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To root or not to root? The economics of jailbreak

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ABSTRACT

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We construct a structural model that allows us to jointly estimate the demand for smartphones and paid apps using a Bayesian approach. Our data comes from more than 500 college students in Hong Kong and Shanghai. We find that the utility cost rather than the upfront monetary cost of jailbreaking smartphones determines its prevalence. Users mainly jailbreak smartphones to use paid apps for free, a reason more important among Android users than iPhone users. Paid apps contribute the lion's share of the profits (between 66% and 59%) for both the Android and iPhone. Strictly prohibiting jailbreaking would decrease the aggregate market share of smartphones in the cell phone market. Apple, however, would sell even more iPhones at the expense of Android smartphones. *Journal of Comparative Economics* **000** (2016) 1–17. Shanghai Jiao Tong University, China; Wake Forest University, US; The Chinese University of Hong Kong, China; University at Albany, SUNY, USA.

1. Introduction

Jailbreaking is a process that unlocks restrictions on smartphones imposed by either the manufacturers or carriers.[1] Jailbreaking enables the user of a smartphone to personalize the phone settings (e.g., the strength of the Wifi antenna). Users of jailbroken iPhones can also sideload unauthorized apps, legal or illegal, from platforms other than the iTunes App Store. Jailbreaking can be deemed a violation of the 1998 Digital Millenium Copyright Act (DMCA). In 2010, the U.S. Library of Congress granted an exemption to jailbreaking from the DMCA, which the Apple Inc tried very hard to lobby against. The exemption was renewed in 2012. During the hearings and public comments surrounding the 2012 exemption, the Joint Creators, composed of app developers such as the Association of American Publishers, opposed the renewal of the exemption based on the ground that it may facilitate app piracy.

What drives users to jailbreak their smartphones? How does a change in copyright policy on jailbreaking affect the smartphone market? Would the effects differ between Apple and Android smartphones? We address these problems by

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[1] "Jailbreaking" is a term applied to Apple's iOS devices such as the iPhone. A similar term for Android smartphones is "rooting." We use the two terms interchangeably in this paper.

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constructing a random-coefficient discrete-choice demand model of smartphones and apps. Within the model, consumers choose whether to jailbreak the smartphones of their choice. Jailbreaking a smartphone within our model enables users to download, install and use paid apps for free and unofficial apps not endorsed by either Apple or Google. We estimate the model using a unique dataset collected from more than 500 college students in Hong Kong and Shanghai through conjoint surveys, and find several interesting results.[2]

First, paid apps contribute significantly to the market shares of smartphones. While varying their prices is inconsequential, the availability of paid apps matters significantly to the smartphones' market shares. Second, because paid apps are important to smartphone users, using paid apps for free is a main reason for jailbreaking, a reason more decisive among Android users than Apple iPhone users. Third, the upfront monetary cost of jailbreaking a smartphone plays a much smaller role than the utility cost in explaining its prevalence.[3] Fourth, strictly prohibiting jailbreaking would bring down the aggregate market share of smartphones. More people would switch back to using traditional cell phones. However, Apple's sales of iPhones would surprisingly strengthen at the expense of Android smartphones, and Apple would make even more profit. This suggests that Apple should have tried its best to fight the exemption and make it costly to jailbreak not only iPhones but also Android smartphones. This result is at odds with Apple's lack of effort in objecting against the 2012 renewal of the DMCA exemption.

A caveat of our study should be stated up-front. While we acknowledge that the smartphone industry is two-sided (strictly speaking, it is richer than that), we do not study the changes in app supply across different copyright regimes for two reasons. First, we do not have data that would allow us to account for the app developers' responses to different hypothetical copyright regimes. In particular, app developers' responses are inherently dynamic. Changes in the copyright regimes, smartphone demand, app demand and jailbreaking propensity are all factors that enter into the calculation of app developers when they decide whether to develop apps. Not only would the data be hard to come by, but these dynamic responses would be extremely difficult to model. Second, we find it is important to single out the responses of consumers and how phone producers respond to them. Without addressing app developers' responses, we would not be able to estimate the overall profit of phone producers, as the important component of app income would be missing.

Our paper relates to studies on the effect of counterfeits and digital goods piracy on legitimate markets. Grossman and Shapiro (1988a) and Grossman and Shapiro (1988b) are the first to analyze this issue. There have also been numerous studies on the effect of music piracy on album sales. Most have found that music piracy has a significantly negative effect on album sales, with the exception of (Oberholzer-Gee and Strumpf, 2007).[4] However, with the exception of (Leung, 2015), which quantifies the effect of music piracy on iPod sales, none of these studies has examined the effect of piracy in a two-sided market framework.

Some papers have examined counterfeit and piracy in China. For instance, Qian (2008) shows that in the Chinese shoe industry, firms with less government protection differentiate their products through innovation, self-enforcement and subtle high-price signals to decrease counterfeit sales. Bai and Waldfogel (2012) conduct surveys in China and find that unpaid movie consumption comprises about 75% of Chinese respondents' movie consumption (compared with approximately 5% reported in the U.S. sample). Further, they find that sales displacement is far smaller for the Chinese sample than U.S. sample.

Our study also contributes to the growing literature on the complementarity between apps and smartphones. Waterson and Doyle (2012) look into eBay auctions on iPhone 4 in the U.K. and show that transaction prices are higher when the phone is unlocked and can be sold overseas. Sun (2012) estimates a consumer demand for the smartphone and app supply and shows that apps contribute to the growing value of smartphones. Kim (2012) estimates consumer demands for both smartphones and apps and shows that Apple provides more app benefits to its users and that Android's stronger sales come entirely from advantages in the price-adjusted quality of its hardware. Our study differs by looking into the effects of jailbreaking on the joint demand of smartphones and apps.

In the next section, we describe the background of the DMCA exemption and the smartphone industry and explain the concept of jailbreaking in more detail. Section 3 describes the data. Section 4 details the model and explains that the conjoint survey provides it with identification by exogenously varying the different prices and attributes of smartphones. Section 5 discusses the results. Section 6 discusses counterfactuals that correspond to different prices, availability of paid apps and that correspond to different copyright regimes.

2. Jailbreaking smartphones under the digital millennium copyright act

Introducing apps, a move Apple first made in the summer of 2008, is key to the iPhone's success. The average quarterly worldwide sales of iPhones before apps were born were approximately 1.2 million units. On July 10, 2008, Apple launched

[2] We acknowledge that our sample is not representative. In particular only 39% of all smartphones were owned by people aged below 24 in 2012 according to statistics from Statista.com. Given that college students are more likely than others to jailbreak their smartphones, our results of the impacts of jailbreaking on smartphone sales can be seen as an upper bound of the true ones.

[3] The utility cost in our model captures factors including the hassle in updating the smartphone or the moral cost of jailbreaking.

[4] See (Blackburn, 2004), (Hui and Png, 2003), (Leung, 2015), (Liebowitz, 2006), (Peitz and Waelbroeck, 2004), (Rob and Waldfogel, 2006), and (Zentner, 2006). Smith and Telang (2012) provide a more recent review of the literature.

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