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An Empirical Analysis of Tying and Users' Choice

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Abstract: Tying results in efficiencies that benefit consumers, though it could be used for anticompetitive purposes. The welfare implications of tying are theoretically ambiguous, so further theoretical and empirical studies are expected to provide some guides for policymakers. This paper focuses on the tying Internet Explorer (IE) with Windows by Microsoft. I examine users' choice of browser empirically and evaluate the effects of tying on competition in the Japanese browser market. Estimation results imply that other browsers could compete with IE by improving their quality, though tying increases choice probabilities of IE.

JEL code: C25,D12, L42, L86
Key words: Tying, Competition policy, User survey, Discrete choice model

1. Introduction

With tying, a firm only sells product A with the purchase of product B. Bundling is similar to tying, but in a bundle a firm sells A and B together and sells them separately as well. So many theoretical literatures have explained both of efficient and anticompetitive aspects of tying and bundling. The explanations of their efficiency include price discrimination, an improvement of quality, a reduction of production / distribution costs and so on. On the other hand, the anticompetitive role of tying has been rationalized by the leverage theory historically. According to the leverage theory, tying by firms which have monopoly power in the tying goods market can foreclose entry of firms in the tied goods market. However it was criticized by the Chicago School. The Chicago School argued that the abuse of monopoly power is not the reason for vertical restraints. Winston (1990) asserts that tying can be profitable for a monopolist under different conditions from the Chicago School argument. Afterward, many literatures

such as Carlton and Waldman (2002), Nalebuff (2004), Choi (2004), Carlton and Waldman (2005) and Rochet and Tirole (2008) demonstrate theoretical developments in this research field. Choi (2007) reviews those recent literatures.

Because the welfare implications are theoretically ambiguous, the empirical studies are expected to be so useful for informing theory and providing guidance for antitrust authority. However, the empirical studies on tying are very few, as pointed out by Lafontaine and Slade (2008) which surveys the empirical methods and findings on vertical restraints including tying. Haas-Wilson (1987) investigates the price and quality effects of tying the sales of contact lenses to the service of ophthalmologists and optometrists. Hanssen (2000) finds that the block booking in film industry was intended to cheaply provide films in quantity. Evans and Salinger (2008) models competitive bundling and tying, and analyzes empirically the bundling of pain relievers with decongestants. And Cooper et. (2005) concludes that there is a paucity of support for the proposition that vertical restraints are likely harm consumers, reviewing over twenty empirical studies on vertical restraints. Lafontaine and Slade (2008) asserts that further empirical works in this area should be encouraged.

For these fifteen years, tying issues have been front and center in antitrust lawsuits. In the Department of Justice case against Microsoft, one of the central issues was whether Microsoft's inclusion of IE in the Windows operating system was an illegal tie, preventing personal computer manufacturers and consumers from choosing Netscape Navigator. European Commission investigated that Microsoft infringed EC Treaty rules on abuse of a dominant position by tying Windows Media Player or IE with Windows. A few decades ago, legal opinion was almost uniformly hostile to all vertical restraints including tying. Though tying could be used for anticompetitive purposes, tying sometimes benefits consumers through lower prices or rapid innovation. Today, the courts are inclined to rule of reason approach for tying. The challenge lies in achieving a balance between the efficiency gains and the anticompetitive losses. Evans (2006) asserts that the only way to distinguish efficient tying and anticompetitive one is to evaluate each case under rule of reason. Policymakers and analysts must know whether tying is likely to harm consumers more than they benefit competition. Further economic theoretical literature and empirical studies could offer some guidance for antitrust authorities to assess tying arrangement in practice.

The purpose of this paper is to investigate empirically the effects of tying on users' choice of browser and discuss about the competition in the Japanese browser market to give competition policy implications. The remainder of the paper is organized as follows. Section 2 presents the overview of the Japanese browser market. Section 3

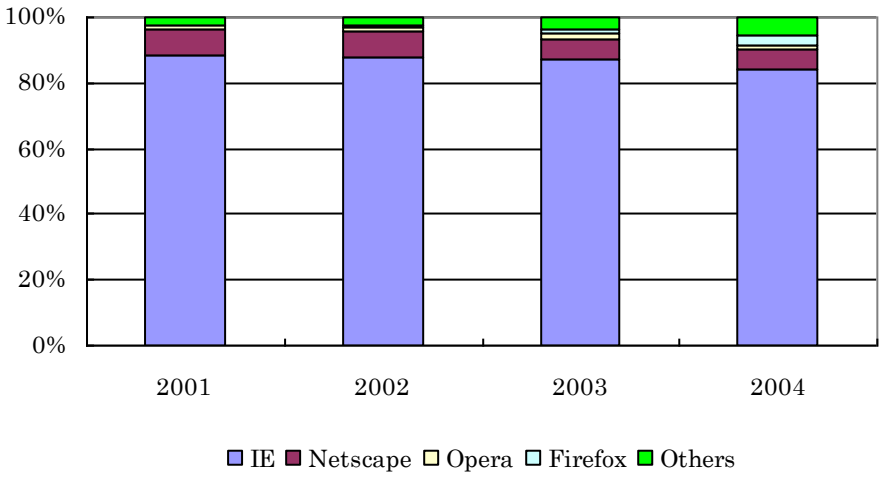
explains some important factors which would have effects on users' choice of browser. Section 4 shows the result of user survey. Section 5 explains econometric model and data, and shows the results. Section 6 concludes.

2. Overview of the Japanese Browser Market

Communications Usage Trend Survey of Ministry of Internal Affairs and Communications shows that the population penetration rate of internet in Japan is increasing up to 75.3% in 2008. Browser is a software product to access and interact with web contents hosted on servers which are connected to the internet. We need to install the browser on a PC for using internet. The development of new online services makes the browser an increasingly important software for businesses and consumers. Browsers are developed and manufactured by several companies.

I obtain the market share of browsers for Windows in Japan, calculating the individual usage data of browsers from our user survey. Figure 1 shows the results. IE's share declines slightly year by year, but keeps more than 80% throughout from 2001 to 2004, followed by other three major browsers, Netscape Navigator (released by Netscape Communications), Opera (Opera Software) and Firefox[1](Mozilla Foundation) . All those three browsers have a very small market share. That implies that IE kept a dominant position at that time in Japan.

Figure 1 Market Share of Browsers in Japan



[1] Firefox was released to the public in September 2002. The first stable release of Firefox was available in November 2004.

3. Factors which have effects on users' choice of browser

On conducting a user survey and an econometric analysis, I describe some important factors which would have effects on users' choice of browser.

First of all, I consider tying IE to Windows which is the crucial issue in this paper. When we use internet, we need both of OS and a browser installed on a PC. Most consumers purchase a PC on which OS and some software have already been pre-installed from a PC manufacturer. According to our user survey, 79.1% of Windows XP users acquire Windows XP pre-installed on a PC. It is important to ensure consumer choice through the computer manufacture channel. And more than 40% of Windows users upgrade it at the same time of a purchase of a new PC. If software is pre-installed on a PC, users can save a time and labor of installing or downloading it by themselves and avoid a risk of getting PC unstable by self-installing. When Windows is pre-installed on a PC, IE which is tied to Windows is also pre-installed. If the pre-installation is beneficial for users, they would choose a pre-installed browser on a PC among browsers. Competing browsers may therefore be set at a disadvantage which is not related to their quality. In this paper, I consider that tying affects users' choice most in the form of the pre-installation on a PC with Windows through the computer manufacturer channel.

Windows has a dominant position in the Japanese OS market. Tanaka et. (2005) shows that Windows has monopoly power for the reason of network effects in the Japanese OS market. So, from the viewpoint of competition policy, whether Microsoft may abuse its dominant position in the OS market by harming competition in the browser market through the tying of IE with Windows should be discussed. I investigate whether IE could prevent users from choosing other browsers due to an advantage of the pre-installation on a PC with Windows.

Focusing on the effects of the pre-installation to analyze the effects of the tying has some problems. Pre-installation is possible through not only tying but also other strategies. Any other browser vendors could make its own browser pre-installed on a PC, by making contracts with PC manufacturers. In fact, we could see other browsers which are pre-installed on a PC only in a few cases. So the effects of pre-installation may include those of such strategies. Furthermore, Microsoft sells Windows not only to PC manufactures but also directly to end users. When end users install Windows package to their own PC by themselves, IE is also installed together because of tying. That would affect users' browser choice, too. But in this paper such effects are not examined.

In addition to tying arrangement, network effects which work in the browser

market are considered to affect users' choice of browser. IE has partly its own specifications, not following open standard of web specification. It means that IE is not always compatible with browsers which are based on open internet standards. IE is a dominant in the browser market, so the content providers and software developers have incentives to design websites or software primarily for IE. However, the web contents which are designed for IE are not perfectly browsed through other browsers. Users prefer browsers in which web pages are browsed without troubles. The more web pages are designed for IE, the more users choose IE as their browser. That means that the indirect network effects could work in the browser market.

Furthermore, switching costs would be a factor which has an effect on users' choice of browser, too. Once users use the specific browser, they are locked in and switching costs would prevent them from switching it to another browser. When users switch the browser, they need to install new browser software, learn how to operate new one, and face the risk that the installation of new browser makes their PC unstable. Such switching costs are considered to make an influence to users' choice behavior.

We conducted questionnaire survey to users to investigate how those factors work on users' choice.

4. Questionnaire Survey to users

We conducted a single-choice questionnaire survey[2] in Jan. and Feb. 2005 to 2571 browser users who registered as a monitor of a web research firm, My Voice com. We showed them five candidates of the reason why he/she chose the current browser. Five candidates are as follows.

[1] It has a good quality
[2] It is pre-installed on a PC
[3] Many web pages are designed for it
[4] He/she is familiar with its operation
[5] Others

We employ choice [2] which implies the effect of tying, as mentioned above. choice [3] is a network effects factor. And choice [4] is a switching costs factor.

Table 1 shows the results. 79.2% of Firefox users and 66.7% of Opera users choose choice [1]. These two browsers are chosen because of their good qualities. On the

[2] The questionnaire of user survey was made up with Tatsuo Tanaka (Keio University) and Yoshihito Yasaki (Kogakuin University).

other hand, only 9.6% of IE users choose choice [1]. For IE users, the most important reason for choice is choice [2]. 49.8% of IE users choose it. It implies that the pre-installation affects IE users' choice so much as we expected. As for network effects, IE users seem to gain benefits from network effects, but only 12.3% of IE users choose choice [3]. Network effects do not work so much in the market. And regarding choice [4], a switching cost factor, 26.5% of IE users, 19.3% of Netscape users, 12.4% of Opera users and 7.8% of Firefox users choose it. Switching costs are recognized by users of any browser to some extent.

For the next step, I estimate the effects of those factors quantitatively by using a discrete choice model.

Table 1 Results of User Survey

Choices of reason	IE	Netscape	Opera	Firefox
It has a good quality	9.6	35.5	66.7	79.2
It is pre-installed on a PC	49.8	24.4	3.8	6.5
Many web pages are designed for it	12.3	4.8	4.8	0.0
He/she is familiar with its operation	26.5	19.3	12.4	7.8
Others	1.8	16.0	12.4	6.5

(unit=%)

5. Discrete Choice Model Analysis

5.1 Model and Data

I employ conditional logit model using micro data (see MacFadden (1974), Amemiya (1985)). When the representative utility for alternative j of decision maker i is v_{ij}, v_{ij} can be written as

$$v_{ij} = \beta X_{ij} + \delta_j S_i + \varepsilon_{ij},$$

where X_{ij} represents characteristic variables of alternative j, S_i is a attribute of the decision maker i, β and δ_j denote parameters vector and ε_{ij} captures the factors that affect utility but are unobserved. When choice probability of alternative j of decision maker i is P_{ij}, P_{ij} is given by

$$P_{ij} = \Pr(v_{ij} > v_{ik}).$$

By assuming that each ε_{ij} is independently, identically distributed extreme value, P_{ij} is

written as

$$P_{ij} = \frac{\exp(v_{ij})}{\sum_{k=1}^{J} \exp(v_{ik})}.$$

Conditional logit model exhibits IIA (Independence from irrelevant alternatives). A test of IIA is conducted in the way that the parameter estimates obtained on the subset of alternatives are not significantly different from those obtained on the full set of alternatives (Hausman Test).

I use an individual data set from our user survey. Details about variables used for estimations are as follows.

-Choice: Major four browsers for choices which Windows users could choose as of 2004, IE, Netscape, Opera, Firefox. I do not make a distinction of their versions.

-PREINSTALL: When the browser is pre-installed on a PC, dummy takes the value 1. If not, dummy takes the value 0. I expect the coefficient of PREINSTALL would be positive, because users seem to choose the browser which is pre-installed on a PC.

-PREVIOUSYEAR: When the browser is the same as one that users used in the previous year, 2003, dummy takes the value 1. If not, dummy takes the value 0. This variable represents the factor of switching cost. I expect the coefficient of PREVIOURYEAR would be positive, because users tend to choose the browser which users used in the previous year.

-OFFICE: When the browser is the same as one in user's office (or school), dummy takes the value 1. If not, dummy takes the value 0. This represents the factor of switching cost, too. I expect the coefficient of OFFICE would be positive, because users tend to choose the browser which is the same as in their office or school.

-WP_FREQUENCY: Users' evaluation of how frequently they meet web pages which they could not browse through each browser is used. Seven-step evaluation is employed. Users choose one for each browser from seven alternatives as follows.
1=never, 2=about once in a year, 3=about once in half a year, 4=about once every three months, 5=about once a month, 6=about once a week, 7=about once every two or three days.

-WP_RATE: A rate of web pages which users can browse through each browser is used. Users choose one for each browser from eleven alternatives as follows.
90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100 (unit= %).

-QUALITY: Users' evaluation of the total qualities of each browser when the perfect score of the best browser is a hundred is used. Users choose one for each browser from eleven candidates as follows.
0, 10, 20, 30, 40, 50, 60, 70, 80, 90,100 (unit= point).

-FEATURE: A variety of features is one of the most important qualities of the browser at that time. Users' evaluation of the variety of features of each browser when the score of the best browser is a hundred is used. Users choose one for each browser from eleven candidates as follows.
0, 10, 20, 30, 40, 50, 60, 70, 80, 90,100 (unit= point).

-STABILITY: Stability is one of the most important qualities of the browser at that time. Users' evaluation of stability of each browser when the score of the best browser is a hundred is used. Users choose one for each browser from eleven candidates as follows.
0, 10, 20, 30, 40, 50, 60, 70, 80, 90,100 (unit= point).

-LIGHTNESS: Lightness of operation is one of the most important qualities of the browser at that time. Users' evaluation of lightness of operation of each browser when the score of the best browser is a hundred is used. Users choose one for each browser eleven candidates as follows.
0, 10, 20, 30, 40, 50, 60, 70, 80, 90,100 (unit= point).

Above-mentioned explanatory valuables are all X_{ij} which represents characteristic variables of alternative j. I also employ another valuable as S_i which is an attribute of the decision maker i as follows.

-INTERNET: Users' average usage time per day of the internet is used. Users choose one from eight alternatives as follows.
1 = less than 30 minutes, 2 = more than 30min. less than 1 hour, 3 = more than 1h. less than 1h.30min., 4 = more than 1h.30min. less than 2h., 5 = more than 2h. less than 3h., 6 = more than 3h. less than 4h., 7 = more than 4h. less than 5h., 8 = more than 5h.

Variables of price are not included, because browsers are usually supplied free of charge. Table 2 shows the descriptive statistics of variables.

5.2 Estimation Results

Table 3 shows the results of estimation. I estimate 4 models according to the

combination of explanatory variables. WP_FREQUENCY for Model 1 and 3 and WP_RATE for Model 2 and 4 are employed as variables which represent network effects. QUALITY for Model 1 and 2 and FEATURE, STABILITY and LIGHTNESS for Model 3 and 4 are used as variables which represent evaluations of quality.

The coefficient of PREINSTALL is positive significantly in all models as I expected. That implies that users tend to choose the browser which is pre-installed on a PC. The coefficients of PREVIOUSYEAR and OFFICE are positive significantly in all models as I expected. Those results imply that users tend to choose the same browser as one which he/she used in the previous year or in the office (or school).

On the other hand, the coefficients of WP_FREQUENCY and WP_RATE are not significant in all models. Network effects in the browser market do not seem to work so much, because the incompatibility between IE and other browsers is not so serious. This estimation result is consistent with the result of user survey (Table 1).

The coefficients of valuables regarding quality are positive significantly in all models as I expected. It implies that the higher the quality is, the higher its choice provability is.

It is obvious that some factors affect users' choice of browser. In the next step, I discuss to what extent those factors influence competition in the browser market.

Marginal effects mean the degree in which the change of the valuable affects on the choice provability of the alternative. Marginal effects of Model 1 (Table 4) show that when IE is pre-installed on a PC, the choice provability of IE increases by 1.87%, and that of Firefox decreases by 0.735%. If QUALITY point of Firefox increases by 20 points due to innovation, the choice provability of Firefox increases by 2.3%[3] and that of IE decreases by 1.72%. That means that even if tying IE to Windows raises the choice provability of IE, Firefox can take back market share by improving its quality. As shown in Table 2, the average point of QUALITY of IE is 78.4 points, and that of Firefox is 58.4 points. It is possible that Firefox improves its total quality by 20 points and catch up IE. I obtain the almost same results about Model 3 as Model 1. Marginal effects of Model 3 (Table5) show that when IE is pre-installed on a PC, the choice provability of IE increases by 1.89%, and that of Firefox decreases by 0.752%. If Firefox improves FEATURE by 15 points, STABILITY by 10 points and LIGHTNESS by 5 points, the choice provability of Firefox increases by 1.52% and that of IE decreases by 1.14%. That also means that even if tying raises the choice provability of IE, Firefox can compete through the quality improvement. The results of Model 2 and 4 also show that innovation makes it possible that other browsers could compete with IE which has an

[3] $0.00115 \times 20 = 0.023$

advantage of the pre-installation.

On the other hand, the effects of switching factors are rather large. In the case of Model 1, to overturn the effects of PREVIOUSYEAR and OFFICE, 40 points and 14 points for each, totally 54 points improvement of the quality is necessary. Model 2, 3 and 4 have almost same results. As shown in Table 2, the average point of QUARITY of all four browsers is 65.3 points. Is such a big improvement of quality possible? According to our user survey, 57.7% of IE6 users and 54.6% of Netscape7 recognize that current version of each browser is more than 1.2 times better than each previous version. To foresee the frontier of technology is very difficult, which is common to the market in which innovation plays an important role. So it is impossible to deny such a big improvement. And switching costs like a time and labor to install software on a PC is expected to become lower, as users' computer literacy advances.

As regards marginal effects of INTERNET in Model 1 (Table 4), the longer users use internet, the more they choose Firefox. It might be possible to interpret that users who have higher computer literacy tend to evaluate Firefox.

In summary, the use of IE is promoted through tying. However, it is impossible to conclude that tying prevents users from choosing other browsers and harms competition in the Japanese browser market, because other browsers could compete with IE by improving their quality.

The market research of ASCII Media Works in September 2008 shows that IE has a market share of only 66.3% in the Japanese browser market followed by Firebox (23.2%), Sleipnir (5.3%) and Opera (1.8%). Firefox increases its market share and obtains the highest evaluation from users. That implies that an innovative browser like Firefox could compete with IE. It is consistent with the results of this paper.

6. Conclusions

Welfare implications of tying are theoretically ambiguous, so competition policy authorities should distinguish an efficient tying and anticompetitive one case by case. To help it, more empirical studies are expected to be conducted, but they are not enough so far.

Focusing on the case of tying IE with Windows by Microsoft, this paper examines empirically whether tying influences users' choice of browser and competition in the Japanese browser market. The results show that the pre-installation of IE with Windows which is considered to represent tying effects increase significantly choice probabilities of IE. However, it is impossible to conclude that tying prevents users from

choosing other browsers and harms competition in the Japanese browser market, because other browsers could compete with IE by improving their quality. So it implies that policy interventions for the purpose of promoting the competition, such as the adoption of "browser ballot" screen brought in European Commission, are not expected at the time of this research in the Japanese browser market.

Table 2　Descriptive Statistics of Data

	IE		Netscape		Opera		Firefox	
Variables	average	s.d.	average	s.d.	average	s.d.	average	s.d.
PREINSTALL	0.633	0.482	0.026	0.159	0.00076	0.027	0.00076	0.027
PREVIOUSYEAR	0.874	0.332	0.058	0.234	0.019	0.137	0.008	0.091
OFFICE	0.63	0.48	0.056	0.23	0.004	0.065	0.011	0.103
WP_FREQUENCY	2.14	1.71	3.27	0.64	3.82	0.4	3.48	0.35
WP_RATE	97	2.99	94	2.63	93.3	1.8	93.3	1.67
QUALITY	78.4	14.9	66.3	12.8	58.1	12.4	58.4	12.6
FEATURE	74.1	16.6	64.2	13.8	59.3	11.4	58.1	11.4
STABILITY	70.2	19.7	62.9	13.7	57.7	11.3	58.1	11.3
LIGHTNESS	65.3	19.9	56.9	15.2	61.5	11.9	60	11.5
INTERNET	4.93	1.93	4.88	1.84	5.16	1.94	5.46	1.81

n=2571

Table 3　Results of Estimation

	Model 1	Model 2	Model 3	Model 4
valuables	coefficient (t stats.)	coefficient (t stats.)	coefficient (t stats.)	coefficient (t stats.)
PREINSTALL	0.663 (3.18)***	0.651 (3.13)***	0.656 (3.16)***	0.656 (3.16)***
PREVIOUSYEAR	3.223 (21.65)***	3.2 (21.66)***	3.221 (22.21)***	3.21 (22.22)***
OFFICE	1.082 (6.36)***	1.076 (6.31)***	1.225 (7.10)***	1.219 (7.02)***
WP_FREQUENCY	0.0381 (0.665)		0.0366 (0.625)	
WP_RATE		0.0241 (0.78)		0.00736 (0.233)
QUALITY	0.0778 (12.48)***	0.0771 (12.31)***		
FEATURE			0.0484 (7.49)***	0.0482 (7.44)***
STABILITY			0.0187 (3.20)***	0.0185 (3.16)***
LIGHTNESS			0.0167 (3.17)***	0.0168 (3.20)***
INTERNET				
Netscape	−0.102 (−2.68)***	−0.0855 (−2.23)**	−0.112 (−2.91)***	−0.102 (−2.62)***
Opera	−0.0679 (−1.34)	−0.0499 (−1.00)	−0.169 (−3.28)***	−0.156 (−3.01)***
Firefox	0.0865 (2.11)**	0.101 (2.44)**	0.0128 (0.309)	0.0224 (0.53)
N	2571	2571	2571	2571
Log Likelihood	−389.765	−389.682	−397.941	−398.113
McFadden ρ	0.57	0.57	0.56	0.56

***significance at 1% level, **significance at 5% level

Table 4　Marginal Effects of Model 1

	IE	Netscape	Opera	Firefox
PREINSTALL (IE)	0.0187	−0.00748	−0.00389	−0.00735
QUALITY (Firefox)	−0.000862	−0.000186	−0.000105	0.00115
INTERNET	0.000485	−0.00149	−0.000499	0.00198

Table 5　Marginal Effects of Model 3

	IE	Netscape	Opera	Firefox
PREINSTALL (IE)	0.0189	−0.0073	−0.00412	−0.00752
FEATURE (Firefox)	−0.000555	−0.000113	−0.0000715	0.000739
STABILITY (Firefax)	−0.000215	−0.0000437	−0.0000277	0.000286
LIGHTNESS (Firefox)	−0.000191	−0.0000388	−0.0000246	0.000254

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