Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 1998 Proceedings

Americas Conference on Information Systems (AMCIS)

December 1998

Network Externalities and Composite IT Goods: An Empirical Investigation of the WWW Software Market

John Gallaugher
Boston College

Yu-Ming Wang
National Taiwan University

Network Externalities and Composite IT Goods: An Empirical Investigation of the WWW Software Market

John M. Gallaugher
Carroll School of Management
Boston College

Yu-Ming Wang
College of Commerce
National Taiwan University

Abstract

This paper uses the WWW software market to empirically test the network externalities hypothesis in a market of composite goods. Among the results is that vendors that provide both components to a composite goods market (e.g. client and server) enjoy a higher price premium than do single product (e.g. server) providers.

Introduction

Consumers value many products and services based on both intrinsic features as well as on the size of the product's *network* (installed base). As a result, we see that in many industries, consumers are willing to pay more for products and services that are market leaders. This results from a phenomenon that economists call *positive consumption network externalities*. When network externalities are present, the valuation which consumers place on a product or service will increase as the installed base (or *network*) expands (e.g. Katz and Shapiro 1985).

This concept may be particularly important for information technology. Any product with a larger installed base will be able to foster a greater level of value-enhancing exchange among adopters (e.g. of information, money, programs). Network theory suggests that consumers recognize these advantages and should be willing to pay more for IT products and services that are dominant in their respective markets, all else equal. Empirical verification of this concept has been performed using the PC spreadsheet market as a context (Bryjolfsson and Kemerer 1996; Gandal 1995, 1994).

Many types of IT markets can be referred to as composite markets, that is more than one class of product is required to derive utility. Examples of composite markets in IT include hardware/software, client/server, and content authoring/content viewer markets. Firms participating in such markets have a choice to produce either component of the composite mix, or both components. Gogan and Applegate (1995) suggest that some practitioners have found this choice particularly troubling. However, no study to date has attempted to identify whether there are advantages to providing the market with both components. This work presents results using the market for WWW software as a context to empirically examine whether IT products from integrated providers enjoy a price premium over those from single component manufacturers. The finding that there is a price premium for firms producing both components may have broad strategic implications for firms participating in composite IT markets. Researchers should also find the results interesting, given the relative lack of empirical work on network externalities in IT, and the absence of work studying composite IT products.

Model

Brynjolfsson and Kemerer's (1996) generic model for testing network externalities among computer software is used as the base model for this research. Their model uses price as a proxy for the value the average consumer places on a product. This model is extended here to account for the uniqueness of network externalities among composite goods. In cases of composite products, firms providing a primary product (e.g. servers) may also provide the market with its requisite complement (e.g. browsers). The extended model is expressed as:

$$P_i = f(F_i, N^S{}_i, S_i, N^{-v}{}_i, 0_i) \quad \text{where:}$$

P_i = price of product i
F_i = product feature attributes of primary product
$N^s{}_i$ = the installed base of the primary product
S_i = standards attributes of primary product
$N^v{}_i$ = the installed base of the complement component
O_i = other variables influencing price

Context

The context of this study is the market for WWW software. The structure of this market provides an excellent context for examining network externalities in composite goods markets since two products are necessary for a user to derive utility – a client (employed by the user) and a server (employed by the content provider). The market is also worthy of study given that 1) the Web is one of the most rapidly adopted information technologies and impacts many constituencies, 2) many network technologies (e.g. audio, video, push) are evolving that have a composite structure resembling web software, and 3) issues of competitiveness and market dominance in the WWW software market are currently fostering great debate in government and industry.

Since the context of this study is a composite good with split ownership, tests must focus on the value of one product in the composite mix (i.e. network benefits as they are related to the price of the browser or the price of the server). Given that many participants have chosen to provide the market with free browsers, an act that may be considered a market-seeding subsidy (e.g. Katz and Shapiro 1994), the logical choice is to focus on the web server price as the dependent unit of analysis.

Empirical Method and Data

This study employed hedonic pricing expressed as a multiple regression model in order to test for factors influencing the natural log of the server price. A similar method and semi-log model were used in earlier studies of network externalities in computer software (Bryjolfsson and Kemerer 1996; Gandal 1995, 1994).

$$LNPRICE_{it} = b0 + b1*BSHARE_{it} + b2*SSHARE_{it} + b3*DURATION_{it} + b4*DBLINK_{it} + b5*SSL_{it} + b6*SHTTP_{it} + b7*GUI_{it} + b8*REMM_{it} + b9*SCRIPT_{it} + b10*SEARCH_{it} + b11*UDIR_{it} + b12*TRIAL_{it} + b13*TIME + e$$

The variables above are represented as follows, with the subscripts *i* and *t* representing the observation of product *i* during month *t*. LNPRICE = log of the server's list price in U.S. dollars, BSHARE = browser market share, SSHARE = server's market share, DURATION = the number of months a product has been on the market, DBLINK = 1 if server provides database linking, SSL = 1 if server provides SSL security, SHTTP = 1 if server provides SHTTP security, GUI = 1 if the server offers a graphical user interface for configuration, REMM = 1 if the server provides remote host maintenance features, SCRIPT = 1 if the server provides a scripting language, SEARCH = 1 if the server provides a search engine, UDIR = 1 if the server supports multiple user directories, TRIAL = 1 if the server provides a pre-purchase trial version, and TIME = the current month of the study (0-17).

Data for this study was obtained from public data, industry research reports, a content analysis of the press, and feedback from vendors. Multiple sources of data were identified and used to ensure the quality and constancy of the data. Commercial products from only one platform (Windows operating systems) were included in the study. The final data set includes a total of 321 cross-sectional observations on 34 commercial web server products reflected over 18 monthly periods from August 1995 through February 1997.

Results and Interpretation

Results are displayed in Table 1. Model (a) shows the results of a regression performed with all variables collected while Model (b) represents a refined model arrived at by removing variables insignificant below the 90% confidence level. The expectation is that the collection of variables presented in the refined model (b) constitute an effective proxy for determining an average consumer's willingness to pay for a Windows web server during the time period studied.

Table 1. Regression Results

	a) WIN Full Model		b) WIN Refined Model		c) WIN Excluding BSHARE	
Variable	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	4.11	29.18	4.18	31.84	4.12	30.46
BSHARE	0.0095	3.21	0.0117	7.59		
SSHARE	0.0360	1.2127			0.1153	6.93
DBLINK	0.36	4.48	0.38	4.71	0.35	4.29
DURATION	-0.14	-12.74	-0.14	-13.49	-0.14	-12.87
GUI	0.56	4.62	0.52	4.40	0.57	4.65
REMM	0.49	5.12	0.52	5.78	0.45	4.97
SCRIPT	0.42	6.23	0.38	6.22	0.47	7.66
SEARCH	0.32	2.80	0.31	3.98	0.16	1.97
SHTTP	0.10	0.74				
SSL	0.54	4.12	0.56	5.57	0.67	6.44
TIME	0.07	6.36	0.07	6.43	0.07	6.21
TRIAL	0.88	13.82	0.91	14.90	0.86	13.74
UDIR	0.50	6.98	0.48	7.06	0.52	7.73
n	321		321		321	
R-sq.	0.784		0.782		0.776	
Adj. R-sq.	0.775		0.775		0.769	
Durbin-Watson	1.906		1.934		1.901	
F-stat.	85.651		100.976		97.592	

The full model shows a positive relationship with respect to price for the network dominance measures BSHARE (browser market share) and SSHARE (server market share). However, the server market share variable is not significant enough to warrant a position in the refined model (b). This suggests that during the time studied, direct externalities related to dominance in the browser market are more significant than the indirect externalities of dominance in the server market (e.g. Katz and Shapiro 1985). Although the log transformation makes model interpretation a bit more difficult, the BSHARE coefficient of 0.0117 suggests that with all other factors held constant, a one percent increase in the browser's

installed base warrants a price that is slightly over 1 percent higher than its competitors ($e^{0.0117}$ = 1.0117; or 1.17%). This coefficient is similar to the result of model (a), which includes both SSHARE and BSHARE.

A model (c) was run demonstrating the impact of server market share when browser share is excluded. This was important given that a high level of correlation between BSHARE and SSHARE was noted. [1] Running a separate model excluding BSHARE from the variable allows us to examine the impact of SSHARE and compare it to that of BSHARE. Although server share shows up as positive and significant, the t-statistics of browser share suggest a higher degree of probability of significance (t = 7.5 vs. t = 6.9) and model (b) contains slightly higher r-squared (0.782 vs. 0.776) and F statistic values (100.976 vs. 97.592). This suggests that the browser model is a slightly stronger representation describing the behavior of observed phenomenon and that one may have greater confidence in BSHARE as a contributor to describing the behavior of the studied phenomenon vs. that of SSHARE. However, caution in the interpretation of these results is warranted, as the separate models may not adequately express the relationship between the BSHARE and SSHARE variables.

The variables for security protocol (SSL and SHTTP) and the ability to link a server with a database (DBLINK) may also be considered as constructs for network benefits. Variables for product market share offer a more pure representation of network benefits than do the indicator variables for network extending standards. However, the use of standards allows a network to be extended to a larger number of applicable contexts (such as secure transactions) while the ability to link to external databases provides the product with access to external data networks. Similar indicator variables for file accessibility and data access were employed in Gandal's (1994) study of the spreadsheet market. The full model (a) reveals that the signs of all three of these indicators are positive, as is expected by the network externalities hypothesis. However, the variable SHTTP is not significant at the threshold level and has been removed in the refined model (b). It is noted that SSL and S-HTTP are competing, although not mutually exclusive security standards. Sample descriptive statistics suggest that the SSL standard (mean .4205) is much more popular than the SHTTP standard (mean .1489). Thus these results may be interpreted as being supportive of the existence of network externalities in this market as witnessed via a significant premium being placed on the more popular security standard.

The proxy for trialability (TRIAL) proved highly significant. An interpretation of this is that firms that offer a trial version of their servers were (ceteris paribus) able to price their products nearly 1½ times higher than those which do not offer a trial version. This may be taken as a validation of Nejmeh's (1994) assertion that the Internet can be a strategic tool for the software enterprise. In this context, the Web allows the firm to reap advantages from distributing demonstration versions at a low, fixed cost. This also supports Rogers' (1983) assertion that there is a risk associated with adoption and that trial versions of products help reduce this risk. In this context, offering a trial version seems to have translated into a substantial valuation premium.

The variable DURATION (indicating the number of months a product has been on the market) shows a negative coefficient. Software costs are highly weighted toward the fixed cost of software development. Hence a firm which has a product available longer in the market is able to take advantage of scale-style benefits and can reduce its price over time. The larger duration of product availability may result in more sales which work to 'pay down' the fixed cost investment, while product upgrades and enhancements are achieved at a much lower investment premium than newcomers' ability to develop a new product from scratch.

Curiously, the significance and positive coefficient of the TIME variable suggests that server prices have increased over time, all else being equal. These results are contrary to the quality-adjusted price declines over time identified in other studies of IT (e.g. Chow, 1967, Gordon, 1993). One explanation for this effect is that as the Internet continued to grow, Internet software was recognized as being more valuable to an organization and new manufacturers coming to market reflected this perceived higher valuation in higher product prices. Further tests (not shown) demonstrated that the time indicator can be removed without altering the interpretation of the results.

References

Brynjolfsson, E. and Kemerer, C. "Network Externalities in Microcomputer Software: An Econometric Analysis of the Spreadsheet Market," *Management Science* (42:12), December 1996, pp. 1627-1647.

Gandal, N. "Hedonic Price Indexes for Spreadsheets and an Empirical Test of the Network Externalities Hypothesis", *RAND Journal of Economics* (25:1), Spring 1994, pp. 160-170.

Gandal, Neil. Competing compatibility standards and network externalities in the PC software market. *Review of Economics & Statistics*. (77:4), November 1995, pp. 599-608.

Gogan, J.L. and Applegate, L.M., Open Market, Inc.(1995), in *Corporate Information Systems Management: Text and Cases, Fourth Edition*, Applegate, McFarlan, and McKenney (eds.), Irwin, Chicago, Illinois, 1996.

Katz, M. and Shapiro, C. "Systems Competition and Network Effects," *Journal of Economic Perspectives* (8:2), 1994, pp. 93-115.

Katz, M. and Shapiro, C. "Network Externalities, Competition and Compatibility," *American Economic Review* (75:3), 1985, pp. 424-440.

Nejmeh, Brian A., "The Internet : a strategic tool for the software enterprise", *Communications of the ACM* (37:11), November 1994, pp. 23-27.

[1] The correlation matrix and VIF tests did not reveal any further concerns regarding multi-coliniarity in any of the models tested