the explicit or implicit threat of a Prohibitive Order**, and where the circumstances and resulting licenses are otherwise sufficiently comparable to the circumstances of the contemplated license.[173]

IEEE's updated patent policy appears to have been influenced by the writings of authors such as Lemley and Shapiro, etc. This is best evidenced by its call for strict incremental value pricing. The policy limits the rates SEP holders can command to the *ex ante* incremental value of their technology. IEEE's policy thus implements a form of ECPR, which we have criticized above (see Section III.4).

But IEEE's patent policy goes even further than the already strict ECPR. Most notably, it caps SEP holders' returns at the value of "*the relevant functionality of the smallest saleable Compliant Implementation that practices the Essential Patent Claim*."[174] This might seem like a small detail, but it has far-reaching implications. Limiting returns to the value of the smallest saleable component effectively implies that high value patents will be under rewarded if they are incorporated in a low value component. Although, this might, at first sight, appear to be impossible as a matter of economic theory (a product should never be worth less than the sum if its inputs), it is a definite possibility in this case.

The devil is in the details. IEEE's policy caps returns beneath the *value* of the smallest saleable implementation, and not its *incremental value* when incorporated into a standard. The plain English of IEEE's policy thus urges parties and authorities to ignore the complementarity that may exist between technologies that make up a standard.[175] One possible consequence is that SEP holders will be prevented from price-discriminating when licensing the same technology (incorporated in the same component) in different end-products. For instance, a next generation 5G chip may be worth far more in a high-end device than in an entry-level alternative. Likewise, a

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[173] *See* IEEE's Patent Policy. IEEE-SA Standards Board Bylaws, Art. 6 (March 2019), *available at* https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/sb_bylaws.pdf.

[174] *Id.*

[175] *See, e.g,* Axel Gautier & Nicolas Petit, *Smallest Salable Patent Practicing Unit and Component Licensing-Why 1$ is Not 1$*, 4 (2017).

high-end satellite navigation system likely contributes more to the value of upmarket vehicles (which might, for instance, also use its functions for autonomous driving). Innovation is partly about combining existing components in new ways, thus creating added value.[176] In such cases, component level pricing may unduly limit innovators' rewards.

This stricter approach also raises practical difficulties. As some scholars have noted, *saleable* does not mean that the component is actually sold.[177] Decisionmakers and parties will often have to reconstruct both the theoretical incremental value of a technology and the hypothetical value of the product it is incorporated in (for instance, the product may be sold at a price which does not account for the intellectual property it contains).[178] All of the practical difficulties associated ECPR (highlighted in throughout this paper), are compounded when component-level pricing is added to the mix.

IEEE's policy also seeks to address two other concerns that have been raised by critics. First, the updated policy underlines that SEP returns must account for the value of other technologies incorporated in a standard *and* must exclude the value generated by the standardization process itself. It is thus resembles the lopsided application of ECPR that we have criticized above (see Section III.4). Second, the policy limits the availability of injunctions, by assuming that royalties are not FRAND if they are "*obtained under the explicit or implicit threat of a Prohibitive Order*".[179] This effectively means that any mention of an injunction by an SEP holder will invalidate the royalties that it then negotiates with a implementer. Threatening infringers with an injunction in order to bring them to the negotiating table is thus ruled out by IEEE's policy. Moreover, SEP holders are also prevented from asking courts for injunctions, because any royalty rate which parties might settle on thereafter would be tainted.

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[176] *See* M. RIDLEY, THE RATIONAL OPTIMIST: HOW PROSPERITY EVOLVES 6 (HarperCollins Publishers. 2010) (Ridley refers to this as "ideas having sex").

[177] *See* Gautier & Petit, *supra* note 175, at 4 (2017).

[178] *See, e.g.*, Erik Hovenkamp, *Tying, Exclusivity, and Standard-Essential Patents*, 19 COLUM. SCI. & TECH. L. REV. 79, 92 (2017).

[179] See IEEE Patent Policy, *supra* note 173, art. 6.

IEEE's policy can be viewed in one of two ways. One possibility is that IEEE has somehow been captured by implementers seeking to impose their distributional concerns upon the SDO.[180] If this is the case, then innovators might be expected to seek other organizations with more favorable terms. However, at least in the short-term, innovators may be locked into the IEEE. Viewed in a more positive light, IEEE's policy may be seen as an attempt to iteratively improve its technological output, by achieving a superior balance between the interests of SEP holders an implementers.

Only time will tell whether the policy successfully increases IEEE's technological output or whether it merely transfers a larger share of a smaller pie to implementers. However, at the time of writing, tentative empirical research suggests that the latter is occurring. Kirti Gupta and Georgios Effraimidis show that IEEE's policy led to a decrease in positive letters of assurance ("LOAs") by which firms declare that they hold patents that may be essential to a technology, and commit to license them under terms that comply with IEEE's policy.[181] The authors also find that the updated policy lengthens the standardization process and did not lead to an increase in new projects.[182] This development is in line with the criticism we have voiced throughout the preceding sections.

Another important question is whether the DOJ was right to sanction this updated patent policy in its business review letter of February 2, 2015.[183] Although this paper argues against the measures taken by IEEE, we agree (from a policy standpoint) with the DOJ's decision not to interfere with the inner-workings of a standard developing organization. As things stand, there is nothing to suggest that the market will not

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[180] And there is some evidence that this may indeed have been the case. *See* J Gregory Sidak, *Testing for Bias to Suppress Royalties for Standard-Essential Patents*, 1 CRITERION J. ON INNOVATION 301, 333 (2016) ("*The treatment of the comments by the ad hoc committee exhibits a statistically significant bias against the firms that opposed the bylaw amendments–primarily large SEP holders–and in favor of revisions designed to devalue SEPs.*").

[181] *See* Kirti Gupta & Georgios Effraimidis, *IEEE Patent Policy Revisions: An Empirical Examination of Impact*, 27 (2018), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3173799 ("*The results suggest that multiple SEP owners are not willing to license under the new terms: the number of new positive LoA submissions has decreased by 91%, while the number of negative LoA submissions has dramatically increased by hitting a historic high in 2016.*").

[182] *Id.*

[183] *See* United States Department of Justice, Response to Institute of Electrical and Electronics Engineers, Incorporated (Feb. 2, 2015), at https://www.justice.gov/atr/response-institute-electrical-and-electronics-engineers-incorporated.

correct potentially inefficient policies agreed upon by SDOs. IEEE should thus be given significant leeway to enact the policies which, in the minds of its members, maximize the profits that are to be divided among them (even if this might favor one faction of the standard setting process). It would be highly inconsistent to caution authorities against shoehorning strict interpretations of FRAND upon private parties, but urge them to intervene when private parties freely decide on such policies. In other words, what matters are not the distributional penchants of antitrust authorities and scholars, but the revealed preferences of the sophisticated players who operate in the standardization space. Saying this does not entirely absolve IEEE of legal scrutiny. Instead we argue that IEEE's updated patent policy should be scrutinized under the lens of contract law – and not antitrust.

While the IEEE's move was lauded by some scholars who were critical of the *status quo ante*[184], it has so far failed to spur similar actions from other SDOs.

B. Ericsson v. D-Link Sys (US)

The stance taken by the members of IEEE stands in stark contrast to the ruling of the United States Court of Appeals for the Federal Circuit's decision in *Ericsson, Inc. v. D-Link Systems, Inc.*[185], which follows a long line of case law dealing concerning the determination of FRAND rates (notably *Microsoft Corp. v. Motorola, Inc.*,[186]). Though a full discussion of this case is outside the scope of this paper[187], it is interesting to highlight how, and why, the Court departed from the approach that would later be implemented by IEEE (in doing so, the Court notably found that royalty stacking and patent holdup were anything but foregone conclusions).[188]

The *Ericsson, Inc. v. D-Link Systems* Court notably rejected the idea that rates should systematically be calculated on the basis of the smallest saleable component which

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[184] *See* Scott Morton & Shapiro, *supra* note 46, 16 INNOVATION POL'Y &THE ECON., at 114 (2016).

[185] *Ericsson v. D-Link*, 773 F.3d 1201 (Fed. Cir. 2014).

[186] *Microsoft Corp. v. Motorola, Inc.*, No. C10-1823JLR, 2013 WL 2111217 (W.D. Wash. Apr. 25, 2013).

[187] For a detailed discussion, *see* J Gregory Sidak, *Apportionment, FRAND Royalites, and Comparable Licenses after Ericsson v. D-Link*, U. ILL. L. REV. 1808 (2016).

[188] *Ericsson v. D-Link*, 773 F.3d 1201, 1234 (Fed. Cir. 2014) ("*The district court need not instruct the jury on hold-up or stacking unless the accused infringer presents actual evidence of hold-up or stacking. Certainly something more than a general argument that these phenomena are possibilities is necessary*.").

practices the relevant patent claim. Instead, the Court accepted that parties use the entire value of the licensed product as a royalty base:

> It is not that an appropriately apportioned royalty award could never be fashioned by starting with the entire market value of a multi-component product—by, for instance, dramatically reducing the royalty rate to be applied in those cases—it is that reliance on the entire market value might mislead the jury, who may be less equipped to understand the extent to which the royalty rate would need to do the work in such instances [...]
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> Thus, where the entire value of a machine as a marketable article is "properly and legally attributable to the patented feature," the damages owed to the patentee may be calculated by reference to that value.[189]

In reaching this conclusion the Court thus dismissed the idea that rates could never exceed the value of the smallest saleable component. Instead, it simply noted that, when rates are calculated with reference to the value of an end product, juries should be particularly careful not to naïvely grant excessive royalties.

The Court also refused to explicitly impose stringent incremental value pricing rules, such as ECPR or the approach championed by IEEE. It chose, instead, to apply a much simpler benchmark:

> The essential requirement is that the ultimate reasonable royalty award must be based on the incremental value that the patented invention adds to the end product.[190]

In doing so, it notably had to contend with an important issue: the value which stems from a technology's inclusion in a standard versus its intrinsic value. While it recognized that the standardization process may increase the value of patents that become essential – and this should not be reflected in royalties – the Court also failed to entirely endorse a systematic reconstruction of *ex ante* competition. Instead, is appeared to focus more on the qualities of a technology and how this contributes to the overall value of an end product. In its own words:

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[189] *Id.* at 40.

[190] *Id.*

> [W]idespread adoption of standard essential technology is not entirely indicative of the added usefulness of an innovation over the prior art [...]. We merely hold that the royalty for SEPs should reflect the approximate value of that technological contribution, not the value of its widespread adoption due to standardization.[191]

What is important here is what the Court is *not* saying. The fact that royalties should be based on the incremental value that a technology adds to an end-product is not the same as saying that rates should exactly reflect the state of *ex ante* competition. Imagine a case where two technologies are relatively close substitutes, and could each contribute substantial value to an end product. Clearly the technology that becomes standard essential will derive some value from its inclusion in the standard (which should arguably be discounted). However, under our understating of the Court's approach, the holder of this patent should not be limited to zero royalties, because its patent makes an important technological contribution to the end product. The *Ericsson v. D-Link Systems* Court appears to endorse this view, seemingly calling upon decisionmakers to find a balance between both factors.

Finally, the Court echoed previous cases in finding that, when possible, reasonably royalties should be calculated by looking at real-world licenses for comparable technologies (with one notable exception being the *Qualcomm* case discussed below, see Section I.D).[192] This is a good thing. As we have argued throughout this paper, reverse-engineering reasonable royalties is a particularly daunting task. As with all prices, these must account for an innumerable number of factors that are hard to compute for a top-down decisionmaker. Using the information revealed by the market is one way for authorities to slightly compensate for their inherent informational disadvantage. The problem is probably best summarized by Friedrich Hayek:

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[191] *Id.* at 53.

[192] *Id.* at 41. *See also,* David Kappos & Paul R Michel, *The Smallest Salable Patent-Practicing Unit: Observations on Its Origins, Development, and Future*, 32 BERKELEY TECH. LJ 1433, 1449 (2017) ("Case law in the realm of patent infringement damages has long recognized that direct, market-based information in the form of actual licenses is very potent evidence of the value of patented technology."). The authors cite other cases that use the comparable technology approach to calculate royalties. These include the *Versata Software* and *CSIRO* cases. *See Versata Software, Inc. v. SAP Am., Inc.*, 717 F.3d 1255, 1267-68 (Fed. Cir. 2013). *See Commonwealth Sci. & Indus. Research Org. v. Cisco Sys., Inc.*, 809 F.3d 1295, 1303 (Fed. Cir. 2015).

> If we can agree that the economic problem of society is mainly one of rapid adaptation to changes in the particular circumstances of time and place, it would seem to follow that the ultimate decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them. We cannot expect that this problem will be solved by first communicating all this knowledge to a central board which, after integrating all knowledge, issues its orders. We must solve it by some form of decentralization.[193]

C. Motorola Mobility, Huawei v. ZTE & Unwired Planet (EU)

The patent holdup literature has also had a significant impact on European competition enforcement. While the European Commission has been quick to endorse the views of critics, the European Court of Justice has opted for a far more restrained stance.

The European Commission notably brought a high-profile case against Motorola for repeatedly "refusing to license" some of its technologies to Apple, despite having previously made FRAND pledges.[194] The decision concerned injunction proceedings brought by Motorola against Apple before German courts. Throughout the procedure, Apple made numerous licensing offers. All of which were refused by Motorola. Finally – after lengthy negotiations and Motorola deciding to enforce its injunction – Apple made a sixth licensing offer which Motorola accepted. The Commission found that all of Motorola's refusals, starting from Apple's second licensing offer, were abusive under European competition law.[195] They notably went against the FRAND pledges which Motorola had made with regards to its standard-essential patents. Furthermore, the Commission concluded that Motorala's behavior had anti-competitive effects which notably resulted in Apple accepting highly disadvantageous

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[193] *See* Friedrich August Hayek, *The use of knowledge in society*, 35 THE AM. ECON. REV. 519, 524 (1945).

[194] *See* Commission Decision No. COMP. AT. 39985 (*Motorola – Enforcement of GPRS Standard Essential Patents*), C(2014) 2892 final, slip. op. (April 29, 2014).

[195] This is because, as of its second licensing offer, Apple had accepted to have a third party decide on the royalty rate. Apple could thus be considered as a "willing licensee". According to the Commission, Motorola's refusal thus went against its FRAND pledges.

settlement terms, pursuant to its sixth offer.[196] The Commission notably took issue with a so-called "patent termination" clause contained in the deal. Under this clause, Motorola could terminate the license agreement with Apple, should the latter decide to challenge the validity of Motorola's patents in Court.[197]

While a detailed discussion of the decision is outside the scope of this paper, it is significant that the Commission clearly bought in to the patent holdup literature. One of its central findings was that Apple would not have accepted Motorola's "abusive" licensing terms were it not for the threat of an injunction. Accordingly, Motorola's licensing terms did not reflect the value of its patented technology:

> Faced with the seeking and enforcement by a SEP holder of an injunction against its products, an implementer of a standard runs the risk that, should it not agree to the licensing terms or royalty rates proposed by the SEP holder, its products will be banned from the market. [...] In such a scenario, it is therefore not the underlying value of the patented technology which drives the negotiation process and the licensing conditions an implementer is ready to agree to, but rather the potential cost of lost sales and damage to reputation.[198]

Given the strict decisional practice of the Commission, it is somewhat surprising that the European Court of Justice adopted a far more nuanced position. In its *Huawei v ZTE* ruling, the European Court of Justice famously held that FRAND is a two-way street: both parties have obligations to undertake actions in order to obtain/avoid an injunction. [199]

In a nutshell, the Court conditioned competition liability on firms showing that they have taken a series of reasonable steps to solve their disputes out of court. It concluded that injunctions by SEP holders were not *prima facie* abusive when:

> [P]rior to bringing that action, the proprietor has, first, alerted the alleged infringer of the infringement complained about by designating that patent and specifying the way in which it has been infringed, and,

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[196] *See Motorola – Enforcement of GPRS Standard Essential Patents*, §§ 322-328.

[197] *Id.* § 145.

[198] *Id.* § 324.

[199] *See* Case C-170/13, *Huawei Technologies Co. Ltd v ZTE Corp. and ZTE Deutschland GmbH*, EU:C:2015:477.

> secondly, after the alleged infringer has expressed its willingness to conclude a licensing agreement on FRAND terms, presented to that infringer a specific, written offer for a license on such terms, specifying, in particular, the royalty and the way in which it is to be calculated, and
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> where the alleged infringer continues to use the patent in question, the alleged infringer has not diligently responded to that offer, in accordance with recognised commercial practices in the field and in good faith, this being a matter which must be established on the basis of objective factors and which implies, in particular, that there are no delaying tactics.[200]

In essence, the Court thus dodged the question of what constitutes a FRAND (Fair Reasonable and Non-Discriminatory) royalty rate and concluded that parties are usually better placed to come up with a satisfactory solution than courts. In doing so, it rightly recognized that price setting by a regulator or a court is no substitute for actual agreements between parties.

Despite that, the *Huawei* ruling is far from perfect. Most notably, it mostly avoids the thorny question of when an SEP holder's injunction actually infringes competition law. Though the ruling clearly suggests that this is a possibility, it offers limited guidance outside of a limited set of presumptions. In addition to the safe harbor outlined above, the Court adds that an SEP holder infringes article 102 if it brings an injunction without prior notice or consultation:

> Accordingly, the proprietor of an SEP which considers that that SEP is the subject of an infringement cannot, without infringing Article 102 TFEU, bring an action for a prohibitory injunction or for the recall of products against the alleged infringer without notice or prior consultation with the alleged infringer, even if the SEP has already been used by the alleged infringer.[201]

This leaves a critical question unanswered: How should injunctions be treated when they lie outside of the limited presumptions outlined in the *Huawei* ruling? The UK Court of Appeal notably sought to address this point (among others) in its *Unwired*

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[200] *Id.* § 71.

[201] *Id.* § 60.

Planet v. Huawei decision.[202] For a start, the Court observed that holdout may be as much of a problem as holdup, and that any SEP framework must preserve the incentives of all parties to participate in the standardization process.[203] With this in mind, the Court found that injunctions were not presumptively unlawful when they fell outside of the negotiation procedure outlined in *Huawei*, so long as the SEP holder complied with the limited notification requirement (above):

> We have come to the firm conclusion that the CJEU was not laying down mandatory conditions at [70] of its judgment such that non-compliance will render the proceedings a breach of Article 102 TFEU…[204]

The upshot from this discussion is that there is still significant uncertainty surrounding the availability of injunctions for SEP holders in Europe. On the positive side, the *Huawei* ruling currently ensures that injunctions at not entirely taken off the table for rights holders (at least, not under competition law). Unfortunately, this still leaves a particularly large grey area, where firms may be sanctioned. This is especially problematic given the European Commission's proven proclivity for such cases, best evidenced in its *Motorola* decision.[205] But, even here, all is not bleak. The Commission's recently adopted communication on Standard Essential Patents notably states that:

> When assessing the availability of injunctive relief, courts are bound by Article 3(2) of the IPR Enforcement Directive, and notably the requirement to ensure that injunctive relief is effective, proportionate and dissuasive. Given the broad impact an injunction may have on businesses, consumers and on the public interest, particularly in the context of the

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[202] *Unwired Planet International Ltd & Anor v Huawei Technologies Co Ltd & Anor* [2018] EWCA Civ 2344 (23 October 2018), https://www.bailii.org/ew/cases/EWCA/Civ/2018/2344.html.

[203] *Id.* at 266 ("*SEP owners may hold-up implementers by using the threat of litigation and an injunction to charge excessive licensing fees. Conversely, implementers may hold-out against the payment of reasonable licensing fees by refusing to engage in good faith licensing negotiations. So,* […] *there is a need to set out key principles that foster a balanced, smooth and predictable framework for SEPs that will incentivise the development and inclusion of top technologies in standards by preserving fair and adequate return for their technical contribution, and also ensure the smooth and wide dissemination of standards based upon fair access conditions.*").

[204] *Id.* at 269.

[205] *See* Motorola, *supra* note 196.

> digitalised economy, the proportionality assessment needs to be done carefully on a case-by-case basis.[206]

In short, though European policymakers and courts have definitely taken notice of the critiques that are being levelled against SEP holders, it is equally clear that they have not entirely bought-in to the most radical policy prescriptions of this literature. Instead, they have opted for a (slightly) more measured approach, ostensibly seeking to weigh the interests of all parties to the standardization process.

D. FTC v. Qualcomm

More recently, a United States District Court ruled in favor of the FTC, putting a temporary stop to its high-profile legal dispute with Qualcomm.[207] In her ruling, Judge Lucy Koh concluded that that a combination of anticompetitive practices had enabled Qualcomm to charge "unreasonably high royalty rates" for its CDMA and LTE cellular communications technology. [208] Chief among these practices was Qualcomm's so-called "no license, no chips" policy, whereby the firm refuses to sell baseband processors to implementers that have not taken out a license for its communications technology.[209] Other grievances included Qualcomm's purported refusal to license its patents to rival chipmakers, and allegations that it attempted to extract exclusivity obligations from large handset manufacturers, such as Apple. According to Judge Koh, these practices resulted in "unreasonably high" royalty rates that failed to comply with Qualcomm's FRAND obligations. [210]

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[206] *See* Communication, European Commission, Setting out the EU approach to Standard Essential Patents", art. 3.2, (Oct. 29, 2017,) *available at* https://ec.europa.eu/docsroom/documents/26583/attachments/1/translations/en/renditions/native.

[207] FTC v. Qualcomm Inc., No. 17-CV-00220-LHK, 2017 U.S. Dist. LEXIS 98632 (N.D. Cal. June 26, 2017), *available at* https://www.ftc.gov/system/files/documents/cases/qualcomm_findings_of_fact_and_conclusions_of_law.pdf. At the time of writing, Qualcomm has already appealed the ruling.

[208] *Id.* at 186.

[209] *Id.* at 157.

[210] *Id.* at 157-183.

Regardless of the case's underlying merits, the ruling perfectly illustrates the numerous pitfalls that decisionmakers face when they second-guess the distributional outcomes achieved through market forces and *de jure* standardization.

The first striking feature of Judge Koh's ruling is what it omits. Throughout the more than two-hundred-page long document, there is not a single reference to the concepts of holdup or holdout (crucial terms of art for a ruling that grapples with the prices charged by and SEP holder).

At first sight, this might seem like a semantic quibble. But words are important. Patent holdup (along with the "unreasonable" royalties to which it arguably gives rise) is only possible when a number of cumulative conditions are met. Most importantly, the foundational literature on economic opportunism shows that holdup (and holdout) mostly occur when parties have made asset-specific sunk investments. [211] This focus on asset-specific investments is echoed by even the staunchest critics of the standardization status quo.[212]

Though such investments may well have been present in the case at hand, there is no evidence that they played any part in the Court's decision. This is not without consequences. If parties did not make sunk relationship-specific investments, then the antitrust case against Qualcomm should have turned upon the exclusion of competitors, not the level of Qualcomm's royalties. The DOJ said this much in its statement of interest concerning Qualcomm's motion for partial stay of injunction pending appeal.[213] Conversely, if these investments existed, then patent holdout (whereby implementers refuse to license key pieces of intellectual property) was just

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[211] *See, e.g.,* Klein et al., *supra* note 47, 21 THE J.OF L. & ECON. at 298 (1978). ("*The particular circumstance we emphasize as likely to produce a serious threat of this type of reneging on contracts is the presence of appropriable specialized quasi rents*."). *See also*, Williamson, *supra* note 39, 22 THE J. OF L. & ECON. at 234 (1979). ("[O]*pportunism is especially important for economic activity that involves transaction-specific investments in human and physical capital*.").

[212] *See* Lemley & Shapiro, *supra* note 8, at 1991.

[213] *See* Brief for Federal Trade Commission v. Qualcomm Inc. , as United States' Statement of Interest Concerning Qualcomm's Motion for Partial Stay of Injunction Pending Appeal, FTC v. Qualcomm Inc., No. 19-16122, 2019 U.S. App. LEXIS 21992 (9th Cir. July 23, 2019) Jul. 16, 2019, 4 https://www.justice.gov/atr/case-document/file/1183936/download ("*The district court failed to identify a harm to the competitive process as required under Section 2 of the Sherman Act. [...] Charging high prices is not anticompetitive.*").

as much of a risk as patent holdup. [214] And yet the Court completely overlooked this possibility.

A second important feature is that the Court objected to Qualcomm's practice of basing license fees on the value of handsets, rather than that of modem chips. In simplified terms, implementers paid Qualcomm a percentage of their devices' resale price. The Court found that this was against Federal Circuit law. Instead, it argued that royalties should be based on the value the smallest salable patent-practicing component (in this case, baseband chips):

> Further, Qualcomm's use of the handset device as the royalty base is inconsistent with Federal Circuit law on the patent rule of apportionment. Under the rule of apportionment, "[a] patentee is only entitled to a reasonable royalty attributable to the infringing features." Power Integrations, Inc. v. Fairchild Semiconductor Int'l, Inc., 904 F.3d 965, 977 (Fed. Cir. 2018). In line with that principle, the Federal Circuit held in LaserDynamics, Inc. v. Quanta Computer, Inc. that "it is generally required that royalties be based not on the entire product, but instead on the smallest salable patent-practicing unit." 694 F.3d 51, 67 (Fed. Cir. 2012). Thus, Qualcomm is not entitled to a royalty on the entire handset.
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> ***
>
> Because Qualcomm's own document states that a handset's value is now attributable primarily to the "user experience" and not "modem leadership," Qualcomm's collection of a royalty on the entire handset is inconsistent with VirnetX and Federal Circuit law on the smallest salable patent practicing unit.[215]

This conclusion is dubious both as a matter of law and of policy. From a legal standpoint, the question of the appropriate royalty base seems far less clear-cut than Judge Koh's ruling might suggest. For instance, Gregory Sidak observes that in *TCL v. Ericsson* Judge Selna used a device's net selling price as a basis upon which to calculate

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[214] *See* Epstein & Noroozi, *supra* note 40, at 1382 ("*This Article shows both theoretically and empirically that courts' failure to appreciate these aspects of the FRAND bargain, combined with their overreliance on liability rules (i.e., damages over injunctions) incentivizes the very patent holdout problem FRAND was intended to avoid*.").

[215] *Qualcomm Inc.*, *supra* note 207, at 172.

FRAND royalties (and not the price of the smallest saleable practicing component).[216] Likewise, in *CSIRO v. Cisco*, the Court also declined to use the "smallest saleable practicing component" as a royalty base.[217] And finally, as Jonathan Barnett observes, the Circuit Laser Dynamics case law cited by Judge Koh relates to the calculation of damages in patent infringement suits.[218] There is no legal reason to believe that its findings should hold any sway outside of that narrow context. It is one thing for courts to decide upon the methodology that they will use to calculate damages in infringement cases - even if it is a contested one. It is a whole other matter to shoehorn private parties into adopting this narrow methodology in their private dealings.

More importantly, from a policy standpoint, there are important advantages to basing royalty rates on the price of an end-product, rather than that of an intermediate component.[219] This type of pricing notably enables parties to better allocate the risk that is inherent in launching a new product. In simplified terms: implementers want to avoid paying large (fixed) license fees for failed devices; and patent holders want

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[216] *See* Gregory Sidak, *Judge Selna's Errors in TCL v. Ericsson Concerning Apportionment, Nondiscrimination, and Royalties Under the FRAND Contract*, 4 THE CRITERION JOURNAL ON INNOVATION 101, 200 (2019) ("I infer that Judge Selna used a practicing device's net selling price as the royalty base for his calculation.").

[217] *CSIRO v. Cisco*, 809 F.3d 1295 (Fed. Cir. 2015), at 13. ("*Fundamentally, the smallest salable patent-practicing unit principle states that a damages model cannot reliably apportion from a royalty base without that base being the smallest salable patent-practicing unit. That principle is inapplicable here, however, as the district court did not apportion from a royalty base at all.*").

[218] *See* Washington Bytes Chat, *No License, No Chips? No Dice: Dissecting Judge Koh's Opinion in FTC v. Qualcomm*, FORBES (Jun. 10, 2019), https://www.forbes.com/sites/washingtonbytes/2019/06/10/no-license-no-chips-no-dice-dissecting-judge-kohs-opinion-in-ftc-v-qualcomm/#388d6e529069. ("*Patent law has generally only mandated use of the smallest saleable unit (in multi-component products) as the royalty base in jury trials where there are concerns that jury members will not appreciate that a small royalty on an entire product royalty base is economically equivalent to a larger royalty on a component-level royalty base. Those sophistication concerns do not generally apply outside that context (as in a business negotiation.*").

[219] For a far more detailed discussion on the merits of the appropriate royalty base, *see, e.g.* Gerard Llobet & Jorge Padilla, *The optimal scope of the royalty base in patent licensing*, 59 THE J. OF L. & ECON. 45, 67 (2016) ("*We have shown that, under many circumstances, ad valorem royalties, which are based on the value of sales, yield superior outcomes from the standpoints of both consumer welfare and total welfare than do per-unit royalty rates, which are based on the value of the components of the infringing product that are covered by the patented technology*." The authors argue that ad valorem licensing decreases double marginalization and increase firms' investments in new technologies).

to share in the benefits of successful devices that rely on their inventions. The solution, as Alain Bousquet and his co-authors explain, is to agree on royalty payments that are contingent on success in the market:

> Because the demand for a new product is uncertain and/or the potential cost reduction of a new technology is not perfectly known, both seller and buyer may be better off if the payment for the right to use an innovation includes a state-contingent royalty (rather than consisting of just a fixed fee). The inventor wants to benefit from a growing demand for a new product, and the licensee wishes to avoid high payments in case of disappointing sales.[220]

While this explains why parties might opt for royalty-based payments over fixed fees, it does not entirely elucidate the practice of basing royalties on the price of an end device. One explanation is that a technology's value will often stem from its combination with other goods or technologies. Basing royalties on the value of an end-device enables patent holders to more effectively capture the social benefits that flow from these complementarities.[221]

Imagine the price of the smallest saleable component is identical across all industries, despite it being incorporated into highly heterogeneous devices. For instance, the same modem chip could be incorporated into smartphones (of various price ranges), tablets, vehicles, and other connected devices. The Bousquet line of reasoning (above) suggests that it is efficient for the patent holder to earn higher royalties (from the IP that underpins the modem chips) in those segments where market demand is strongest (i.e. where there are stronger complementarities between the modem chip and the end device).

One way to make royalties more contingent on market success is to use the price of the modem (which is presumably identical across all segments) as a royalty base and

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[220] *See* Alain Bousquet, Helmuth Cremer, Marc Ivaldi & Michel Wolkowicz, *Risk sharing in licensing*, 16 INT'L J. OF INDUS. ORG. 535, 535-536 (1998).

[221] *See* Gregory Sidak, *The Proper Royalty Base for Patent Damages*, 10 J. OF COMPETITION L. & ECON.,989, 994 (2014). ("*The market price of an individual patented component (such as a camera lens contained within a mobile device) may not account for the value of the complementarity effects and the network effects that the component generates. By using the market price of an individual patented component as a reference, the manufacturer of that component does not internalize the benefits that its technology creates when used in conjunction with the other components of the downstream product.*").

negotiate a separate royalty rate for each end device (charging a higher rate for devices that will presumably benefit from stronger consumer demand). But this has important drawbacks. For a start, identifying those segments (or devices) that are most likely to be successful is informationally cumbersome for the inventor. Moreover, this practice could land the patent holder in hot water. Antitrust authorities might naïvely conclude that these varying royalty rates violate the "non-discriminatory" part of FRAND.

A much simpler solution is to apply a single royalty rate (or at least attempt to do so) but use the price of the end device as a royalty base. This ensures that the patent holder's rewards are not just contingent on the number of devices sold, but also on their value. Royalties will thus more closely track the end-device's success in the marketplace.

In short, basing royalties on the value of an end-device is an informationally light way for the inventor to capture some of the unforeseen value that might stem from the inclusion of its technology in an end device. Mandating that royalty rates be based on the value of the smallest saleable component ignores this complex reality.

A third important point is that Judge Koh was similarly imperceptive when assessing Qualcomm's contribution to the value of key standards, such as LTE and CDMA. For a start, she reasoned that Qualcomm's royalties were large compared to the number of patents it had contributed to these technologies:

> Moreover, Qualcomm's own documents also show that Qualcomm is not the top standards contributor, which confirms Qualcomm's own statements that QCT's monopoly chip market share rather than the value of QTL's patents sustain QTL's unreasonably high royalty rates.[222]

Given the tremendous heterogeneity that usually exists between the different technologies that make up a standard, simply counting each firm's contributions is a crude way to gage the value of their patent portfolios. Accordingly, Qualcomm argued that it had made pioneering contributions to technologies such as CDMA, and 4G/5G.[223] Though the value of Qualcomm's technologies is ultimately an empirical

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[222] *Qualcomm Inc.*, *supra* note 207, at 165.

[223] *Id.* at 167.

question, the Court's crude patent counting was unlikely to provide a satisfying answer.

Just as problematically, the Court also concluded that Qualcomm's royalties were unreasonably high because "modem chips do not drive handset value". In its own words:

> Qualcomm's intellectual property is for communication, and Qualcomm does not own intellectual property on color TFT LCD panel, mega-pixel DSC module, user storage memory, decoration, and mechanical parts. The costs of these non-communication-related components have become more expensive and now contribute 60-70% of the phone value. The phone is not just for communication, but also for computing, movie-playing, video-taking, and data storage. [224]

The Court's reasoning on this point is particularly unfortunate. Though it is clearly true that superior LCD panels, cameras, and storage increase a handset's value – regardless of the modem chip that is associated with them – it is equally obvious that improvements to these components are far more valuable to consumers when they are also associated with high-performance communications technology. For example, though there is undoubtedly standalone value in being able to take improved pictures on a smartphone, this value is multiplied by the ability to instantly share these pictures with friends, and automatically back them up on the cloud. Likewise, improving a smartphone's LCD panel is more valuable if the device is also equipped with a cutting-edge modem (both of which are necessary for consumers to enjoy high-definition media online).

In more technical terms, the Court fails to acknowledge that, in the presence of perfect complements, each good makes an incremental contribution of 100% to the value of the whole. [225] A smartphone's components would be far less valuable to consumers if they were not associated with a high-performance modem, and vice versa. The fallacy to which the Court falls prey is perfectly encapsulated by a quote it cites from Apple's COO:

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[224] *Id.* at 169.

[225] *See* Lemley & Shapiro, *supra* note 8, at 2041 ("*When the various patented components are complementary in creating value, the sum of their incremental contributions will exceed their total contribution.*").

> Apple invests heavily in the handset's physical design and enclosures to add value, and those physical handset features clearly have nothing to do with Qualcomm's cellular patents, it is unfair for Qualcomm to receive royalty revenue on that added value. [226]

The question the Court should be asking, however, is whether Apple would have gone to the same lengths to improve its devices were it not for Qualcomm's complementary communications technology. By ignoring this question, Judge Koh all but guaranteed that her assessment of Qualcomm's royalty rates would be wide of the mark.

To summarize, the FTC v. Qualcomm case shows that courts will often struggle when they are made to act as makeshift price regulators. This is especially true in complex industries, such as the standardization space. The colossal number of parameters that affect the price for a technology are almost impossible to reproduce in a top-down fashion, as the Court attempted to do in the Qualcomm case. As a result, courts will routinely draw poor inferences from factors such as the royalty base agreed upon by parties, the number of patents contributed by a firm, and the complex manner in which an individual technology may contribute to the value of an end-product.

E. Summary of findings

As this section has shown, some organizations have very much embraced the idea that the standardization space was not functioning properly. This is notably the case with IEEE, whose amended patent policy goes well beyond the calls of even the staunchest critics. Likewise, the European Commission's *Motorola* decision takes a particularly hostile view towards SEP holders and their ability to seek injunctions.

In contrast, with the exception of Judge Koh's ruling in *FTC v Qualcomm*, courts on both sides of the Atlantic have proved far more reluctant to adopt the policy prescriptions of critics. In the US, the *Ericsson v. D-Link Sys* court reaffirmed that FRAND rates should achieve a balance between the interests of all parties to the standardization process, and not just implementers. It thus refused to apply extreme versions of incremental value pricing.

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[226] *Qualcomm Inc.*, *supra* note 207, at 170.

In the EU, both the European Court of Justice (in *Huawei*) and the UK Court of Appeal (in *Unwired Planet*) ensured that injunctions were not categorically ruled for SEP holders. European courts' refusal to rule out injunctions is particularly revealing. Unlike the scholars who would preclude such legal tools for SEP holders, the experience of these courts likely tells them that injunctions are often the only effective tool that SEP holders can use to go after opportunistic implementers and bring them to the negotiating table. They thus display at least some understanding of the important holdout risk that overzealous antitrust enforcement may entail.

But even these comparatively positive case law developments are not without flaws. When one accounts for the empirical evidence that contradicts patent hold-up theory, and our earlier arguments that combatting holdup may do more harm than good, then these legal developments merely complicate the life of patent holders with very little added benefits for consumers. A *laissez faire* policy – allowing market forces to discover those arrangements that maximize the technological output of SDOs – would likely have been more desirable, as we discuss in the final part of this paper.

V. Conclusion: Standardization as a common-pool resource

At the beginning of this paper, we suggested that interoperability standards could be framed as a version of the "Battle of the Sexes" game theory problem. Our intuition (which has been voiced by many others before us) was that there are great benefits to be had if firms can coordinate their behavior and agree upon interoperability standards, which ensure that their respective technologies interact seamlessly.[227] However, despite these evident benefits, it is important to acknowledge that this type of cooperation raises the *prospect* of opportunistic behavior – one point on which we agree with the critics of current standardization practices – for which the Prisoner's Dilemma game is a more apt metaphor.

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[227] *See, e.g.*, Stanley M Besen & Joseph Farrell, *Choosing how to compete: Strategies and tactics in standardization*, 8 J.OF ECON. PERSP. 117, 121 (1994). *See also*, Dong-Hee Shin, Hongbum Kim & Junseok Hwang, *Standardization revisited: A critical literature review on standards and innovation*, 38 COMPUTER STANDARDS & INTERFACES 152, 154 (2015). *See also* Paul Belleflamme, *Coordination on formal vs. de facto standards: a dynamic approach*, 18 EUR. J. OF POL. ECON. 153, 158 (2002).

But saying that cooperation raises the *prospect* of defection (be it in the form of holdup, royalty stacking or holdout) is not the same thing as concluding that such an outcome will ever occur – and this is where we vehemently disagree with the Lemley and Shapiro strand of literature. For instance, Axelrod and Hamilton found that, under certain circumstances, the dominant strategy in a prisoner's dilemma game changes from defection, in a single-shot game, to cooperation when the game is repeated iteratively.[228] The most important condition for co-operation in such a setting is that players do now know when the game will end—so parties do not know whether they are playing the last round, the one before last, etc. If the end is known, it would be optimal to defect on the final iteration of the game and cooperation may unravel through backward induction. Conversely, when there is no clear end in sight, it is far less certain that cooperation will fail. In this setting, the likelihood of cooperation notably depends on players' ability to attribute opportunistic behavior to another person (reputational consequences), and the probability that players will play another game together. [229] The upshot is that opportunistic behavior is not a given in repeated games with no end in sight. This seems to be a good framing of the standardization space. For instance, firms that are currently developing 5G mobile communications do not know whether there will be a 6G, 7G, 8G, etc. They probably have a sense that they will have new opportunities to cooperate in the future, but critically they do not know when these will come to an end.

More fundamentally, the firms who are active in the standardization space are not just playing Prisoner's Dilemma (whether iteratively or not). Instead, what happens within each attempt at a standard (each round of prisoner's dilemma, so to speak), is part of a much bigger picture. Imagine the following stylized framing. In the second period of a game, two firms (an SEP holder and an implementer) have developed a standard together and are entering negotiations to split its potential benefits. Two settings are possible. The first matrix shows the firms' hypothetical payoffs with no institutional arrangement in place, the second one shows their payoffs with an opportunism-mitigating arrangement (for instance, an SDO which imposes FRAND licensing):

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[228] *See* Axelrod & Hamilton, *supra* note 10,at 1392..

[229] *Id.*

		Implementer	
		Coop.	**Defect**
SEP Holder	**Coop.**	3,3	0, 5
	Defect	5, 0	**1,1**

		Implementer	
		Coop.	**Defect**
SEP Holder	**Coop.**	3,3	1,4
	Defect	4, 1	**2,2**

Our example posits that defecting is the dominant strategy in both settings, but this does not have to be case. What matters is that firms have the possibility to define the rules of *ex post* competition (for instance, by creating an SDO with binding IPR policies), before they develop a standard and enter negotiations.[230] Given this potential for *ex ante* arrangements, they thus face the following payoffs in the first period:

[230] Alexander Galetovic and Stephen Haber come to a similar intuition. *See* Alexander Galetovic & Stephen H Haber, *SEP ROYALTIES: WHAT THEORY OF VALUE AND DISTRIBUTION SHOULD COURTS APPLY?* 35 (WORKING PAPER 2019, 2019) (The authors find that allowing parties to negotiate royalty rates *ex post* is not harmful to economic welfare when, because it from a conscious *ex ante* decision by firms. They notably find that "*Again, the reason is simple: everyone involved knew from the start that the winning technology development firm would receive a monopoly royalty; and thus in equilibrium there was more entry by technology development firms, more R&D, and more competition to become the standard. The result is more innovation.*").

		Implementer: SDO	Implementer: No SDO
SEP Holder	SDO	2,2	1, 1
	No SDO	1, 1	**1,1**

This game is a story of glass half full or half-empty. On the one hand, both creating the SDO and not doing so are Nash equilibria. Given one firm's refusal to set up the SDO (for strategic reasons, for instance), the other firm can do no better than also refusing to enter this arrangement. On the other hand, the SDO would be mutually beneficial, so firms do have some incentive to set aside their differences.

This is precisely the type of situation which Elinor Ostrom envisioned in her work on the governance of the commons.[231] The fruits of standardization can be thought of as a common-pool resource (CPR). Once the standard has been developed, there is essentially a fixed pie which members must share among each other. Though each firm may be tempted to seize a larger piece of this pie, this opportunistic behavior may reduce joint profits below the monopoly benchmark and undermine players' incentives to invest in future standardization efforts.

Ostrom wisely recognized that, in these settings, cooperation is not a given:

> [W]e can reject the notion that appropriators are incapable of supplying their own institutions to solve CPR problems; but we cannot replace it with a presumption that appropriators will adopt new rules whenever the net benefits of a rule change will exceed net costs.[232]

Instead, she highlighted a number of features that may greatly facilitate the emergence of superior arrangements:

> Most appropriators share a common judgement that they will be harmed if they do not adopt an alternative rule.

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[231] *See* OSTROM, *infra* note 237.

[232] *Id.* at 210.

> Most appropriators will be affected in similar ways by the proposed rule changes.
>
> Most appropriators highly value the continuation activities from this CPR; in other words, they have low discount rates.
>
> Appropriators face relatively low information, transformation and enforcement costs.
>
> Most appropriators share generalized norms of reciprocity and trust that can be used as initial social capital.
>
> The group appropriating from the CPR is relatively small and stable.[233]

The real question for policymakers is thus whether the standardization space exhibits many of these characteristics, and whether firms and SDOs have seized upon them to adopt mutually beneficial rules to allocate the benefits of standardization. As we have explained above, the latter conjecture appears to be borne out by empirical research (see section I.B).

This is not surprising, given the characteristics of the standardization industry. For a start, the theory of patent holdup and royalty stacking strongly suggests that all participants are harmed if they do not prevent these events from occurring. There is also a strong prospect of future revenue streams, if firms can maintain their technological advantage from one generation of standards to the next. Moreover, the prospect of firms secretly taking more than their allotted share is relatively low (on the contrary, cases where patent holders are alleged to have demanded excessive royalties tend to be very high profile). Likewise, the very fact that firms have invested so much time in SDOs is evidence that there is at least some trust and social capital on which they can bank. And, finally, a relatively small number of major players are often involved in successive generations of a standard (think of firms like Samsung, Qualcomm, Ericsson, Nokia and LG, who have been involved in a long series of mobile communication standards).[234]

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[233] *Id.* at 211.

[234] IRUNAWAY, PATENT & LANDSCAPE ANALYSIS OF 4G-LTE (2012), *available at* https://www.i-runway.com/images/pdf/iRunway%20-%202G%20and%203G%20Mobile%20Communication.pdf. https://www.i-runway.com/images/pdf/iRunway%20-%20Patent%20&%20Landscape%20Analysis%20of%204G-LTE.pdf.

However, it is slightly less clear whether the second factor highlighted by Ostrom is present. On some level, firms are indeed affected in similar ways by holdup and royalty stacking. Whether they are SEP holders or implementers, all firms risk losing their quasi-rents when these harms occur. On the other hand, there are two big categories of players in this space – SEP holders and implementers (though some firms are both) – and potential rules may have opposite effects on each group. This may give rise to some jockeying, with each group trying to further its own interests. Does this cripple standardization efforts, and prevent firms from weeding out harmful behavior? Throughout this paper, we have argued that this is unlikely to be the case. Along similar lines, Jonathan Barnett concludes that:

> It can nonetheless be observed that there exists some meaningful range of circumstances where the most influential market participants are likely to have socially compatible incentives and capacities to correct the transaction cost burdens and associated losses that arise from overpropertization outcomes.[235]

So where does this leave antitrust policy? Given what precedes, we argue that policymakers should worry less about firms' behavior once a standard has been adopted (relying on contract law to solve outstanding issues), and focus instead on the events leading up to the formation of SDOs and the adoption of their internal rules. This is all the more true, given that sporadic occurrences of holdup and royalty stacking may ultimately increase firms' incentives to improve the functioning of SDOs for future standardization efforts. These incentives may be compounded by competition between standards (and between standard developing organizations). Finally, naïve attempts to curb patent holdup and royalty stacking may have the united consequence of incentivizing holdout behavior, thus reducing innovation. And when policymakers do miss the mark, market participants will not always be able to correct their misguided policies.[236] As a result, government intervention in the standardization space comes with high potential costs.

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[235] *See, e.g.*, Jonathan M Barnett, *Property as Process: How Innovation Markets Select Innovation Regimes*, 119 YALE LJ 384, 456 (2009) (The author thus concludes that: "*And if that is the case, then widespread but inherently uncertain claims that innovation markets chronically suffer from too much property are presumptively vulnerable for a simple reason: sometimes, the market will not stand for it.*")

[236] This is akin to the argument made by Frank Easterbrook in his seminal article concerning the costs and benefits of antitrust enforcement. *See* Frank H Easterbrook, *Limits of antitrust*, 63 TEX. L. REV. 3

In sum, the question which this paper seeks to answer is whether policymakers should follow the calls of Lemley, Shapiro, and other standardization sceptics; or whether there is an element of nirvana fallacy involved in the writings of these scholars (as the early holdup scholarship suggests). Our paper has notably explained that the *ex post* contractual gap-filling required to implement these proposals would be informationally challenging and could be gamed by the sophisticated players that operate in the standardization space. But there is also a more fundamental objection. As we have argued, the standardization space is an emergent phenom with numerous complexities that decisionmakers and scholars may fail to grasp. Given this complexity, and the potentially self-correcting nature of the failures that have been alleged (but not empirically observed), we urge decisionmakers the adopt a hands-off approach, drawing inspiration from the wise words of Elinor Ostrom:

> The intellectual trap in relying entirely on models to provide the foundation for policy analysis is that scholars then presume that they are omniscient observers able to comprehend the essentials of how complex, dynamic systems work by creating stylized descriptions of some aspects of those systems. With the false confidence of presumed omniscience, scholars feel perfectly comfortable in addressing proposals to governments that are convinced in their models as omnicompetent powers able to rectify the imperfections that exist in all field settings.[237]

(1984) (Easterbrook argued that antitrust authorities should favor false negatives over false positives because it is easier for markets to self-correct: "*But this should not obscure the point: judicial errors that tolerate baleful practices are self-correcting, while erroneous condemnations are not.*").

[237] *See* ELINOR OSTROM, GOVERNING THE COMMONS 215 (Cambridge university press. 2015).