

Rasch, Alexander; Wenzel, Tobias

Working Paper

The impact of piracy on prominent and non-prominent software developers

DICE Discussion Paper, No. 167

Provided in Cooperation with:

Düsseldorf Institute for Competition Economics (DICE), Heinrich Heine University Düsseldorf

Suggested Citation: Rasch, Alexander; Wenzel, Tobias (2014) : The impact of piracy on prominent and non-prominent software developers, DICE Discussion Paper, No. 167, ISBN 978-3-86304-166-3, Heinrich Heine University Düsseldorf, Düsseldorf Institute for Competition Economics (DICE), Düsseldorf

This Version is available at:

<https://hdl.handle.net/10419/104537>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

DISCUSSION PAPER

No 167

The Impact of Piracy on Prominent and Non-prominent Software Developers

Alexander Rasch,
Tobias Wenzel

November 2014

IMPRINT

DICE DISCUSSION PAPER

Published by

düsseldorf university press (dup) on behalf of
Heinrich-Heine-Universität Düsseldorf, Faculty of Economics,
Düsseldorf Institute for Competition Economics (DICE), Universitätsstraße 1,
40225 Düsseldorf, Germany
www.dice.hhu.de

Editor:

Prof. Dr. Hans-Theo Normann
Düsseldorf Institute for Competition Economics (DICE)
Phone: +49(0) 211-81-15125, e-mail: normann@dice.hhu.de

DICE DISCUSSION PAPER

All rights reserved. Düsseldorf, Germany, 2014

ISSN 2190-9938 (online) – ISBN 978-3-86304-166-3

The working papers published in the Series constitute work in progress circulated to stimulate discussion and critical comments. Views expressed represent exclusively the authors' own opinions and do not necessarily reflect those of the editor.

The Impact of Piracy on Prominent and Non-prominent Software Developers*

Alexander Rasch^{1,†} Tobias Wenzel^{1,‡}

¹Duesseldorf Institute for Competition Economics (DICE),
University of Duesseldorf

November 2014

Abstract

This paper studies the impact of software piracy on prominent and non-prominent software developers in markets based on a two-sided platform business. Consumer behavior is imperfect and, when adopting a platform, consumers only take prominent software into account. We show that prominent software exhibits higher piracy rates than non-prominent software. However, contrary to intuition, this does not necessarily mean that prominent software developers benefit more from increased software protection. Indeed, we show that prominent developers may lose out whereas non-prominent developers may gain from better software protection.

Keywords: Piracy; Platform; Software; Two-sided market.

JEL-Classification: L11; L86.

*We would like to thank three anonymous referees and Justus Haucap, the guest editor, for their very helpful comments and suggestions.

[†]Email: rasch@dice.hhu.de. Address: Duesseldorf Institute for Competition Economics (DICE), University of Duesseldorf, Universitaetsstrasse 1, 40225 Duesseldorf, Germany.

[‡]Email: wenzel@dice.hhu.de. Address: Duesseldorf Institute for Competition Economics (DICE), University of Duesseldorf, Universitaetsstrasse 1, 40225 Duesseldorf, Germany.

1 Introduction

Many software products are centered around platforms. Examples for these industries include game consoles, e-book readers, and applications for smartphones. In particular, applications for smartphones or tablet PCs have gained much importance in recent years. Common to all these examples is that the platform has to attract two sides. Consider the examples of game consoles. There, a platform (i.e., the game console such as Microsoft's Xbox 360, Nintendo's Wii, or Sony's PlayStation) has to attract gamers (users who buy the game console) and game developers. Users only find the game console attractive if many games are available; at the same time, game developers only find the platform attractive if they can reach many gamers. In this aspect, these markets are characterized by two-sided network externalities (see, e.g., Armstrong, 2006; Caillaud and Jullien, 2003; Hagiu, 2006, 2009; Rochet and Tirole, 2003, 2006).

Piracy of software seems to be a growing concern in these markets, potentially leading to losses for both developers and platforms.¹ Our study is in particular motivated by the steadily growing market for software applications (so-called apps) which are popular among users of Internet-compatible digital devices such as smartphones or tablets. In this market, operating systems (such as Android [Google], BlackBerry OS [BlackBerry], iOS [Apple], Windows Phone [Microsoft]) act as platforms and software developers provide applications which run on the operating systems. As a matter of fact, many sources point out that overall software piracy seems to be a major issue in this market with some apps and/or games having piracy rates of more than 90%.² However, software developers seem to be affected differently by illegal downloads and software piracy. A recent study by the Yankee Group and Skyhook investigating the impact of app piracy on 75 Android developers revealed that 27% consider piracy a "huge problem" and another 26% consider it "somewhat of a problem".³ This means that slightly less than half of the developers surveyed appear not very concerned by the existence of piracy. In a survey of UK videogame developers, the trade in-

¹See Rasch and Wenzel (2013) for examples and sources.

²See, e.g., <http://www.guardian.co.uk/technology/appsblog/2012/jul/23/dead-trigger-android-free-piracy>.

³See http://www.yankeegroup.com/about_us/press_releases/2011-09-08-1.html.

dustry group TIGA found that only 10% of developers considered piracy a threat to their business survival but 90% viewed it a “constant or increasing problem”. However, 30% would not do business differently as a direct consequence from the existence of piracy (with 50% saying they were in favor of a change in business practices and 20% answering “don’t know”).⁴ This raises the question why firms have such different views on piracy. In this paper, we will provide a possible explanation, based on different prominence levels, why some software firms within an industry may favor piracy (or are affected to a lesser extent) whereas others may not.

We study the impact of piracy when software developers are differentiated according to prominence. Prominent and non-prominent software differs in two dimensions. Firstly, under a prominent piece of software we understand a piece of software that is known by users well in advance of adopting a platform and which is important for their adoption decision. Other pieces of software are less well known and do not play a role in a user’s adoption decision. Secondly, given that prominent software is better known, it is reasonable that prominent software is more likely to be purchased by a user than a non-prominent piece of software. We model this by assuming that users derive a higher utility from prominent software.

The important assumption imposed in this model is that users are fully informed about the availability of prominent software before adopting a platform whereas users discover some other, non-prominent software only after they have adopted a software platform. Hence, at the adoption stage, only prominent software is considered which means that the availability of a prominent piece of software may have a large impact on market shares on the user side.⁵ To the contrary, whether a non-prominent piece of software is available or not does not influence users’ adoption decisions. However, we think that this myopic user behavior is reasonable in many instances.

Let us discuss this main assumption and the motivation for using it in more detail. Consider, for example, a situation where a user wants to buy a new smartphone. Given the extremely large number of applications available on the different operating systems, it is almost impossible for a customer

⁴See <http://www.gamepolitics.com/2009/11/11/uk-dev-survey-piracy-problem-not-threat#.USTcuq5STxo>.

⁵In this aspect, our notion of prominence is closely related to ‘must-have’ components in Hogendorn and Yuen (2009).

to know all of them. Most likely, the customer will be only aware of major applications (prominent software) but not of other, less prominent software. Thus, at the adoption stage, only the prominent software matters.⁶ Over time and after having gained some experience on the software platform, the customer may discover software he was initially unaware of and which he then eventually decides to purchase.

Within our framework we provide two main results. Firstly, given its larger popularity, prominent software is more likely to be pirated by users. That is, prominent software exhibits a higher piracy rate than non-prominent software. However, contrary to basic intuition, this does not necessarily mean that prominent developers benefit more from additional software protection, which is our second main results. Indeed, we show that piracy and software protection may affect software developers quite differently depending on whether a developer is prominent or not. The reason lies in the platforms' pricing strategies toward these different types. Platforms have an incentive to subsidize prominent developers to attract more users. This effect is not present (or only to a smaller extent) with non-prominent developers. Thus, software protection has two effects for developers. Firstly, it increases developers' immediate revenues from software sales to users. This positive effect of software protection applies to both types of developers. Secondly, with stricter software protection, users value additional software less (as software prices tend to be higher with more protection) inducing platforms to compete less hard for developers. In other words, piracy induces platforms to compete harder for developers. This leads to reduced license fees for prominent developers. This second, negative effect of software protec-

⁶Note that one may argue that the most established applications are usually available on the most popular operating systems Android and iOS and that, as a consequence, differences in software may not matter that much for a consumer deciding between those two platforms. However, this is not necessarily the case for other platforms with a lower user base, such as BlackBerry OS or Windows Phone. Indeed, it has been pointed out that the lack of a sufficiently large number of available applications has contributed to the low (declining) market shares of those platforms. In that sense, the existence of established software on a mobile platform appears an important aspect for users' adoption decisions (see, e.g., <http://www.crn.com/news/mobility/232301056/the-decline-of-blackberry-where-rim-went-wrong.htm> or <http://www.cnet.com/news/blackberrys-loss-is-windows-phones-gain/>). A comparison of the (non-)availability of the top 50 free and top 50 paid apps featured in the Apple App Store and Google Play in the United States on BlackBerry World and Windows Phone store yielded a rate of only 34% as of May 21, 2013 (see <http://www.canalys.com/newsroom/top-ios-and-android-apps-largely-absent-windows-phone-and-blackberry-10>).

tion applies only to prominent developers. As a result, due to the first effect, stricter software protection is positive for non-prominent firms. For prominent developers, the second effect may outweigh the first one making them possibly benefit from less software protection.

By now there is a growing literature on firm competition in the presence of myopic user behavior.⁷ Related to our paper, models have been developed where consumer take only a subset of price components into account when selecting a product (Gabaix and Laibson, 2006; Spiegler, 2006).⁸ This literature is also concerned with the effects of a firm's prominence by either assuming that a prominent firm serves as the default option (Piccione and Spiegler, 2009; Gu and Wenzel, 2013) or, in the context of search, by assuming that a firm's prominence affects a consumer's search order (Armstrong et al., 2009; Armstrong and Zhou, 2011). We build on this literature by providing a model where consumers are myopic regarding their platform adoption decision and take only prominent software into account when choosing which platform to adopt. The main focus of this paper is how this imperfect, myopic consumer behavior affects platform pricing and the effects of piracy on prominent and non-prominent software developers.

The literature on piracy in platform markets is very limited.⁹ With the exception of Rasch and Wenzel (2013) who focus on the (mis)alignment of platforms' and developers' software protection incentives, we are not aware of further studies concerning this issue. However, given the increased importance of software markets, which are organized as two-sided markets, software piracy in these markets is getting more important. In contrast to Rasch and Wenzel (2013), in this paper we consider imperfect consumer behavior and explore how heterogeneous software developers, which differ in their prominence, are affected by software piracy. We show that it is important to take this myopic consumer behavior into account since the different types of software developers may be affected differently by piracy.

The remainder of the paper is organized as follows. In Section 2, we describe the model setup. Section 3 presents our main results. Section 4 discusses two extensions of the base model. Finally, Section 5 concludes.

⁷A survey is provided by Huck and Zhou (2011) and a textbook by Spiegler (2011).

⁸See also Armstrong and Vickers (2012) for an application to financial products.

⁹For a survey on digital piracy, see Belleflamme and Peitz (2012).

2 The model

This section introduces a model of piracy in a platform framework. The model draws on the two-sided-market models of Armstrong (2006), Choi (2010), and Belleflamme and Peitz (2010) as well as on the piracy model by Rasch and Wenzel (2013).

Software platforms

There are two software platforms located at opposite ends of a unit line where platform 1 is located at 0 and platform 2 is located at 1 (Hotelling, 1929). Platforms generate income from both users (by charging an access fee of p_i , $i \in \{1, 2\}$), prominent software developers (by a charging license fee l_i), and non-prominent software developers (by a charging license fee \hat{l}_i). All possible costs are normalized to zero.

Software developers

There is a unit mass of software developers which come in two types. A fraction γ are prominent developers and a fraction $1 - \gamma$ are non-prominent developers. Prominent and non-prominent developers differ in two aspects: (i) when adopting a platform, only prominent software is taken into account by users and (ii) prominent software offers a higher (base) utility to users than non-prominent software.

Software developers may multi-home and offer software products on both platforms. Developing software is associated with an investment of f which is uniformly distributed on the unit interval, independently for each type.

The profit of a prominent software developer that produces for platform i amounts to

$$\pi = \phi s_i - l_i - f,$$

where s_i denotes the number of users at platform i and ϕ is the amount a developer earns for each user reached on the platform. For now we take ϕ as

given but we will provide a foundation below.¹⁰ In principle, the amount a developer earns depends on its pricing strategy as well as on the level of software protection. The license fee l_i and the investment cost f is subtracted from revenues.

Analogously, the profit of a non-prominent software developer that produces for platform i amounts to

$$\hat{\pi} = \hat{\phi}s_i - \hat{l}_i - f.$$

Note that profits per user may differ for prominent and non-prominent software. In addition, platforms may also set different license fees for prominent and non-prominent developers.

Developers offer their product on a platform i as long as they do not incur a loss, i.e., $\pi \geq 0 \Leftrightarrow f < \phi s_i - l_i =: \bar{f}$ and $\hat{\pi} \geq 0 \Leftrightarrow f < \hat{\phi}s_i - \hat{l}_i =: \hat{\bar{f}}$. All developers with $f < \bar{f}$ and $f < \hat{\bar{f}}$ enter.

Assuming that the platforms can price-discriminate between the two types of software, the amount of prominent and non-prominent software on platform i can then be expressed as

$$n_i = \gamma(\phi s_i - l_i) \tag{1}$$

and

$$\hat{n}_i = (1 - \gamma)(\hat{\phi}s_i - \hat{l}_i).$$

Software users

Users who only buy from one of the two platforms (i.e., they single-home) are distributed uniformly along the unit interval. The location of a user is denoted by x . When making the adoption decision, users are only aware of the amount of prominent software. Thus, at the decision stage, the perceived utility of a user who is located at x and who buys access to platform

¹⁰Note that, in principle, the amount a developer earns for each user may also depend on the adopted platform. However, as platforms are identical (apart from the available software), the value of a software product is identical across platforms and, hence, the earnings per consumer does not depend directly on the platform. A similar reasoning applies to the benefit a user receives from software consumption, which is introduced below.

1 or platform 2, respectively, is given by

$$u_1 = v + \theta n_1 - p_1 - \tau x$$

and

$$u_2 = v + \theta n_2 - p_2 - \tau(1 - x).$$

Users derive an intrinsic utility of v from buying access to a platform.¹¹ The more prominent software n_i is available on a platform the higher is a user's perceived utility. The benefit from an extra unit of prominent software is given by θ . Below we will endogenize this parameter by modeling the interaction between software firms and users in detail. Again, it will mainly depend on the developers' pricing strategy and on the extent of software protection. Users incur linear transportation costs of τ per unit of distance traveled.

Platforms' market shares in the user market depend on user prices and the amount of prominent software. The market share of platform i is determined by the user who is indifferent between buying from either of the two platforms and is given according to the Hotelling formula:¹²

$$s_i = \frac{1}{2} + \frac{\theta(n_i - n_j) - p_i + p_j}{2\tau}. \quad (2)$$

Piracy decision

We adopt a framework where legal and illegal software is vertically differentiated (Yoon, 2002; Belleflamme, 2003; Bae and Choi, 2006). Suppose that each software developer is a monopolist and that each user may buy one unit of software from each software firm. This specification implies that although users are not aware of non-prominent developers before the decision which platform to go to, they may buy their products later on. Users differ in their valuation δ for the software. This valuation is uniformly distributed on $[0, 1]$ (and independent of users' platform preferences). A user can choose between buying the software and copying it illegally. A user

¹¹This stand-alone value may be due to pre-existing software or additional features the platform offers (e.g., the possibility to watch DVDs or Blu-rays on game consoles).

¹²We assume that the market is covered, i.e., any user along the linear city buys access to exactly one platform. This can be guaranteed by assuming v sufficiently large.

may also decide not to use the product. Illegal copies provide a lower utility than legally purchased software (e.g., due to a lack of manuals/technical support or blocked access to an online community).

The utility of a user δ considering to buy a prominent piece of software is

$$V = \begin{cases} \delta - p_s & \text{purchase a legal copy,} \\ (1 - \alpha)\delta - k & \text{obtain an illegal copy,} \\ 0 & \text{otherwise,} \end{cases} \quad (3)$$

where $\alpha \in (0, 1)$ measures the quality degradation of an illegal copy. There is a (fixed) cost k associated with pirating a software product. This fixed cost will be our measure of software protection. Better protected software is harder to pirate, and hence, the lower is the threat of piracy. The price charged by a prominent software developer is p_s .

Users derive a lower utility from consuming a non-prominent software product. This is captured by a parameter $\beta \in (0, 1)$ that measures the discount on the base utility of a non-prominent piece of software relative to a prominent one:

$$\hat{V} = \begin{cases} \delta\beta - \hat{p}_s & \text{purchase a legal copy,} \\ (1 - \alpha)\delta\beta - k & \text{obtain an illegal copy,} \\ 0 & \text{otherwise,} \end{cases}$$

where \hat{p}_s is the price charged by a non-prominent developer.

We assume that the costs of obtaining an illegal copy must not be too high:

Assumption 1.

$$k \leq \frac{\alpha(1 - \alpha)\beta}{1 + \alpha} =: \bar{k}.$$

This assumption ensures that in equilibrium some users indeed obtain an illegal copy so that it is optimal for software developers to accommodate piracy.¹³

¹³Setting the limit price that deters all users from obtaining the software illegally is only profit-maximizing if the costs of piracy are higher than imposed under *Assumption 1*. For an analysis of this case, see Yoon (2002) and Belleflamme (2003).

Timing

In the first stage, platforms simultaneously set prices for users and license fees for software developers. In the second stage, users and developers decide which platform(s) to join. In the third stage, software developers set the prices for their products and in the fourth stage, users decide whether to buy software or copy it illegally.

3 Results

User piracy and the pricing of software

We start the analysis by studying users' piracy decisions and the optimal price setting by software firms. At this stage, platform adoption decisions (by users and software developers) as well as platform prices are given.

We start with the consumption decision of a user regarding a prominent piece of software. According to the utility function (equation (3)), the user who is indifferent between buying the legal product and obtaining an illegal copy is given by $\bar{\delta} := (p_s - k)/\alpha$. The marginal user who is indifferent between obtaining the pirated copy and not consuming is $\underline{\delta} := k/(1 - \alpha)$. Hence, all users with $\delta \geq \bar{\delta}$ purchase the product and all users with $\bar{\delta} > \delta \geq \underline{\delta}$ copy it illegally. Users with valuation lower than $\underline{\delta}$ do not consume the software.

For a given software price p_s , the prominent software developer expects to earn an income of $p_s(1 - (p_s - k)/\alpha)$ from selling the software to a user. The optimal price is set at $p_s = (\alpha + k)/2$. Thus, from the interaction with each user, a prominent software firm expects a revenue of $\phi(k) = (\alpha + k)^2/4\alpha$.¹⁴ Note that ϕ strictly increases with the level of software protection. This implies that, for given adoption decisions by users and developers, a prominent firm benefits from stricter software protection.

Denote by $\bar{\delta}^*$ the marginal user who is indifferent between copying and purchasing a legal copy given the optimal price. The expected surplus of a user

¹⁴We will write ϕ instead of $\phi(k)$ for simplification purposes in the following.

for each prominent software product can be expressed as

$$\theta = \int_{\underline{\delta}^*}^{\bar{\delta}^*} ((1 - \alpha)\delta - k)d\delta + \int_{\bar{\delta}^*}^1 \left(\delta - \frac{\alpha + k}{2} \right) d\delta.$$

Simplification yields $\theta(k) = (4 - 3\alpha)/8 - 3k/4 + (1 + 3\alpha)k^2/8\alpha(1 - \alpha)$.¹⁵ Note that θ decreases in the level of software protection k . Finally, we can also derive the piracy rate of a prominent software product given the optimal prices. This piracy rate amounts to $\bar{\delta}^* - \underline{\delta}^* = 1/2 - k(1 + \alpha)/2\alpha(1 - \alpha)$.

In a similar way, we can derive the optimal price set by developers of non-prominent software. The only difference that arises is that the user utility from consuming this type of software is discounted by a factor β . We obtain the optimal price for non-prominent software as $\hat{p}_s = (\alpha\beta + k)/2$ and revenue per user of $\hat{\phi} = (\alpha\beta + k)^2/4\alpha\beta$. Non-prominent software exhibits a piracy rate of $\hat{\delta}^* - \underline{\delta}^* = 1/2 - k(1 + \alpha)/2\alpha(1 - \alpha)\beta$.

Our first result compares the piracy rates of prominent and non-prominent software:

Proposition 1. The piracy rate of prominent software is higher than of non-prominent software.

The proposition shows that prominent software developers suffer to a greater extent from piracy than non-prominent developers. The result also implies that, for given adoption decisions, prominent developers would benefit to a larger degree from increased software protection. However, in the following analysis we will show that these preferences towards software protection may be reversed, in particular for prominent software developers, if adoption decisions are taken into account.

Adoption decisions and platform behavior

We now analyze the adoption decisions and the price decisions by the platforms.

¹⁵In what follows, we will write θ instead of $\theta(k)$ for simplification.

The adoption decisions by users and prominent software developers are interrelated and, hence, the demand for users and prominent developers at a platform is interrelated. To take this into account, we solve equations (1) and (2) simultaneously and express demand in terms of prices only, i.e.,

$$s_i = \frac{1}{2} + \frac{\gamma\theta(l_j - l_i) - p_i + p_j}{2(\tau - \gamma\theta\phi)}$$

and

$$n_i = \gamma \left(\phi \left(\frac{1}{2} + \frac{\gamma\theta(l_j - l_i) - p_i + p_j}{2(\tau - \gamma\theta\phi)} \right) - l_i \right).$$

User demand is independent of the amount of non-prominent software available on a platform. However, the demand for non-prominent software developers depends on the market share on the user side:

$$\hat{n}_i = (1 - \gamma) \left(\hat{\phi}s_i - \hat{l}_i \right).$$

Platform profits depend on three sources: access prices from users and license fees from both prominent as well as from non-prominent software developers. Hence, profits of a platform i are given by

$$\Pi_i = s_i p_i + n_i l_i + \hat{n}_i \hat{l}_i.$$

In the symmetric equilibrium, platforms charge the following prices:¹⁶

$$p^* = \tau - \frac{3\gamma\theta\phi + \gamma\phi^2 + (1 - \gamma)\hat{\phi}^2}{4}, \quad (4)$$

$$l^* = -\frac{\theta - \phi}{4},$$

and

$$\hat{l}^* = \frac{\hat{\phi}}{4}.$$

Proposition 2. (i) Platforms may subsidize prominent developers, that is, the license fee for prominent developers may be negative. (ii) The optimal license fee for non-prominent developers is positive. (iii) User prices are

¹⁶We focus on market-sharing equilibria. This can be guaranteed by assuming that horizontal differentiation among the platforms is sufficiently large.

lower the more prominent software there is (higher γ).

Proof. Ad (i): follows as $\phi > 0$ and $\theta > 0$. The license fee is negative (positive) if $\theta > (<) \phi$. Ad (ii): follows from the fact that $\hat{\phi} > 0$. Ad (iii): by differentiating expression (4) with respect to γ . \square

We see that introducing prominent and non-prominent software has two effects on platforms' pricing strategies. Firstly, platforms may subsidize prominent software developers which has also been shown in Rasch and Wenzel (2013). This can be optimal for a platform as users care about the amount of prominent software such that it influence users' adoption decisions. This is not the case for non-prominent software so that it is optimal to charge a strictly positive license fee toward these non-prominent developers. Secondly, platforms charge lower user prices the larger is the mass of prominent software. This is because platforms earn less from prominent than from non-prominent developers. Hence, the opportunity costs of attracting an additional user are lower when γ is high. In turn, user prices are lower with γ .

The following proposition evaluates the impact of software protection on equilibrium license fees:

Proposition 3. (i) The license fees charged to prominent and non-prominent software developers increase with the level of software protection. (ii) This effect is stronger for prominent software developers.

Proof. Ad (i): $\partial l^*/\partial k > 0$ as ϕ is increasing in k and θ is decreasing in k . $\hat{\partial} l^*/\partial k > 0$ as $\hat{\phi}$ is increasing in k . Ad (ii): it must be shown that $\partial l^*/\partial k > \hat{\partial} l^*/\partial k$. To this end, define $\check{k} := 3\alpha(1-\alpha)\beta/(2(1-\alpha) + \beta(5\alpha-1))$ and note that $\check{k} > \bar{k}$. It holds that $\partial l^*/\partial k > \hat{\partial} l^*/\partial k$ for all $k < \check{k}$ and hence, for all $k < \bar{k}$. \square

As the proposition highlights, license fees for both types of developers increase with the level of software protection. This is also one finding in Rasch and Wenzel (2013). However, what is new is that the license fee for prominent developers increases to a larger extent due to a decreased subsidization

by the platform. There are two effects at work. Firstly, a higher level of software protection increases developers' immediate revenues from software sales to users so that platforms can extract more rents from developers and consequently increase the license fee. This effect applies to both types of developers. Secondly, with stricter software protection, users value additional software less inducing platforms to compete less hard for developers which induces platforms to increase license fees for prominent developers even further. This second effect of software protection applies only to prominent developers as only they are important for users' adoption decisions.

Equilibrium platform profits amount to

$$\Pi^* = \frac{\tau}{2} - \frac{3\gamma\theta\phi}{8} - \frac{\gamma(\theta^2 + \phi^2) + (1 - \gamma)\hat{\phi}^2}{16},$$

whereas the profits (net of developing costs) of prominent and non-prominent software firms are given by

$$\pi^* = \frac{\theta + \phi}{4}, \quad (5)$$

and

$$\hat{\pi}^* = \frac{\hat{\phi}}{4}. \quad (6)$$

We now evaluate the impact of software protection on firms' profits. Let $\tilde{k} := \alpha(1 - \alpha)/(3 + \alpha)$. Then, we obtain the following result:

Proposition 4. (i) Prominent software firms are hurt by a higher level of software protection if $k < \tilde{k}$ and benefit from a higher level of software protection if $k > \tilde{k}$. (ii) Non-prominent software firms benefit from a higher level of software protection. (iii) Non-prominent developers benefit from a higher level of software protection to a larger extent than prominent developers.

Proof. Ad (i): differentiating expression (5) with respect to k and solving yields \tilde{k} . It follows that $\partial\pi^*/\partial k \geq 0 \Leftrightarrow k \geq \tilde{k}$. Ad (ii): differentiating expression (6) with respect to k is always positive as $\partial\hat{\phi}/\partial k > 0$. (iii) It needs to be shown that $\partial\hat{\pi}^*/\partial k > \partial\pi^*/\partial k$. Note that $\partial\hat{\pi}^*/\partial k > \partial\pi^*/\partial k \Leftrightarrow$

$\partial \hat{\phi} / \partial k - \partial \phi / \partial k > \partial \theta / \partial k$. It holds that $\partial \hat{\phi} / \partial k > \partial \phi / \partial k$ and $\partial \theta / \partial k < 0$. Hence, $\partial \hat{\pi}^* / \partial k > \partial \pi^* / \partial k$. \square

The proposition shows that prominent and non-prominent software developers may be affected quite differently by piracy and software protection. A higher level of software protection is favorable for non-prominent software developers but may be to the detriment of prominent ones. In other words, while prominent firms may appreciate more piracy, non-prominent firms are indeed always hurt by piracy.

With more software protection, both types of software firms benefit from an increase in legal sales to the same extent. The difference, however, stems from the different pricing strategies by platforms toward these two groups. With more software protection, platforms increase the license fee towards both types of developers; however, the increase towards prominent developers is larger (see Proposition 3).

Now if users' fixed cost of piracy—starting from a low level—increases, the immediate positive effect with respect to sales revenues is outweighed by the relatively higher license fees which leads to a decrease in profits for established developers (Rasch and Wenzel, 2013). In this case, users rarely purchase the legal version and hence developers make only low profits from users. In order to nevertheless secure developers' platform participation, platforms compete hard to be attractive for users and therefore end up subsidizing developers. As users start to purchase legal copies due to higher costs for owning an illegal copy, the need for developer subsidization is strongly reduced because at the same time, a larger number of developers due to higher sales relaxes the competition on the user side. As a consequence, platforms have a strong incentive to cut subsidies to developers. Note that for high levels of software protection, there is less or no subsidization which weakens the above effects.

As a result, for prominent software developers, the negative effect of an increase in the license fee may not be compensated by the positive effect of higher legal sales whereas for non-prominent software developers facing lower increases in license fees, the increase in legal sales is always the dominating effect.

It is noteworthy that the effect of piracy is always relatively more positive for prominent than for non-prominent software developers (see part (iii) of Proposition 4). Even in the case where the overall effect of piracy is negative for prominent developers (that is, prominent developers benefit from more software protection), these developers are at least partially compensated by lower license fees which is less the case for non-prominent software developers. Or put in other words, non-prominent software always benefit from stricter software protection to a larger extent.

Existing studies have provided several explanations why developers of digital media products may actually benefit from piracy. For instance, it has been shown that piracy may benefit developers in the presence of network externalities (Conner and Rumelt, 1991; Shy and Thisse, 1999; Peitz, 2004), complementary products (Gayer and Shy, 2006; Dewenter et al., 2012), sampling (Peitz and Waelbroeck, 2006), or two-sided business models (Rasch and Wenzel, 2013). This paper qualifies these results. The message is that it is important to take developer heterogeneity into account as the effects of piracy are likely to be heterogeneous across developers. Hence, this paper provides an explanation why developers within an industry may have quite different stands toward software protection and piracy.

As a final point we point out that, as in Rasch and Wenzel (2013), also the impact of software protection on platform profits is ambiguous. There are two counteracting forces. Competition for users may be intensified and competition for developers relaxed and either effect can dominate.

4 Extensions

In this section, we consider two extensions to the baseline model. For tractability, in these extensions, we focus on the case $\beta = 1$, so that the only difference between prominent and non-prominent software lies in the different impact on users' adoption decisions. With $\beta = 1$, this implies $\hat{\phi} = \phi$ and $\hat{\theta} = \theta$.

4.1 Prominence

In the base model, we have assumed that there are two groups of software developers: prominent and non-prominent developers. In this section, we relax this assumption.

Suppose there are N groups of developers. Each group of developers $h = 1, \dots, N$ is characterized by ω_h which denotes the probability that software from this group is taken into account by users when making the adoption decision. Thus, ω_h serves as an indicator for the prominence of a particular piece of software. Without loss of generality, suppose $\omega_1 > \omega_2 > \dots > \omega_N$. The fraction of developers in group h is $\gamma_h \in (0, 1)$ with $\sum_h \gamma_h = 1$.¹⁷ We still assume that platforms can set a different license fee to each group.¹⁸

With h groups of developers, a user's perceived utility at the decision stage is

$$u_1 = v + \sum_h \omega_h \theta_h n_{h,1} - p_1 - \tau x$$

and

$$u_2 = v + \sum_h \omega_h \theta_h n_{h,2} - p_2 - \tau(1 - x).$$

The profits of platform i read as

$$\Pi_i = s_i p_i + \sum_h n_{h,i} l_{h,i},$$

and the profit of developer of type h on platform i is

$$\pi_h = \phi_h s_i - l_{h,i} - f.$$

As in the base model investment costs are uniformly distributed on the unit interval.

It can then be shown that the license fee group h is charged is given by

$$l_h^* = -\frac{\omega_h \theta - \phi}{4}.$$

¹⁷The base model analyzed in Section 3 is the special case with two groups ($N = 2$) where $\omega_1 = 1, \omega_2 = 0, \gamma_1 = \gamma$, and $\gamma_2 = 1 - \gamma$. Moreover, $\beta = 1$.

¹⁸We will later explore the consequences of lifting this assumption.

The license fee is the lower the more prominent a piece of software is, that is, $dl^h/d\omega^h < 0$ as platforms are competing harder to attract those developers that are important for users' adoption decisions. The profit of a developer of group h is:

$$\pi_h^* = \frac{\omega_h \theta + \phi}{4}. \quad (7)$$

The following proposition evaluates the impact of software protection on software developers' profits. Let $\tilde{k}(\omega_h) = \alpha(1 - \alpha)(3\omega_h - 2)/(2(1 - \alpha) + \omega_h(1 + 3\alpha))$.

Proposition 5. (i) A developer of type h is hurt by a higher level of software protection if $k < \tilde{k}(\omega_h)$ and benefits if $k > \tilde{k}(\omega_h)$. (ii) The higher is the level of prominence, the smaller is the parameter range where a developer benefits from increased software protection.

Proof. Ad (i): differentiating expression (7) with respect to k and solving yields the critical value $\tilde{k}(\omega_h)$. Ad (ii): by differentiation, it follows that $\partial \tilde{k}(\omega_h)/\partial \omega_h > 0$. \square

Proposition 5 demonstrates that the more prominent a firm is, the more likely it is that this developer benefits from piracy and thus favors a low level of software protection. All developers, independent of their degree of prominence, benefit from an increase in legal sales if software protection is high. However, developers are hurt by the increase in the license fees. This effect is more pronounced for more prominent than for less prominent firms. Hence, only for the most prominent firms, the increase in legal revenues is consumed by the increase in the license fee. The effect of stricter software protection becomes more and more negative the more prominent a developer is.

4.2 Uniform license fee

In the base model, we have assumed that platforms can price-discriminate between prominent and non-prominent software developers. This requires

that platforms have a good knowledge of which software products are important for users' adoption decisions. For many circumstances, this seems to be a quite reasonable assumption. In other circumstances, however, the distinction between prominent and non-prominent software products may be less obvious and price discrimination may not be feasible. In particular, price discrimination becomes less easy if there are many different groups as in the preceding section. This section discusses the impact of piracy on developers when platforms cannot set different license fees for prominent and non-prominent software developers but are required to set a uniform license fee to both types of developers.

It can be shown that the license fee for all developers is set at

$$l^* = -\frac{\gamma\theta - \phi}{4}$$

so that each developer earns profits of

$$\pi^* = \frac{\gamma\theta + \phi}{4}. \quad (8)$$

Let $\tilde{k}(\gamma) := \alpha(1 - \alpha)(3\gamma - 2)/(2(1 - \alpha) + \gamma(1 + 3\alpha))$, we obtain the following result:

Proposition 6. (i) Software developers are hurt by a higher level of software protection if $k < \tilde{k}(\gamma)$ and benefit if $k > \tilde{k}(\gamma)$. (ii) The higher is the share of prominent developers (γ), the smaller is the parameter range where a developer benefits from increased software protection.

Proof. Ad (i): differentiating expression (8) with respect to k and solving yields the critical value $\tilde{k}(\gamma)$. Ad (ii): by differentiation, it follows that $\partial\tilde{k}(\gamma)/\partial\gamma > 0$. \square

Proposition 6 shows that software developers can also be hurt by stricter software protection if software platforms are not able to set different license fees for prominent and non-prominent developers. In this case, also non-prominent developers may benefit from a lower level of software protection. They benefit from the presence of prominent developers and platforms' inability to price-discriminate.

5 Conclusion

This paper analyzes piracy in software markets that are characterized by two-sided network externalities. This issue is gaining in importance as an increasing number of software markets are organized as two-sided business models (e.g., smartphone applications, e-books), and piracy appears to be a growing concern in those markets.

This paper argues that taking firm heterogeneity into account is an important factor when evaluating the effects of software piracy in such markets. In this paper, we develop a model with imperfect consumer behavior where consumers only consider prominent software when choosing between competing platforms. We find that even though prominent pieces of software suffer from higher piracy rates, contrary to conventional wisdom, this does not necessarily mean that higher software protection benefits those firms. We show that relatively well-known products may indeed benefit from a low level of software protection whereas less known software products are hurt. The key to this result is that (i) there is tougher platform competition for prominent than for non-prominent developers and (ii) competition for prominent developers intensifies in the presence of low software protection so that license fees are reduced heavily for prominent software developers.

This paper also raises issues for further research. In this paper, we propose prominence as one potential reason why developers may have different attitudes towards piracy. On the theory side, future research could identify alternative sources of heterogeneity that might also explain the different stances towards piracy. On the empirical side, our paper invites research that assesses the effects of piracy on different firm types or different industries. It would be valuable to evaluate which type of software firm benefits/loses from piracy and how different firm characteristics affect those results since our model suggests that the effects might be heterogeneous across firms and/or industries.

References

Armstrong, M. (2006). Competition in two-sided markets. *RAND Journal of Economics*, 37:668–691.

- Armstrong, M. and Vickers, J. (2012). Consumer protection and contingent charges. *Journal of Economic Literature*, 50:477–493.
- Armstrong, M., Vickers, J., and Zhou, J. (2009). Prominence and consumer search. *RAND Journal of Economics*, 40:209–233.
- Armstrong, M. and Zhou, J. (2011). Paying for prominence. *Economic Journal*, 121(556):F368–F395.
- Bae, S. H. and Choi, J. P. (2006). A model of piracy. *Information Economics and Policy*, 18:303–320.
- Belleflamme, P. (2003). Pricing information goods in the presence of copying. In Gordon, W. and Watt, R., editors, *The Economics of Copyright: Developments in Research and Analysis*, pages 41–67. Cheltenham: Edward Elgar.
- Belleflamme, P. and Peitz, M. (2010). Platform competition and seller investment incentives. *European Economic Review*, 54:1059–1076.
- Belleflamme, P. and Peitz, M. (2012). Digital piracy: Theory. In Peitz, M. and Waldfogel, J., editors, *The Oxford Handbook of the Digital Economy*. Oxford University Press.
- Caillaud, B. and Jullien, B. (2003). Chicken & egg: competition among intermediation service providers. *RAND Journal of Economics*, 34:309–328.
- Choi, J. P. (2010). Tying in two-sided markets with multihoming. *Journal of Industrial Economics*, 58:607–626.
- Conner, K. R. and Rumelt, R. P. (1991). Software piracy: an analysis of protection strategies. *Management Science*, 37:125–139.
- Dewenter, R., Haucap, J., and Wenzel, T. (2012). On file sharing with indirect network effects between concert ticket sales and music recordings. *Journal of Media Economics*, 25:168–178.
- Gabaix, X. and Laibson, D. (2006). Shrouded attributes, consumer myopia and information suppression in competitive markets. *Quarterly Journal of Economics*, 121:505–540.
- Gayer, A. and Shy, O. (2006). Publishers, artists, and copyright enforcement. *Information Economics and Policy*, 18:374–384.

- Gu, Y. and Wenzel, T. (2013). Strategic obfuscation and consumer protection policy. Forthcoming *Journal of Industrial Economics*.
- Hagiu, A. (2006). Pricing and commitment by two-sided platforms. *RAND Journal of Economics*, 37:720–737.
- Hagiu, A. (2009). Two-sided platforms: Product variety and pricing structures. *Journal of Economics & Management Strategy*, 18:1011–1043.
- Hogendorn, C. and Yuen, K. Y. S. (2009). Platform competition with ‘must-have’ components. *Journal of Industrial Economics*, 57:294–318.
- Hotelling, H. (1929). Stability in competition. *Economic Journal*, 39:41–57.
- Huck, S. and Zhou, J. (2011). Consumer Behavioral Biases in Competition: A Survey. Unpublished working paper.
- Peitz, M. (2004). A strategic approach to software protection. *Journal of Economics & Management Strategy*, 13:371–374.
- Peitz, M. and Waelbroeck, P. (2006). Why the music industry may gain from free downloading – The role of sampling. *International Journal of Industrial Organization*, 24:907–913.
- Piccione, M. and Spiegler, R. (2009). Framing Competition. UCL-ELSE Working paper No. 336.
- Rasch, A. and Wenzel, T. (2013). Piracy in a two-sided software market. *Journal of Economic Behavior & Organization*, 88:78–89.
- Rochet, J.-C. and Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, 1:990–1029.
- Rochet, J.-C. and Tirole, J. (2006). Two-sided markets: A progress report. *RAND Journal of Economics*, 37:645–667.
- Shy, O. and Thisse, J. (1999). A strategic approach to software protection. *Journal of Economics & Management Strategy*, 8:163–190.
- Spiegler, R. (2006). Competition over agents with boundedly rational expectations. *Theoretical Economics*, 1:207–231.

Spiegler, R. (2011). *Bounded Rationality and Industrial Organisation*. Oxford University Press.

Yoon, K. (2002). The optimal level of copyright protection. *Information Economics and Policy*, 14:327–348.

PREVIOUS DISCUSSION PAPERS

- 167 Rasch, Alexander and Wenzel, Tobias, The Impact of Piracy on Prominent and Non-prominent Software Developers, November 2014.
Forthcoming in: Telecommunications Policy.
- 166 Jeitschko, Thomas D. and Tremblay, Mark J., Homogeneous Platform Competition with Endogenous Homing, November 2014.
- 165 Gu, Yiquan, Rasch, Alexander and Wenzel, Tobias, Price-sensitive Demand and Market Entry, November 2014.
- 164 Caprice, Stéphane, von Schlippenbach, Vanessa and Wey, Christian, Supplier Fixed Costs and Retail Market Monopolization, October 2014.
- 163 Klein, Gordon J. and Wendel, Julia, The Impact of Local Loop and Retail Unbundling Revisited, October 2014.
- 162 Dertwinkel-Kalt, Markus, Haucap, Justus and Wey, Christian, Raising Rivals' Costs Through Buyer Power, October 2014.
- 161 Dertwinkel-Kalt, Markus and Köhler, Katrin, Exchange Asymmetries for Bads? Experimental Evidence, October 2014.
- 160 Behrens, Kristian, Mion, Giordano, Murata, Yasusada and Suedekum, Jens, Spatial Frictions, September 2014.
- 159 Fonseca, Miguel A. and Normann, Hans-Theo, Endogenous Cartel Formation: Experimental Evidence, August 2014.
Forthcoming in: Economics Letters.
- 158 Stiebale, Joel, Cross-Border M&As and Innovative Activity of Acquiring and Target Firms, August 2014.
- 157 Haucap, Justus and Heimeshoff, Ulrich, The Happiness of Economists: Estimating the Causal Effect of Studying Economics on Subjective Well-Being, August 2014.
Forthcoming in: International Review of Economics Education.
- 156 Haucap, Justus, Heimeshoff, Ulrich and Lange, Mirjam R. J., The Impact of Tariff Diversity on Broadband Diffusion – An Empirical Analysis, August 2014.
- 155 Baumann, Florian and Friehe, Tim, On Discovery, Restricting Lawyers, and the Settlement Rate, August 2014.
- 154 Hottenrott, Hanna and Lopes-Bento, Cindy, R&D Partnerships and Innovation Performance: Can There be too Much of a Good Thing?, July 2014.
- 153 Hottenrott, Hanna and Lawson, Cornelia, Flying the Nest: How the Home Department Shapes Researchers' Career Paths, July 2014.
- 152 Hottenrott, Hanna, Lopes-Bento, Cindy and Veugelers, Reinhilde, Direct and Cross-Scheme Effects in a Research and Development Subsidy Program, July 2014.
- 151 Dewenter, Ralf and Heimeshoff, Ulrich, Do Expert Reviews Really Drive Demand? Evidence from a German Car Magazine, July 2014.

- 150 Bataille, Marc, Steinmetz, Alexander and Thorwarth, Susanne, Screening Instruments for Monitoring Market Power in Wholesale Electricity Markets – Lessons from Applications in Germany, July 2014.
Published in: Economics Letters, 125 (2014), pp.223-225.
- 149 Kholodilin, Konstantin A., Thomas, Tobias and Ulbricht, Dirk, Do Media Data Help to Predict German Industrial Production?, July 2014.
- 148 Hogrefe, Jan and Wrona, Jens, Trade, Tasks, and Trading: The Effect of Offshoring on Individual Skill Upgrading, June 2014.
- 147 Gaudin, Germain and White, Alexander, On the Antitrust Economics of the Electronic Books Industry, September 2014 (Previous Version May 2014).
- 146 Alipranti, Maria, Milliou, Chrysovalantou and Petrakis, Emmanuel, Price vs. Quantity Competition in a Vertically Related Market, May 2014.
Published in: Economics Letters, 124 (2014), pp.122-126.
- 145 Blanco, Mariana, Engelmann, Dirk, Koch, Alexander K. and Normann, Hans-Theo, Preferences and Beliefs in a Sequential Social Dilemma: A Within-Subjects Analysis, May 2014.
Published in: Games and Economic Behavior, 87 (2014), pp.122-135.
- 144 Jeitschko, Thomas D., Jung, Yeonjei and Kim, Jaesoo, Bundling and Joint Marketing by Rival Firms, May 2014.
- 143 Benndorf, Volker and Normann, Hans-Theo, The Willingness to Sell Personal Data, April 2014.
- 142 Dauth, Wolfgang and Suedekum, Jens, Globalization and Local Profiles of Economic Growth and Industrial Change, April 2014.
- 141 Nowak, Verena, Schwarz, Christian and Suedekum, Jens, Asymmetric Spiders: Supplier Heterogeneity and the Organization of Firms, April 2014.
- 140 Hasnas, Irina, A Note on Consumer Flexibility, Data Quality and Collusion, April 2014.
- 139 Baye, Irina and Hasnas, Irina, Consumer Flexibility, Data Quality and Location Choice, April 2014.
- 138 Aghadadashli, Hamid and Wey, Christian, Multi-Union Bargaining: Tariff Plurality and Tariff Competition, April 2014.
- 137 Duso, Tomaso, Herr, Annika and Suppliet, Moritz, The Welfare Impact of Parallel Imports: A Structural Approach Applied to the German Market for Oral Anti-diabetics, April 2014.
Published in: Health Economics, 23 (2014), pp. 1036-1057.
- 136 Haucap, Justus and Müller, Andrea, Why are Economists so Different? Nature, Nurture and Gender Effects in a Simple Trust Game, March 2014.
- 135 Normann, Hans-Theo and Rau, Holger A., Simultaneous and Sequential Contributions to Step-Level Public Goods: One vs. Two Provision Levels, March 2014.
Forthcoming in: Journal of Conflict Resolution.
- 134 Bucher, Monika, Hauck, Achim and Neyer, Ulrike, Frictions in the Interbank Market and Uncertain Liquidity Needs: Implications for Monetary Policy Implementation, July 2014 (First Version March 2014).

- 133 Czarnitzki, Dirk, Hall, Bronwyn, H. and Hottenrott, Hanna, Patents as Quality Signals? The Implications for Financing Constraints on R&D?, February 2014.
- 132 Dewenter, Ralf and Heimeshoff, Ulrich, Media Bias and Advertising: Evidence from a German Car Magazine, February 2014.
Published in: Review of Economics, 65 (2014), pp. 77-94.
- 131 Baye, Irina and Sapi, Geza, Targeted Pricing, Consumer Myopia and Investment in Customer-Tracking Technology, February 2014.
- 130 Clemens, Georg and Rau, Holger A., Do Leniency Policies Facilitate Collusion? Experimental Evidence, January 2014.
- 129 Hottenrott, Hanna and Lawson, Cornelia, Fishing for Complementarities: Competitive Research Funding and Research Productivity, December 2013.
- 128 Hottenrott, Hanna and Rexhäuser, Sascha, Policy-Induced Environmental Technology and Inventive Efforts: Is There a Crowding Out?, December 2013.
- 127 Dauth, Wolfgang, Findeisen, Sebastian and Suedekum, Jens, The Rise of the East and the Far East: German Labor Markets and Trade Integration, December 2013.
Forthcoming in: Journal of European Economic Association.
- 126 Wenzel, Tobias, Consumer Myopia, Competition and the Incentives to Unshroud Add-on Information, December 2013.
Published in: Journal of Economic Behavior and Organization, 98 (2014), pp. 89-96.
- 125 Schwarz, Christian and Suedekum, Jens, Global Sourcing of Complex Production Processes, December 2013.
Published in: Journal of International Economics, 93 (2014), pp. 123-139.
- 124 Defever, Fabrice and Suedekum, Jens, Financial Liberalization and the Relationship-Specificity of Exports, December 2013.
Published in: Economics Letters, 122 (2014), pp. 375-379.
- 123 Bauernschuster, Stefan, Falck, Oliver, Heblich, Stephan and Suedekum, Jens, Why Are Educated and Risk-Loving Persons More Mobile Across Regions?, December 2013.
Published in: Journal of Economic Behavior and Organization, 98 (2014), pp. 56-69.
- 122 Hottenrott, Hanna and Lopes-Bento, Cindy, Quantity or Quality? Knowledge Alliances and their Effects on Patenting, December 2013.
Forthcoming in: Industrial and Corporate Change.
- 121 Hottenrott, Hanna and Lopes-Bento, Cindy, (International) R&D Collaboration and SMEs: The Effectiveness of Targeted Public R&D Support Schemes, December 2013.
Published in: Research Policy, 43 (2014), pp.1055-1066.
- 120 Giesen, Kristian and Suedekum, Jens, City Age and City Size, November 2013.
Published in: European Economic Review, 71 (2014), pp. 193-208.
- 119 Trax, Michaela, Brunow, Stephan and Suedekum, Jens, Cultural Diversity and Plant-Level Productivity, November 2013.
- 118 Manasakis, Constantine and Vlassis, Minas, Downstream Mode of Competition With Upstream Market Power, November 2013.
Published in: Research in Economics, 68 (2014), pp. 84-93.

- 117 Sapi, Geza and Suleymanova, Irina, Consumer Flexibility, Data Quality and Targeted Pricing, November 2013.
- 116 Hinloopen, Jeroen, Müller, Wieland and Normann, Hans-Theo, Output Commitment Through Product Bundling: Experimental Evidence, November 2013.
Published in: *European Economic Review*, 65 (2014), pp. 164-180.
- 115 Baumann, Florian, Denter, Philipp and Friehe Tim, Hide or Show? Endogenous Observability of Private Precautions Against Crime When Property Value is Private Information, November 2013.
- 114 Fan, Ying, Kühn, Kai-Uwe and Lafontaine, Francine, Financial Constraints and Moral Hazard: The Case of Franchising, November 2013.
- 113 Aguzzoni, Luca, Argentesi, Elena, Buccirosi, Paolo, Ciari, Lorenzo, Duso, Tomaso, Tognoni, Massimo and Vitale, Cristiana, They Played the Merger Game: A Retrospective Analysis in the UK Videogames Market, October 2013.
Forthcoming in: *Journal of Competition Law and Economics* under the title: "A Retrospective Merger Analysis in the UK Videogame Market".
- 112 Myrseth, Kristian Ove R., Riener, Gerhard and Wollbrant, Conny, Tangible Temptation in the Social Dilemma: Cash, Cooperation, and Self-Control, October 2013.
- 111 Hasnas, Irina, Lambertini, Luca and Palestini, Arsen, Open Innovation in a Dynamic Cournot Duopoly, October 2013.
Published in: *Economic Modelling*, 36 (2014), pp. 79-87.
- 110 Baumann, Florian and Friehe, Tim, Competitive Pressure and Corporate Crime, September 2013.
- 109 Böckers, Veit, Haucap, Justus and Heimeshoff, Ulrich, Benefits of an Integrated European Electricity Market, September 2013.
- 108 Normann, Hans-Theo and Tan, Elaine S., Effects of Different Cartel Policies: Evidence from the German Power-Cable Industry, September 2013.
Published in: *Industrial and Corporate Change*, 23 (2014), pp.1037-1057.
- 107 Haucap, Justus, Heimeshoff, Ulrich, Klein, Gordon J., Rickert, Dennis and Wey, Christian, Bargaining Power in Manufacturer-Retailer Relationships, September 2013.
- 106 Baumann, Florian and Friehe, Tim, Design Standards and Technology Adoption: Welfare Effects of Increasing Environmental Fines when the Number of Firms is Endogenous, September 2013.
- 105 Jeitschko, Thomas D., NYSE Changing Hands: Antitrust and Attempted Acquisitions of an Erstwhile Monopoly, August 2013.
Published in: *Journal of Stock and Forex Trading*, 2 (2) (2013), pp. 1-6.
- 104 Böckers, Veit, Giessing, Leonie and Rösch, Jürgen, The Green Game Changer: An Empirical Assessment of the Effects of Wind and Solar Power on the Merit Order, August 2013.
- 103 Haucap, Justus and Muck, Johannes, What Drives the Relevance and Reputation of Economics Journals? An Update from a Survey among Economists, August 2013.
- 102 Jovanovic, Dragan and Wey, Christian, Passive Partial Ownership, Sneaky Takeovers, and Merger Control, August 2013.
Published in: *Economics Letters*, 125 (2014), pp. 32-35.

- 101 Haucap, Justus, Heimeshoff, Ulrich, Klein, Gordon J., Rickert, Dennis and Wey, Christian, Inter-Format Competition Among Retailers – The Role of Private Label Products in Market Delineation, August 2013.
- 100 Normann, Hans-Theo, Requate, Till and Waichman, Israel, Do Short-Term Laboratory Experiments Provide Valid Descriptions of Long-Term Economic Interactions? A Study of Cournot Markets, July 2013.
Published in: *Experimental Economics*, 17 (2014), pp. 371-390.
- 99 Dertwinkel-Kalt, Markus, Haucap, Justus and Wey, Christian, Input Price Discrimination (Bans), Entry and Welfare, June 2013.
- 98 Aguzzoni, Luca, Argentesi, Elena, Ciari, Lorenzo, Duso, Tomaso and Tognoni, Massimo, Ex-post Merger Evaluation in the UK Retail Market for Books, June 2013.
Forthcoming in: *Journal of Industrial Economics*.
- 97 Caprice, Stéphane and von Schlippenbach, Vanessa, One-Stop Shopping as a Cause of Slotting Fees: A Rent-Shifting Mechanism, May 2012.
Published in: *Journal of Economics and Management Strategy*, 22 (2013), pp. 468-487.
- 96 Wenzel, Tobias, Independent Service Operators in ATM Markets, June 2013.
Published in: *Scottish Journal of Political Economy*, 61 (2014), pp. 26-47.
- 95 Coublucq, Daniel, Econometric Analysis of Productivity with Measurement Error: Empirical Application to the US Railroad Industry, June 2013.
- 94 Coublucq, Daniel, Demand Estimation with Selection Bias: A Dynamic Game Approach with an Application to the US Railroad Industry, June 2013.
- 93 Baumann, Florian and Friehe, Tim, Status Concerns as a Motive for Crime?, April 2013.
- 92 Jeitschko, Thomas D. and Zhang, Nanyun, Adverse Effects of Patent Pooling on Product Development and Commercialization, April 2013.
Published in: *The B. E. Journal of Theoretical Economics*, 14 (1) (2014), Art. No. 2013-0038.
- 91 Baumann, Florian and Friehe, Tim, Private Protection Against Crime when Property Value is Private Information, April 2013.
Published in: *International Review of Law and Economics*, 35 (2013), pp. 73-79.
- 90 Baumann, Florian and Friehe, Tim, Cheap Talk About the Detection Probability, April 2013.
Published in: *International Game Theory Review*, 15 (2013), Art. No. 1350003.
- 89 Pagel, Beatrice and Wey, Christian, How to Counter Union Power? Equilibrium Mergers in International Oligopoly, April 2013.
- 88 Jovanovic, Dragan, Mergers, Managerial Incentives, and Efficiencies, April 2014 (First Version April 2013).
- 87 Heimeshoff, Ulrich and Klein Gordon J., Bargaining Power and Local Heroes, March 2013.
- 86 Bertschek, Irene, Cerquera, Daniel and Klein, Gordon J., More Bits – More Bucks? Measuring the Impact of Broadband Internet on Firm Performance, February 2013.
Published in: *Information Economics and Policy*, 25 (2013), pp. 190-203.
- 85 Rasch, Alexander and Wenzel, Tobias, Piracy in a Two-Sided Software Market, February 2013.
Published in: *Journal of Economic Behavior & Organization*, 88 (2013), pp. 78-89.

- 84 Bataille, Marc and Steinmetz, Alexander, Intermodal Competition on Some Routes in Transportation Networks: The Case of Inter Urban Buses and Railways, January 2013.
- 83 Haucap, Justus and Heimeshoff, Ulrich, Google, Facebook, Amazon, eBay: Is the Internet Driving Competition or Market Monopolization?, January 2013.
Published in: International Economics and Economic Policy, 11 (2014), pp. 49-61.
- 82 Regner, Tobias and Riener, Gerhard, Voluntary Payments, Privacy and Social Pressure on the Internet: A Natural Field Experiment, December 2012.
- 81 Dertwinkel-Kalt, Markus and Wey, Christian, The Effects of Remedies on Merger Activity in Oligopoly, December 2012.
- 80 Baumann, Florian and Friehe, Tim, Optimal Damages Multipliers in Oligopolistic Markets, December 2012.
- 79 Duso, Tomaso, Röller, Lars-Hendrik and Seldeslachts, Jo, Collusion through Joint R&D: An Empirical Assessment, December 2012.
Published in: The Review of Economics and Statistics, 96 (2014), pp.349-370.
- 78 Baumann, Florian and Heine, Klaus, Innovation, Tort Law, and Competition, December 2012.
Published in: Journal of Institutional and Theoretical Economics, 169 (2013), pp. 703-719.
- 77 Coenen, Michael and Jovanovic, Dragan, Investment Behavior in a Constrained Dictator Game, November 2012.
- 76 Gu, Yiquan and Wenzel, Tobias, Strategic Obfuscation and Consumer Protection Policy in Financial Markets: Theory and Experimental Evidence, November 2012.
Forthcoming in: Journal of Industrial Economics under the title "Strategic Obfuscation and Consumer Protection Policy".
- 75 Haucap, Justus, Heimeshoff, Ulrich and Jovanovic, Dragan, Competition in Germany's Minute Reserve Power Market: An Econometric Analysis, November 2012.
Published in: The Energy Journal, 35 (2014), pp. 139-158.
- 74 Normann, Hans-Theo, Rösch, Jürgen and Schultz, Luis Manuel, Do Buyer Groups Facilitate Collusion?, November 2014 (First Version November 2012).
Forthcoming in: Journal of Economic Behavior and Organization.
- 73 Riener, Gerhard and Wiederhold, Simon, Heterogeneous Treatment Effects in Groups, November 2012.
Published in: Economics Letters, 120 (2013), pp 408-412.
- 72 Berlemann, Michael and Haucap, Justus, Which Factors Drive the Decision to Boycott and Opt Out of Research Rankings? A Note, November 2012.
- 71 Muck, Johannes and Heimeshoff, Ulrich, First Mover Advantages in Mobile Telecommunications: Evidence from OECD Countries, October 2012.
- 70 Karaçuka, Mehmet, Çatik, A. Nazif and Haucap, Justus, Consumer Choice and Local Network Effects in Mobile Telecommunications in Turkey, October 2012.
Published in: Telecommunications Policy, 37 (2013), pp. 334-344.
- 69 Clemens, Georg and Rau, Holger A., Rebels without a Clue? Experimental Evidence on Partial Cartels, April 2013 (First Version October 2012).
- 68 Regner, Tobias and Riener, Gerhard, Motivational Cherry Picking, September 2012.

- 67 Fonseca, Miguel A. and Normann, Hans-Theo, Excess Capacity and Pricing in Bertrand-Edgeworth Markets: Experimental Evidence, September 2012.
Published in: Journal of Institutional and Theoretical Economics, 169 (2013), pp. 199-228.
- 66 Riener, Gerhard and Wiederhold, Simon, Team Building and Hidden Costs of Control, September 2012.
- 65 Fonseca, Miguel A. and Normann, Hans-Theo, Explicit vs. Tacit Collusion – The Impact of Communication in Oligopoly Experiments, August 2012.
Published in: European Economic Review, 56 (2012), pp. 1759-1772.
- 64 Jovanovic, Dragan and Wey, Christian, An Equilibrium Analysis of Efficiency Gains from Mergers, July 2012.
- 63 Dewenter, Ralf, Jaschinski, Thomas and Kuchinke, Björn A., Hospital Market Concentration and Discrimination of Patients, July 2012 .
Published in: Schmollers Jahrbuch, 133 (2013), pp. 345-374.
- 62 Von Schlippenbach, Vanessa and Teichmann, Isabel, The Strategic Use of Private Quality Standards in Food Supply Chains, May 2012.
Published in: American Journal of Agricultural Economics, 94 (2012), pp. 1189-1201.
- 61 Sapi, Geza, Bargaining, Vertical Mergers and Entry, July 2012.
- 60 Jentzsch, Nicola, Sapi, Geza and Suleymanova, Irina, Targeted Pricing and Customer Data Sharing Among Rivals, July 2012.
Published in: International Journal of Industrial Organization, 31 (2013), pp. 131-144.
- 59 Lambarraa, Fatima and Riener, Gerhard, On the Norms of Charitable Giving in Islam: A Field Experiment, June 2012.
- 58 Duso, Tomaso, Gugler, Klaus and Szücs, Florian, An Empirical Assessment of the 2004 EU Merger Policy Reform, June 2012.
Published in: Economic Journal, 123 (2013), F596-F619.
- 57 Dewenter, Ralf and Heimeshoff, Ulrich, More Ads, More Revs? Is there a Media Bias in the Likelihood to be Reviewed?, June 2012.
Published in: Economic Modelling, 44 (2014), pp. 156-161.
- 56 Böckers, Veit, Heimeshoff, Ulrich and Müller Andrea, Pull-Forward Effects in the German Car Scrappage Scheme: A Time Series Approach, June 2012.
- 55 Kellner, Christian and Riener, Gerhard, The Effect of Ambiguity Aversion on Reward Scheme Choice, June 2012.
Published in: Economics Letters, 125 (2014), pp. 134-137.
- 54 De Silva, Dakshina G., Kosmopoulou, Georgia, Pagel, Beatrice and Peeters, Ronald, The Impact of Timing on Bidding Behavior in Procurement Auctions of Contracts with Private Costs, June 2012.
Published in: Review of Industrial Organization, 41 (2013), pp.321-343.
- 53 Benndorf, Volker and Rau, Holger A., Competition in the Workplace: An Experimental Investigation, May 2012.
- 52 Haucap, Justus and Klein, Gordon J., How Regulation Affects Network and Service Quality in Related Markets, May 2012.
Published in: Economics Letters, 117 (2012), pp. 521-524.
- 51 Dewenter, Ralf and Heimeshoff, Ulrich, Less Pain at the Pump? The Effects of Regulatory Interventions in Retail Gasoline Markets, May 2012.

- 50 Böckers, Veit and Heimeshoff, Ulrich, The Extent of European Power Markets, April 2012.
Published in: Energy Economics, 46 (2014), pp. 102-111.
- 49 Barth, Anne-Kathrin and Heimeshoff, Ulrich, How Large is the Magnitude of Fixed-Mobile Call Substitution? - Empirical Evidence from 16 European Countries, April 2012.
Published in: Telecommunications Policy, 38 (2014), pp. 771-782.
- 48 Herr, Annika and Suppliet, Moritz, Pharmaceutical Prices under Regulation: Tiered Co-payments and Reference Pricing in Germany, April 2012.
- 47 Haucap, Justus and Müller, Hans Christian, The Effects of Gasoline Price Regulations: Experimental Evidence, April 2012.
- 46 Stühmeier, Torben, Roaming and Investments in the Mobile Internet Market, March 2012.
Published in: Telecommunications Policy, 36 (2012), pp. 595-607.
- 45 Graf, Julia, The Effects of Rebate Contracts on the Health Care System, March 2012,
Published in: The European Journal of Health Economics, 15 (2014), pp.477-487.
- 44 Pagel, Beatrice and Wey, Christian, Unionization Structures in International Oligopoly, February 2012.
Published in: Labour: Review of Labour Economics and Industrial Relations, 27 (2013), pp. 1-17.
- 43 Gu, Yiquan and Wenzel, Tobias, Price-Dependent Demand in Spatial Models, January 2012.
Published in: B. E. Journal of Economic Analysis & Policy, 12 (2012), Article 6.
- 42 Barth, Anne-Kathrin and Heimeshoff, Ulrich, Does the Growth of Mobile Markets Cause the Demise of Fixed Networks? – Evidence from the European Union, January 2012.
Forthcoming in: Telecommunications Policy.
- 41 Stühmeier, Torben and Wenzel, Tobias, Regulating Advertising in the Presence of Public Service Broadcasting, January 2012.
Published in: Review of Network Economics, 11/2 (2012), Article 1.

Older discussion papers can be found online at:

<http://ideas.repec.org/s/zbw/dicedp.html>

Heinrich-Heine-University of Düsseldorf

**Düsseldorf Institute for
Competition Economics (DICE)**

Universitätsstraße 1_ 40225 Düsseldorf
www.dice.hhu.de