

行政院國家科學委員會專題研究計畫成果報告

網路效應及垂直整合：WWW 軟體市場之研究

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中文摘要

本研究以 WWW 軟體市場為背景，驗證複合式資訊產品市場之網路效應。研究結果顯示同時提供 client 及 server 軟體之廠商，較具競爭優勢，比僅提供單項 server 軟體之廠商，可訂定較高之價格。此項研究結果顯示網路效應在複合式資訊產品市場的重要性，提供管理階層策略上重要涵意。

關鍵詞：網路效應，垂直整合，複合式資訊產品，WWW 軟體，Composite Goods，Web Server Software

Abstract

This research uses the WWW software market to empirically test the network externalities hypothesis in a market of composite goods. Among the findings 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. The results suggest that composite markets exhibit network externalities and yield important managerial implications.

Keywords: Network Externalities, Network Effects, Vertical Integration, Composite Goods, Web Server Software

Introduction

It has been suggested that the economics of a large installed base (i.e. network externalities) play a critical role in electronic markets and in markets that

support the e-commerce infrastructure (Downes and Mui 1998; Hagel and Armstrong 1997), however little empirical research exists supporting these assertions. To test the impact of installed base in composite goods markets; this paper examines the market for World Wide Web (WWW) software – a key component of the e-commerce infrastructure and one that has a structure similar to other current and emerging Internet-based technologies. Using a time series data set that includes over 300 cross-sectional observations on 34 commercial web server products, we test for factors associated with price using the hedonic pricing technique. The results suggest that the web server market exhibits positive network externalities and that IT products from integrated providers enjoy a price premium over those from single component producers. The findings of this study have implications for the timing of market entry, product offerings, R&D, mergers and acquisitions, and the adoption of technical standards.

Literature

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 that consumers place on a product or

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service will increase as the installed base (or *network*) expands (Katz and Shapiro 1985).

This concept may be particularly important for information technology due to the impact of three critical factors – *exchange*, *stranding concerns*, and *extrinsic benefits*. In terms of exchange, users are attracted to a technology that is compatible with a greater network of users, all else equal, because they can engage in a wider option of value-enhancing exchange (e.g. of information, money, and programs). Secondly, users of IT are highly concerned about being *stranded* in an unsupported standard (Fichman and Kemerer 1993). Hence, users favor products that they believe will continue to dominate in the future. Also, the dominant product is likely to attract *extrinsic benefits* (Shurmer 1993). These may include add-on products, books and manuals, and skilled workers. The implied significance of stranding concerns and extrinsic benefits are particularly important for e-commerce firms, as they suggest that network externalities can be generated even in environments that support open standards.

The theory of network externalities 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 (Brynjolfsson and Kemerer 1996; Gandal 1994), however many IT markets exist that have a structure distinctly different from this market. For example, 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.

Firms participating in composite markets have a choice to produce either component of the composite mix, or both components. In a case focused on the web software industry, Gogan and Applegate (1995) suggest that practitioners have found this choice particularly troubling. However, no study to date has empirically examined whether there are advantages to providing the market with both components. This work explores this question 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 producers.

Context

The context for this study is the market for commercial WWW servers for Microsoft Windows operating systems. For a number of reasons, this context provides an exceptional environment for studying network externalities and their impact in composite markets. Web servers are part of a client / server mix, and since some server developers provide the market with clients (browsers) while others do not, the impact of network externalities in composite markets can be easily tested. Examining the market from the server perspective rather than the browser perspective, is most appropriate given that many participants have chosen to provide the market with free browsers, an act that may be considered a market-seeding subsidy (Katz and Shapiro 1994). The client/server structure of the web is also similar to many current and future technologies that support e-commerce (e.g. audio, video, push). Web software also represents one of the most rapidly diffused IT innovations of all time, while competition in this market has raised the scrutiny of the Justice Department.

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Finally, focusing on the Windows market is appropriate, given that during the time of the study, the Windows market was dominated by commercial web servers while the UNIX market was dominated by freeware products provided by the Apache consortium, NCSA, and CERN.

Methodology, Model, and Data

To test the network externalities hypothesis and examine the impact of installed base, the hedonic pricing technique was employed to test for factors associated with price. This technique assumes that price is determined as a function of value bundles - factors that contribute to determining the price that a consumer is willing to pay. In hedonic pricing, the dependent variable price is regressed against various independent variables, which in the case of this model include factors for network externalities, standards, product quality, trialability, and time controls.

The conceptual model is expressed below, along with a description of factors tested in the empirical model, their measures, and their hypothesized direction of influence.

$$P_i = f(N_i^p, N_i^c, S_i, F_i, T_i, O_i)$$

Where P_i = price of product i (log of server price); N_i^p = the installed base of the primary product (server market share percentage; +); N_i^c = the installed base of the complement component (browser market share percentage; +); S_i = standards attributes of primary product; F_i = product feature attributes of primary product; T_i = trialability of the product (1 if a free trial version of the product is offered; +); O_i = other variables influencing price.

The data set used in this study is a time

series containing a total of 321 cross-sectional observations on 34 stand-alone, commercial web servers reflected over 19 monthly periods from August 1995 through February 1997. Data for this study was obtained from a combination of public and proprietary consulting data, industry research reports, a content analysis of the press, and feedback from vendors. Whenever possible, multiple sources were identified and compared to ensure the quality and constancy of the data. Commercial products from only one platform (Windows operating systems) were included in the study.

Results & Interpretation

The results in this study were achieved by regressing the variables collected against the log of price. The model proved quite descriptive, with the adjusted r-squared value indicating that the model explained roughly 77% of the variance in the data. All variables in the refined model were significant above the 99% confidence level.

Two market share variables were tested as sources of network externalities – server share and browser share. Earlier models had shown that all-else equal, consumers are willing to pay more for products that dominate their respective markets (Brynjolfsson and Kemerer 1996). By exploring the market share for both servers and browsers and their relationship to server price, we were able to test for the significance and relative network benefit yielded from each of these components. Of particular interest is the result that browser share remained in the refined model while server share dropped out. One interpretation for this is that although the server market generated far greater revenues for participants than the browser market, there were many more browser users in existence. The

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abundant pool of browser users drove awareness of the dominant server producer, raising product awareness and reducing quality uncertainty and stranding concerns. The coefficient of the browser share variable, .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%). During the time of this study, Netscape clearly dominated the browser market, with a market share varying from 74% to 83%. Netscape's dominance of this market suggests a price premium accruing from network externalities within the range of 87%-97%. Although a number of factors limit the generalizability of any conclusions from these results, the findings of this study suggest strong price advantages for firms that are able to capture market share for the complementary component in a composite goods mix.

The variables for security protocol (SSL and S-HTTP) and the ability to link a server with a database 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 one/zero indicator variables for network extending standards. However, Gandal (1994) points out that standards extend the reach of a network, and thus should be considered for their ability to generate positive network externalities. In this case, the use of security standards allows a product 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 additional data networks. The model reveals that both the database linking and SSL features are positively associated with product price,

as is expected by the network externalities hypothesis. However, support for the S-HTTP security standard was not significant enough for inclusion in the model. SSL and S-HTTP are competing, although not mutually exclusive security standards, but the SSL standard (mean .4205) is much more popular than the S-HTTP 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. As such, firms confronted with the choice of offering an innovative, but non-standard feature vs. complying with the appropriate standard would be wise to consider the network benefits associated with a standard's popularity.

The one/zero indicator variable proxying trialability also 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 not offering a trial version. This may be taken as a validation of Nejme'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 may be particularly true for firms with a smaller installed base, they may wish to offer trial versions to reduce consumers' quality uncertainty in order to compete with their bigger rivals. This also supports Rogers' (1995) 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.

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Conclusions

The results of this research yield important and interesting implications for both researchers and practitioners. For researchers, this study provides much needed empirical support for the network externalities hypothesis in IT markets. Many previous econometric studies of IT pricing have ignored the impact of network externalities, so this work suggests ways to strengthen future analyses by considering network benefits. Also, to the authors' knowledge this is the first study to empirically examine the impact of network externalities on IT markets that can be classified as composite-goods markets. This study demonstrates that network benefits are accrued outside of the single-product IT networks that were the focus of earlier empirical work. This work also suggests that network externalities are important even in markets that are largely based on open, rather than proprietary standards. Additionally, this work extends existing modeling techniques in a way that accounts for the uniqueness of composite goods networks and for the influences of trialability.

For practitioners, this study suggests a number of managerial implications. First, network externalities seem to be significant in client/server markets, even in those markets with open standards. This suggests the wisdom of moving early in order to quickly establish an installed base from which to derive positive demand-side economies of scale. Second, providing complements may yield price-based benefits. The results of this study suggest that the installed base for complementary composite products was positively associated with a firm's ability to command a price premium. Such network benefits may influence a firm's decision to invest

research and development funds to create composite complements and/or to seek to merge with or acquire firms in markets that offer the composite complement. Third, the study offered evidence that adherence to dominant technology standards yields price benefits. Results suggest that products supporting the more popular standard command higher prices. These results are particularly interesting for firms that are faced with a choice between investing in an innovative standard vs. supporting a popular standard. Finally, offering a trial version was shown to be positively related to price. Trial versions may act to lower consumers' quality uncertainty and the risk premiums associated with purchases, and thus increase their willingness to pay.

This research project has been well executed. Significant results were derived and reported in an article forthcoming in *The International Journal of Electronic Markets*.

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