Telecommunications Policy xxx (2017) 1–14

Contents lists available at ScienceDirect

Telecommunications Policy

journal homepage: www.elsevier.com/locate/telpol

An estimate of the average cumulative royalty yield in the world mobile phone industry: Theory, measurement and results☆

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A B S T R A C T

An influential literature argues that dispersed patent ownership may lead to royalty stacking and excessive running royalties, thus increasing the long-run marginal cost of manufacturing phones and their prices. One set of estimates claims that the royalty stack is on the order of 20–40 percent of the value of the average phone. In order to assess this claim, we estimate the average cumulative royalty yield—the sum total of patent royalty payments earned by licensors, divided by the total value of mobile phones shipped— in the world mobile phone industry between 2007 and 2016. We "follow the money" and identify, with varying accuracy, 39 potential licensors in the smartphone value chain. We find that, of these, only 29 charged royalties in 2016, running from a low of $1.6 million to a high of $7.7 billion, summing to $14.2 billion in total, which compares with $425.1 billion in mobile phone sales. The average cumulative royalty yield in 2016 was 3.3 percent or $7.20 per phone. If we restrict this only to smartphones, the result would be $9.60 per phone, roughly 3.4 percent of the average selling price. A sensitivity analysis shows that even under a very restrictive set of assumptions, the average cumulative royalty yield on a smartphone would not exceed 5.6 percent.

> It is generally accepted that the main source of profits to the innovator are those derived from temporary monopoly. Why is it that royalties are not an equivalent source of revenues? In simple theory, the two should be equivalent. Indeed, […]
>
> it should generally be more profitable to the innovator to grant a license to a more efficient producer […] but I have the impression that licensing is a minor source of revenues.
>
> Kenneth Arrow (2012)

☆ We thank Jonathan Barnett, Anne Layne-Farrar, Tim Long, Keith Mallinson, Jorge Padilla, four anonymous referees the editors and others who wished to remain anonymous but provided important perspective and helpful comments. We are also grateful to participants at the IP2 conference in May 2017 for their comments and insights. Jordan Horrillo provided excellent research assistance.

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http://dx.doi.org/10.1016/j.telpol.2018.02.002
Received 12 June 2017; Received in revised form 14 February 2018; Accepted 14 February 2018
Available online xxxx

1. Introduction and motivation

1.1. How high are royalties in the mobile phone value chain?

By almost any measure the mobile phone industry is a success story. Between 1994 and 2013 the number of mobile phones sold rose 62-fold.[2] In June 2015 there were around 7.5 billion subscriber connections, one for every person on the planet.[3]

The impressive growth of mobile phone sales and penetration has been driven by rapid technological progress, which has produced steadily falling prices. In 1983 the first mobile phone cost the current equivalent of nearly $10,000, was the size of a brick, weighed a kilo, and had a battery which only lasted for a 30 minute call. Eight years later, in 1991, 2G GSM technology was introduced with phones that cost about $1,400 and provided consumers with data rates up to 9.6 kbps. Today, 4G phones cost on average less than $300, and provide data transfer speeds in excess of 100,000 kbps.

Mobile phones integrate a wide array of technologies, from computing to consumer electronics to communications, and from semiconductors to hardware, software and services. The technologies integrated in a smartphone have been developed over time by many different patent holders, some of which license them to semiconductor and phone manufacturers. Thus, there is substantial specialization and vertical separation in the mobile phone value chain.[4] At the same time, technology developers, phone manufacturers, and operators develop the technologies that make phones interoperable in standard development organizations (SDOs).

In any industry prices guide resource allocation, remunerate investments in physical capital and R&D and make decentralization and specialization possible. In the mobile phone industry the royalties paid by manufacturers to technology developers make specialization in technology development possible.[5,6] Yet a rather large and influential academic literature argues that decentralization and specialization in the mobile phone industry may lead to excessive royalties, and this has given rise to concern by policy makers and antitrust authorities.[7] Some standards development organizations have also tried to change the rules whereby the FRAND commitment is established and assessed, in part to address concerns that royalties might be excessive.[8]

The argument about excessive royalties runs as follows. A standard-compliant phone uses hundreds, if not thousands of standard essential patents (SEPs) owned by a large number of SEP holders.[9] Each SEP holder sets her running royalty rate independently, and the result is that excessive running royalties are piled on top of excessive running royalties—a theoretical construct that is called "royalty stacking."[10] This royalty stack drives up the marginal cost of manufacturing phones, thereby increasing prices to consumers, and discouraging innovation by manufacturers.[11]

1.2. The question asked by the literature and some answers

The question that has been posed by academics, policy makers, and industry practitioners is how high is the royalty stack, and by how much does it increase marginal costs and phone prices? An exact answer would require measurement of the running royalty paid by phone manufacturers at the margin. What have previous studies said about the royalties charged by patent holders in the mobile phone value chain?

In an influential paper, Lemley and Shapiro (2007, pp. 2026–27), suggest that royalties for the entire package of cell phone functionalities are in the range of 20–40 percent of the price of a phone:

> We have seen estimates as high as 30% of the total price of each phone, but those were based on summing royalty demands before any cross-licensing negotiations began. Bekkers (and West, 2006) suggests that the cost of patent licenses for cell phone Internet functionality after cross-licensing offsets is in the range of 20% of the price of the entire phone. […] Thelander suggests that

[2] See Galetovic and Gupta (2017).

[3] See Mallinson (2016).

[4] See for example, Nenni and Dingee (2015) or Nenni and Mclellan (2013).

[5] Blecker, Sanchez, and Stasik (2016) provides a detailed account of licensing practice in the mobile phone industry. They show that, since the inception of the industry, holders of large patent portfolios have licensed their whole portfolio for a single royalty assessed on the average selling price of each phone.

[6] According to Johnson (2015, p. 198): "A royalty is simply a payment of a fixed fee per item sold ($5 per television set), or a percentage of the licensee's list price for each item, or a percentage of the licensee's receipts from sales […]". According to the *Oxford English Dictionary* "[A royalty is a] sum paid to a patentee for the use of a patent or to an author or composer for each copy of a book." See also OECD (2008). A "running royalty" is a payment that varies with the number of units sold. A "lump sum royalty" is a fixed payment that does not vary with the number of units sold.

[7] See, for example, United States Department of Justice and United States Federal Trade Commission (2007), Baer (2015), United States Federal Trade Commission (2003 and 2011), Hesse (2013, 2014), Shapiro (2001: 125), Scott-Morton and Shapiro (2016: 125), Vestager (2016). On court cases, see the recent comprehensive survey by Barnett (2018).

[8] See, for example, Katznelson (2015). FRAND is the acronym of fair, reasonable and non-discriminatory royalties.

[9] Some estimate that there are about 150,000 declared mobile SEPs worldwide (issued and applied for) in the so-called "4G stack," which includes LTE, WCDMA and GSM/GPRS/EDGE. Of these, about 20,000 are US patents. As Galetovic and Gupta (2017) report, in 2013 there were 128 SEP holders in the 3GPP standard. One should note that it may have been in the interests of patent holders to declare all possible patents as "essential." One reason is that patentees risk legal penalties for not declaring a patent essential. Also, some firms may have acted on the perception that a large SEP portfolio bolstered their reputation and increased their leverage when negotiating royalties. Moreover, the ETSI IPR database, just lists declared essential patents, but neither ETSI nor anybody else audits those declarations. For these reasons, it is not clear how many of these patents are truly essential. Industry participants often estimate the rate of over-declaration at 50 percent or more. Others think that few SEPs would pass a legal test of essentiality.

[10] Contreras and Gilbert (2015) argue that non-SEPs may also add to the royalty stack.

[11] See Shapiro (2001) and Lemley and Shapiro (2007, p 2013 and Appendix A).