



The Value Relevance of Network Advantages: The Case of E-Commerce Firms

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ABSTRACT

We show that network advantages constitute an important intangible asset that goes unrecognized in the financial statements. For a sample of e-commerce firms, we find that network advantages created by Web site traffic have substantial explanatory power for stock prices over and above traditional summary accounting measures such as earnings and book value of equity. Also, network advantages are positively associated with one-year-ahead and two-year-ahead earnings forecasts provided by equity analysts. When we allow network advantages to be endogenously determined by managerial actions, we find that at least part of the value relevance of network effects stems from the presence of affiliate referral programs and higher media visibility.

1. Introduction

In this article we document that the stock market values network advantages over and above traditional financial statement information for a

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sample of e-commerce firms. Network advantages arise when the benefit from being a part of a network increases with the number of other persons or enterprises connected to it (Lev [2001]). Several researchers recently observed that network effects create a significant competitive advantage in innovative organizations although such advantages are not fully reflected in financial statements (e.g., Healy and Palepu [2001, p. 433], Lev [2001]). Lev [2001, p. 31] notes that network advantages are especially “the hallmark of advanced technology, information-based industries.” Hence, we concentrate on a sample of e-commerce firms and show that network effects created by Web site traffic constitute an important intangible asset that the stock market values over and above accounting summary measures such as current earnings and book value of equity.

Investigation of the nature of intangible assets such as network advantages is important to practitioners and standard setters. A recent Financial Accounting Standards Board (FASB) study on business and financial reporting (FASB [2001]) highlights the importance of measurement and recognition of internally generated intangible assets in financial statements. The Jenkins Committee report (AICPA [1994]) suggests that improving disclosures on intangible assets “would provide insight into the identity, importance, and sustainability of a company’s competitive advantages.” Moreover, Securities and Exchange Commission (SEC) Commissioner Wallman [1995, 1996] encourages the accounting profession to address disclosure for “virtual” companies and intellectual assets. As a part of a preliminary proposal to enhance financial reporting, Wallman [1996] suggests a five-layer corporate reporting system that deemphasizes recognition and focuses on providing information that is “highly relevant and consistently measurable with a high degree of reliability” but does not meet the accounting definition of an asset, liability or component of equity.¹ We view our research as a step toward understanding the role of network advantages in creating potentially valuable intangible assets that are not currently captured by the accounting system.

In the e-commerce sector, network advantages arise as the value of a Web site to a visitor depends on how many others visit that site. Once the number of visitors, and hence the size of the virtual community created by the firm, grows, more users find the firm’s Web site attractive because of their ability to interact with other members of the community and their ability to share and contribute to member-generated content. Moreover, accumulation of data about visitors’ preferences makes it possible for vendors and advertisers to tailor products and services to visitors, thus making the site even

¹ The current SEC chairman, Harvey Pitt, echoed similar sentiments in one of his speeches to the AICPA on October 22, 2001: “While rules can be useful tools in achieving our reporting goals, such as comparability and verifiability, they are not and should not be treated as ends in themselves—rather, the goal is clear, verifiable information. . . . We could consider, for example, whether financial disclosure would be more relevant if this picture contains more information about intangibles, and, if so, whether that information would be contained inside or outside the financial statements” (source: <http://www.sec.gov/news/speech/spch516.htm>).

more attractive to future visitors. This, in turn, increases the potential for an e-commerce firm's long-run profitability.

Metcalfe's law of network economics suggests that if there are n people in the network, the value of the network is proportional to the number of other users, that is, $n \times (n - 1) = n^2 - n$ (Shapiro and Varian [1999]).² If Metcalfe's law is descriptive of the data, we would expect the market values of Web businesses to increase nonlinearly with the number of visitors to the firm's Web site. Furthermore, if the accounting system does not adequately capture the value-creating effects of network advantages, we would expect a nonlinear transformation of visitors to be value relevant over and above earnings and equity book value.

Using a sample of 92 firms covering portals, content and community sites, auction sites, financial services sites, and electronic retailers (e-tailers henceforth) over seven quarters beginning with the first quarter of 1999, we present strong evidence that network advantages are incrementally value relevant over earnings and equity book value. The prior accounting literature (e.g., Trueman, Wong, and Zhang [2000], Hand [2000b], Demers and Lev [2001]) assumes that Web traffic is associated with constant returns to scale and hence incorporates traffic as a linear additive nonfinancial value driver in the empirical specifications. We show that traffic is associated with increasing returns to scale and, therefore, is nonlinearly associated with market value in a manner consistent with the functional form suggested by Metcalfe's law of network effects. Thus, we contribute a fundamental insight into how Web traffic translates to firm value.

Another unique feature of our study is that we treat network advantages as endogenously determined by firms' actions. Previous research on the value relevance of nonfinancial indicators (e.g., Trueman, Wong, and Zhang [2000], Hand [2000b], Demers and Lev [2001], Amir and Lev [1996], Ittner and Larcker [1998], Rajgopal, Venkatachalam, and Kotha [2002]) implicitly assumes that the nonfinancial indicators such as Web traffic and customer satisfaction arise exogenously and are unaffected by managerial actions. However, several researchers (Ittner and Larcker [2001], Lambert [1998]) question this assumption and raise the issue as to why managers fail to increase customer satisfaction and Web traffic even more than the observed levels to garner greater market values.

We posit that there are costs or constraints associated with increasing network advantages. We consider several factors that enable firms to generate network advantages such as alliance with a large well-established portal such as America Online (AOL), the presence of affiliate-marketing programs, the magnitude of research and marketing expenditure, the extent of media visibility attained by the firm, firm size, and a key constraint—the amount of

² We recognize that Metcalfe's "law" is more a rule of thumb rather than a law (Shapiro and Varian [1999]). We use the label "law" to be consistent with the manner in which the rule is conventionally cited in the popular press and the academic literature.

cash available with the firm. Furthermore, we also allow for the possibility that firms' market values and network advantages may be simultaneously determined. Our results indicate that the network advantages are endogenous in that the value relevance of network stems not from the network *per se* but from the economic determinants of network advantages such as creating affiliate referral programs, generating media visibility, and firm size.

We also predict that the value of network effects to a firm depends on its business model. The value that an incremental Web site visitor can derive by getting onto the network depends on how many other like-minded community members or auction traders might already be a part of the network. However, it is unclear why an incremental visitor should patronize an electronic retailer and financial service site simply because other customers transact with the site. Consistent with such expectation, we find that the stock market values network advantages from Web traffic for portals and auction sites but not for e-tailers and financial services Web sites. Furthermore, the stock market continues to value network advantages stemming from traffic even after the April 2000 crash in Internet stocks.

To corroborate our findings related to the value relevance of the network advantages stemming from traffic, we investigate whether such advantages are reflected in firms' future earnings. This investigation is important to appreciate why the market might value network effects in the first place. We find that network advantages created by Web traffic are positively associated with analysts' consensus forecasts of one-year-ahead and two-year-ahead earnings. In particular, network advantages appear to increase future sales more than future expenses. This evidence contributes to the stream of recent accounting literature that seeks to understand the link between non-financial leading indicators and future earnings (e.g., Lev and Thiagarajan [1993], Ittner and Larcker [1998], Banker, Potter, and Srinivasan [2000], Behn and Riley [1999], Nagar and Rajan [2001], Rajgopal, Shevlin, and Venkatachalam [2002]).

The remainder of this article is organized as follows. Section 2 discusses the data and descriptive statistics. Section 3 presents empirical evidence on the value relevance of network advantages and the effect of the endogeneity of network effects on the value relevance results. Section 4 examines variation in the value relevance of network effects over time and across business models. Section 5 provides evidence that network effects are related to future earnings, and section 6 concludes.

2. *Data and Descriptive Statistics*

2.1 WEB TRAFFIC DATA

We rely on Web traffic data compiled by PC Data Online—an independent firm that measures Internet audiences. PC Data Online defines its Internet audience as individuals who access the World Wide Web or

proprietary online areas such as America Online during the past 30 days using personal computers with Windows 95/98/NT as their operating system. PC Data Online generates its data from a random panel of 100,000 participants who have installed the company's tracking software on their personal computers at home or at work. This software collects and stores a participant's Web activities on his or her computer. Once the user has been online for 15 minutes, which may be split across one or more sessions, these data are encrypted and sent, in real time, via the Internet to PC Data Online.

Of the various metrics reported by PC Data Online, we focus on unique monthly visitors to firms' Web sites in our study. PC Data Online defines unique visitors as the number of Web-active individuals who visited a particular site(s) belonging to a Web property (company) within a given period. Each visitor is represented only once as a unique user. The data on unique monthly visitors for each month are usually posted within a week to 15 days after the end of the month on PC Data Online's Web site. Traffic statistics compiled by PC Data Online were freely available to the public until recently on PC Data Online's Web site.³

2.2 SAMPLE AND DESCRIPTIVE STATISTICS

We compile our sample firms from the Internet Stock List available at www.internet.com. The Internet Stock List compiled by Internet.com is used by several previous studies (Trueman, Wong, and Zhang [2000, 2001], Hand [2000a, 2000b], Demers and Lev [2001]). We begin with a list of 120 firms from five categories of firms as of July 1, 2000: (1) content and community sites, (2) e-tailers, (3) financial services sites, (4) portals, and (5) auction sites. We focus on only these categories because the business model for firms in these categories involves generating revenue by exploiting traffic attracted to their Web sites. Note that we classify auction sites separately because of the potentially different network advantages for those firms even though Internet.com treats auction sites as e-tailers. We classify a firm as an auction site if the firm indicates that its business model relies predominantly on auctions in its 1999 annual report.

To the initial list, we add four firms (Excite, Geocities, Onsale, and Xoom.com) that have been acquired or merged before July 1, 2000. We exclude 18 firms for which traffic data were not available on PC Data Online for any quarter in our sample period. Fourteen more firms are dropped because we cannot find financial statements for any quarter during the sample period on the SEC's EDGAR database. Thus, our final sample consists of 92 publicly traded pure Internet firms. Table 1 lists our sample firms by industry type. As shown, content and community sites (37 of 92) and e-tailers (33 of 92) dominate the sample.

³ PC Data Online has since been acquired by NPD Intellect Market Tracking (www.intellectmt.com) and has restricted free access to Web traffic data.

TABLE 1
Sample Firms

The list of e-commerce firms is obtained from www.internet.com as of July 1, 2000. To this list, we add four firms (Excite, Geocities, Onsale, and Xoom.com) that have been acquired or merged before July 1, 2000. From the resulting total of 124 firms, we exclude 18 firms for which traffic data were not available and 14 firms for whom financial statements for any quarter during the sample period were not found on the SEC's EDGAR database. Thus, we have 92 firms in the final sample. The sample is classified into five industries: content and community sites, portals, financial service firms, auction sites, and e-tailers.

| Name | Name | Name |
|-----------------------------------------------|--------------------------------------------------|-----------------------------|
| <i>Content and community sites (37 firms)</i> | 36 Women Com Networks | |
| 1 Artistdirect Inc. | 37 Xoom.Com | <i>E-tailers (33 firms)</i> |
| 2 Careerbuilder Inc. | | 1 Alloy Online |
| 3 CNET Networks Inc. | <i>Portals (10 firms)</i> | 2 Amazon Com Inc. |
| 4 Drkoop Com Inc. | 1 About Com Inc. | 3 Ashford Com Inc. |
| 5 EarthWeb Inc. | 2 Ask Jeeves Inc. | 4 Audible Inc. |
| 6 Edgar Online Inc. | 3 Excite | 5 Audiohighway.Com |
| 7 Geocities | 4 GoTo Com Inc. | 6 Barnesandnoble Com Inc. |
| 8 GO2NET Inc. | 5 Infoseek | 7 Beyond Com Corp |
| 9 Healthcentral Com | 6 Infospace Inc. | 8 Bigstar Entmt Inc. |
| 10 Healthgate Data Corp | 7 Looksmart Ltd | 9 Bluefly Inc. |
| 11 Homestore Com Inc. | 8 Lycos Inc. | 10 Buy Com Inc. |
| 12 Hoovers Inc. | 9 Starmedia Network | 11 Cdnw/N2k Inc. |
| 13 Ilife Com Inc. | 10 Yahoo Inc. | 12 Crosswalk Com Inc. |
| 14 Improvenet Inc. | | 13 Cyberian Outpost Inc. |
| 15 Infonautics Corp | <i>Financial service firms (7 firms)</i> | 14 Drugstore Com Inc. |
| 16 Internet.Com Corp | 1 Ameritrade Holding | 15 Emusic.Com Inc. |
| 17 Iturf Inc. | 2 E-Loan Inc. | 16 E-Stamp Corp |
| 18 Ivillage Inc. | 3 E Trade Group Inc. | 17 Etoys Inc. |
| 19 Knot Inc. | 4 Mortgage Com Inc. | 18 Expedia Inc. |
| 20 Launch Media Inc. | 5 Netbank | 19 Fashionmall Com Inc. |
| 21 Mapquest | 6 Nextcard Inc. | 20 Fatbrain Com Inc. |
| 22 Marketwatch.Com | 7 Witcapital | 21 FTD Com Inc. |
| 23 MP3 Com Inc. | | 22 Garden Com Inc. |
| 24 NBC Internet Inc. | <i>Auction sites (5 firms)</i> | 23 Homegrocer Com Inc. |
| 25 Netradio Corp | <i>(classified as e-tailers in Internet.com)</i> | 24 InsWeb Corp |
| 26 Quepasa Com Inc. | 1 eBay Inc. | 25 Musicmaker Com Inc. |
| 27 Quokka Sports Inc. | 2 Egghead Com | 26 Peapod Inc. |
| 28 Salon.com | 3 Onsale | 27 Pets Com Inc. |
| 29 Snowball Com Inc. | 4 Priceline Com Inc. | 28 Planetrx Com Inc. |
| 30 Sportsline Com Inc. | 5 Ubid | 29 Preview Travel |
| 31 Student Advantage (Ipo) | | 30 Smarterkids Com Inc. |
| 32 Switchboard Inc. | | 31 Ticketmaster Online Ctys |
| 33 Talk City Inc. | | 32 Value America Inc. |
| 34 Theglobe Com Inc. | | 33 Vitaminshoppe Com Inc. |
| 35 Thetreet.Com Inc. | | |

We hand-collect all financial data from 10-Qs and 10-Ks filed by firms available on the EDGAR database on the SEC's Web site www.sec.gov. Information about unique monthly visitors for our sample firms comes from PC Data Online for February 1999 to August 2000. In particular, we use

the quarterly average of unique monthly visitors (*UNIVIS*) for our empirical analyses.⁴ Because we have traffic data until August 2000 we can assess the effect of the April 2000 stock market crash on the valuation of network effects created by traffic.

Because PC Data Online issues a press release for a particular month's traffic within 30 days of the end of that month, we measure the market value of the firm's equity 30 days after the 10-Q quarter-end. Stock prices are obtained from www.finance.yahoo.com and Center for Research in Security Prices (CRSP) tapes. Of the possible 644 firm-quarters (92 firms over seven quarters), we are left with 434 firm-quarters for our empirical analyses. This is because all firms in our sample were not publicly traded throughout the sample period.

Table 2 presents descriptive data on *UNIVIS* and several other independent variables used in the analyses. For descriptive reasons, we also provide data on the quarterly average of a firm's *REACH*, defined by PC Data Online as the percentage of unique monthly visitors to a firm's site scaled by the total Web population. The median firm attracts 3% of the Internet population in a quarter or 1.63 million unique visitors in a quarter. Note that the third quartile cutoff of the earnings distribution is negative. About 93% of the observations in the sample report negative earnings (not tabulated). For the median firm, quarterly losses (\$11.20 million) exceed quarterly sales (\$10.58 million). However, the median firm enjoys significant market capitalization as evidenced by the median market-to-book ratio of 3.25. Whether network advantages from Web traffic explain the high market values is explored next.

3. *Network Effects and Their Valuation Implications*

Network effects arise when the value of connecting to a network depends on the number of other people already connected to it (Shapiro and Varian [1999, p. 174]). Once the number of visitors, and the size of the virtual community created by the firm, grows, more users find the firm's Web site attractive because of their ability to interact with other members of the community and their ability to share and contribute to member-generated content (e.g., book reviews generated by readers at Amazon.com). For instance, the ability to interact with more community members can be very valuable to an auction site. eBay's auction site is more popular than any other auction site (including free auction sites such as Yahoo Auctions) because of the huge virtual community that eBay has created. A marginal buyer or seller has strong incentives to transact on eBay because this increases the probability of finding members who would take the other side of the trade.

⁴ Because PC Data Online started reporting traffic numbers from February 1999, we assume that the average unique monthly visitors for the quarter ended March 1999 is the same as the average unique monthly visitors for February and March 1999. Also, because our data collection ended in August 2000 we assume that the average unique monthly visitors for the quarter ended September 2000 is the same as the average unique monthly visitors for July and August 2000.

TABLE 2
Descriptive Statistics

The sample consists of 434 observations over the seven quarters from the first quarter of 1999 to the third quarter of 2000. Financial analysts' forecasts of one-year-ahead (two-year-ahead) earnings and sales are available for 267 (135) observations. The financial statement data are obtained from the EDGAR database on the SEC's Web site www.sec.gov, stock prices are obtained from www.finance.yahoo.com and CRSP tapes, and analysts forecasts are obtained from IBES. *UNIVIS* is the average monthly unique visitors during a quarter; *NTWK* is $(UNIVIS^2 - UNIVIS)$; *REACH* is the average proportion of unique visitors to total Web population during a quarter; *E* is income before extraordinary items; *BVE* is book value of equity; *CC* is amount of contributed capital (i.e., par value + additional paid in capital); ΔCC is change in contributed capital; *TA* is total assets; *SALES* is sales revenues; *MVE* is market value of equity; *MB* is market to book ratio; *VIS* is media visibility measured as the number of articles in leading newspapers and magazines; *R&D* is research and development expenditures; *M&A* is marketing and advertisement expenditures; *CASH* is cash and cash equivalents; *AOL* is a dummy variable for alliance with America Online; *AFF* is a dummy variable for the existence of affiliate programs; *FUTEARN*_{*t*+1,*t*+2} is IBES earnings forecast for one and two years, respectively; *FUTSALES*_{*t*+1,*t*+2} is IBES sales forecast for one and two years ahead, respectively; and *FUTEXP*_{*t*+1,*t*+2} is IBES expense forecast for one and two years ahead, respectively, determined as the difference between *FUTEARN* and *FUTSALES*.

| Variable | <i>N</i> | Mean | Std. Dev. | Median | First Third | Third Quartile |
|----------------------------------------------------|----------|---------|-----------|--------|----------------|-------------------|
| <i>UNIVIS</i> (million) | 434 | 4.26 | 7.30 | 1.63 | 0.51 | 4.83 |
| <i>NTWK</i> ($UNIVIS^2 - UNIVIS$) | 434 | 67.00 | 296.33 | 1.02 | -0.15 | 18.46 |
| <i>REACH</i> | 434 | 0.07 | 0.11 | 0.03 | 0.01 | 0.07 |
| <i>E</i> (\$ million) | 434 | -20.83 | 56.84 | -11.20 | -22.71 | -5.37 |
| <i>BVE</i> (\$ million) | 434 | 196.36 | 331.84 | 83.98 | 36.58 | 207.50 |
| <i>CC</i> (\$ million) | 434 | 287.91 | 355.93 | 155.90 | 75.92 | 329.08 |
| ΔCC (\$ million) | 434 | 46.31 | 112.90 | 3.54 | 0.41 | 37.64 |
| <i>TA</i> (\$ million) | 434 | 471.16 | 1477.34 | 127.30 | 55.12 | 338.52 |
| <i>SALES</i> (\$ million) | 434 | 37.76 | 83.82 | 10.58 | 4.05 | 28.02 |
| <i>MVE</i> (\$ million) | 434 | 2433.45 | 8027.11 | 315.25 | 85.75 | 1078.25 |
| <i>MB</i> | 434 | 10.34 | 44.40 | 3.25 | 1.47 | 7.60 |
| <i>VIS</i> | 434 | 42.02 | 111.75 | 7.00 | 3.00 | 24.00 |
| <i>R&D</i> (\$ million) | 434 | 4.29 | 8.30 | 1.77 | 0.68 | 4.66 |
| <i>M&A</i> (\$ million) | 434 | 15.49 | 22.85 | 8.76 | 4.55 | 18.00 |
| <i>CASH</i> (\$ million) | 434 | 126.70 | 192.16 | 58.34 | 27.12 | 133.19 |
| <i>AOL</i> (dummy) | 434 | 0.27 | 0.45 | 0.00 | 0.00 | 1.00 |
| <i>AFF</i> (dummy) | 434 | 0.39 | 0.49 | 0.00 | 0.00 | 1.00 |
| <i>FUTEARN</i> _{<i>t</i>+1} (\$ million) | 267 | -81.24 | 327.82 | -31.45 | -59.95 | -15.42 |
| <i>FUTEARN</i> _{<i>t</i>+2} (\$ million) | 135 | -31.08 | 270.26 | -8.56 | -30.50 | 9.11 |
| <i>FUTSALES</i> _{<i>t</i>+1} (\$ million) | 267 | 276.30 | 536.62 | 88.79 | 48.00 | 262.50 |
| <i>FUTSALES</i> _{<i>t</i>+2} (\$ million) | 135 | 554.21 | 876.36 | 200.00 | 92.05 | 548.00 |
| <i>FUTEXP</i> _{<i>t</i>+1} (\$ million) | 267 | 357.54 | 627.99 | 141.75 | 79.90 | 344.39 |
| <i>FUTEXP</i> _{<i>t</i>+2} (\$ million) | 135 | 585.28 | 887.34 | 231.28 | 107.76 | 650.58 |

A bigger member base at a content and community site creates opportunities for advertisers and vendors to market a range of products and services to those members. Accumulating data about member profiles and transaction profiles makes it possible to attract even more vendors and advertisers to tailor the products and services to the members, thus making it attractive for members to join the firm's virtual community (Hagel and Armstrong

[1997], Kotha [1998]). This increases the potential for revenue streams from advertisements and subscription-based revenues for content and community sites. Thus, chasing Web traffic in the earlier periods may be value maximizing down the road, because the leaders with larger Web traffic (or user base) can dominate their product space as positive feedback effects take hold (Shapiro and Varian [1999], Hagel and Armstrong [1997]).

Network effects can be empirically detected by evaluating whether the value of the network increases nonlinearly with the number of users in the network. Part of the motivation behind this empirical test is Metcalfe’s law, named after Bob Metcalfe, the inventor of the Ethernet. According to Metcalfe, if there are n people in the network, the value of the network is proportional to the number of other users, i.e., $n \times (n - 1) = n^2 - n$ (Shapiro and Varian [1999, p. 184]).⁵

To assess whether traffic is valued by the market as a barometer of the firm’s ability to generate network effects, we examine the relation between *NTWK*, measured as $UNIVIS^2 - UNIVIS$, and equity market values. To empirically operationalize this relation, we turn to the Ohlson [1995] framework adapted for Internet firms by Keating, Lys, and Magee [2002]. In particular, we treat network effects generated by Web traffic as a component of value-relevant information not yet captured by the accounting system, that is, the v_t term in Ohlson’s model. We begin with the following valuation function posited by Ohlson:

$$MVE_{jt} = (1 - k)BVE_{jt} + k(\varphi E_{jt} + \Delta CC_{jt} - D_{jt}) + \alpha_2 v_{jt} \tag{1}$$

In equation (1), E is net income; ΔCC is the change in contributed capital; D is dividends; v is value-relevant information not yet reflected in BVE and E ; $k = \omega r / (1 + r - \omega)$ where ω represents persistence of clean surplus-based net income and r is the discount factor; $\varphi = 1 + 1/r$; and $\alpha_2 = (1 + r) / [(1 + r - \omega)(1 + r - \gamma)]$ where γ is the persistence of other information (v). Firm and time subscripts are denoted by j and t .

In the spirit of Keating, Lys, and Magee [2002], we estimate the following empirical version of equation (1):

$$MVE_{jt} = \beta_0 + \beta_1 BVE_{jt} + \beta_2 E_{jt} + \beta_3 \Delta CC_{jt} + \beta_4 R\&D_{jt} + \beta_5 M\&A_{jt} + \beta_6 NTWK_{jt} + \beta_7 IND_{jt} + \beta_8 QTR_{jkt} + \varepsilon_{jt} \tag{2}$$

Because our sample firms pay no dividends, the term D is dropped from equation (2) for estimation purposes.⁶ Prior research (e.g. Trueman, Wong,

⁵ The intuition behind Metcalfe’s law in his own words is as follows: “When you connect computers together, the cost of doing so is n , but the value is n^2 , because each of the machines that you hook up gets to talk to all of the other machines on the network. When you graph that, you see that over time your costs go down while the value of the network goes up” (Perkins [1994]).

⁶ Alternate specifications where BVE is left out of the model and where the dependent variable is defined as MVE less contributed capital yield inferences identical to those reported in this article.

and Zhang [2000]) finds that the coefficients on components of earnings are not identical. Hence, we augment the specification in (2) from the theoretical version in (1) to allow separate coefficients for research and development expenses ($R\&D$) and marketing expenses ($M\&A$).

In equation (2), MVE is market value of equity 30 days after the fiscal quarter-end, BVE is book value of common equity measured at the last day of the fiscal quarter, E is earnings before extraordinary items for the fiscal quarter, ΔCC is change in contributed capital during a fiscal quarter, and $NTWK$ is measured as $UNIVIS^2 - UNIVIS$ where $UNIVIS$ is average monthly unique visitors during the fiscal quarter.⁷ We introduce industry dummies and time dummies to control for any unmodeled variation in market value that may covary with industry membership or quarters. IND represents industry dummies that reflect the firm's membership in four of the five ($i = 1, 2, \dots, 5$) industries studied (content and community sites, portals, e-tailers, auction sites, and financial services), and QTR represents quarter dummies that identifies six of the seven ($k = 1, 2, \dots, 6$) quarters studied. To address potential heteroskedasticity in error terms of equation (2), we report White's [1980] adjusted standard errors.

If network effects are value relevant, we would expect the coefficient on $NTWK$, β_6 , to be positive and statistically significant. Results from estimating equation (2) are reported in table 3. We conduct the regression analyses in two stages to document the incremental value relevance of $NTWK$. In the first stage we consider only the financial variables. Note that the coefficient on book value is positive and statistically significant (coefficient = 5.87, t -statistic = 4.49), whereas the coefficient on the change in contributed capital is not significant. The coefficients on earnings and marketing expenditure are insignificant, whereas $R\&D$ assumes a large positive coefficient.⁸ The traditional financial variables explain 58.67% of the cross-sectional variation in market values of firms.

Next, we estimate a model that includes both financial variables and the network measure, $NTWK$. As shown in the second column of table 3, the coefficient on $NTWK$ is reliably positive (coefficient = 20.46, t -statistic = 20.49).⁹ More important, the introduction of the $NTWK$ variable

⁷ The functional form of $NTWK$ as $(UNIVIS^2 - UNIVIS)$ is motivated by Metcalfe's law (Shapiro and Varian [1999]). We validate this functional form for our sample by regressing MVE on $UNIVIS^2$ and $UNIVIS$ (after including the standard controls such as BVE , E , ΔCC , $R\&D$, and $M\&A$). We find that the coefficient on $UNIVIS^2$ is positive and significant ($p < 0.00$), whereas the coefficient on $UNIVIS$ is negative but weakly significant ($p < 0.10$). This is broadly consistent with the functional form posited by Metcalfe.

⁸ Note that only 32 (7%) of the 434 observations had positive earnings. Hence, we did not report results from a specification that allows the coefficient on E to vary depending on whether the firm reports negative earnings (Hand [2000a], Zhang [2000]). Nevertheless, when we allow for different coefficients for positive and negative earnings our inferences regarding the value relevance of network advantages are unchanged.

⁹ We also estimate equation (2) using the generalized least squares (GLS) approach to control for potential cross-correlation in error terms. In untabulated results, we find that the coefficient on $NTWK$ is positive and statistically significant.

TABLE 3

Summary Statistics for the Regression of Equity Market Values on Financial Measures and Network Advantages Created by Web Site Traffic

The sample consists of 434 observations over the seven quarters starting with the first quarter of 1999 and ending with the third quarter of 2000. The financial statement data are obtained from the EDGAR database on the SEC’s Web site www.sec.gov, and stock prices are obtained from www.finance.yahoo.com and CRSP tapes. *NTWK* is ($UNVIS^2 - UNVIS$), *UNVIS* is the average monthly unique visitors during a quarter, *E* is income before extraordinary items, *BVE* is book value of equity, *CC* is amount of contributed capital (i.e., par value + additional paid in capital), ΔCC is change in contributed capital, *MVE* is market value of equity, $R\&D$ is research and development expenditures, and $M\&A$ is marketing and advertisement expenditures. Coefficients on the intercept, quarter dummies (*QTR*) and industry dummies (*IND*) are not reported for expositional convenience. Regression results are presented after deleting outlier observations represented by the absolute value of *R*-student statistic greater than 3.

$$MVE_{jt} = \beta_0 + \beta_1 BVE_{jt} + \beta_2 E_{jt} + \beta_3 \Delta CC_{jt} + \beta_4 R\&D_{jt} + \beta_5 M\&A_{jt} + \beta_6 NTWK_{jt} + \beta_7 IND_{jt} + \beta_{8k} QTR_{jkt} + \varepsilon_{jt} \tag{5}$$

| Variable | Pred. Sign | Coefficient Estimate | <i>t</i> -statistic | Coefficient Estimate | <i>t</i> -statistic |
|-------------|------------|----------------------|---------------------|----------------------|---------------------|
| <i>BVE</i> | + | 5.87 | 4.49** | 3.27 | 2.68** |
| <i>E</i> | + | 14.76 | 1.28 | -8.60 | -2.63** |
| $R\&D$ | +/- | 263.06 | 4.70** | 136.77 | 2.44* |
| $M\&A$ | +/- | 24.01 | 1.10 | 9.92 | 0.50 |
| ΔCC | + | 0.58 | 0.22 | 0.44 | 0.14 |
| <i>NTWK</i> | + | | | 20.46 | 20.49** |
| Adj. R^2 | | 58.67% | | 77.58% | |

**Significant at the $\alpha = 0.01$ level; *significant at the $\alpha = 0.05$ level. The *t*-statistics are one-tailed where the sign is predicted, two-tailed otherwise. The *t*-statistics are adjusted for White’s (1980) correction for heteroskedasticity.

substantially increases the explanatory power of the regression of stock prices on traditional financial statement information alone as R^2 jumps to 77.58% in the second column. Note that the inclusion of *NTWK* changes the sign and the significance of the coefficient on earnings. Consistent with prior work (Hand [2000a], Trueman, Wong, and Zhang [2000]) earnings assumes a negative coefficient (coefficient = -8.60, *t*-statistic = -2.63). The positive coefficient on $R\&D$ diminishes in size and statistical significance with the introduction of *NTWK*, suggesting that R&D expenses are incurred to build network advantages. Thus, network advantages from Web site traffic explain a significant portion of variation in stock prices.¹⁰

¹⁰ Our reported inferences remain unchanged when a returns version of equation (1) is considered. In particular, we regress holding-period return over a three-month period ending 30 days after fiscal quarter-end on *E* (earnings before extraordinary items), ΔE , and $\Delta NTWK$. All of the independent variables are scaled by market value of equity determined 30 days after the previous fiscal quarter-end. Industry and quarter dummies were also retained in the returns specification. We find that $\Delta NTWK$ continues to be positive and significant. Our inferences are not sensitive to the use of abnormal returns (holding-period return adjusted on Nasdaq return) as the dependent variable.

3.1 ENDOGENEITY CONCERNS

The basic value-relevance analysis shown previously documents that network advantages exhibit strong value relevance. However, an important assumption behind the valuation equations is that network advantages do not represent a choice variable for firms (Ittner and Larcker [1998], Lambert [1998]). If greater network advantages imply greater market values, why do managers not increase traffic to their Web sites even further to garner greater market values for their firms? Surely, there must be costs or constraints associated with increasing network advantages.

To address this endogeneity problem, we model network effects as a linear function of six relatively exogenous, but not necessarily mutually exclusive, determinants: (1) an alliance with a major portal (*AOL*), (2) the presence of an affiliate program (*AFF*), (3) the extent of media visibility that the firm attracts (*VIS*), (4) the extent of research and development expenditure and marketing expenditure incurred (*R&D* and *M&A*), (5) the availability of cash balances (*CASH*), and (6) market value of equity (*MVE*).

$$NTWK = f(AOL, AFF, VIS, R\&D, M\&A, CASH, MVE), \quad (3)$$

where f is a linear function operator. Each of the determinants of network effects is discussed in greater detail.

3.1.1. Alliances and Affiliate Programs (AOL, AFF). An alliance is a cooperative agreement or a commitment to cooperation along some important competitive dimension (Hill [1997], Gulati [1998]) such as cobranding or sharing customer traffic. An alliance for traffic with a well-established portal such as Yahoo, MSN, or AOL can enable a firm to garner an initial base of customers to trigger the positive feedback mechanism associated with networked industries (Shapiro and Varian [1999]).

Another type of alliance that is unique to firms that operate on the Internet is the affiliate program. An affiliate program is a referral service from other Web sites to the firm's Web site. When Web traffic is channeled from an associate Web site to a firm's Web site, the associate site earns referral fees for sales generated at the firm's site. Setting up affiliate programs is an efficient way to expand a firm's presence on the Web and create a community of retailers working for the firm. Commenting on Amazon.com's affiliate program, *The Economist* [1997, p. 10] points out:

Amazon.com knows that it will probably never be the best site for rock climbing information or quantum physics discussions, but that the sites specializing in such subjects would be great places to buy books. A link to Amazon.com is an easy, and potentially lucrative way for such specialist sites to do that at one remove: a click on the link takes a viewer to Amazon's relevant page.

Amazon.com's affiliate program was instrumental in the firm's rapid initial acquisition of customers. The more this network grew, the more it attracted other partners, creating a "virtuous" cycle of sites wanting to be

associates. As this network grows and expands, it makes it difficult for other competitors to become ubiquitous on the Internet and has the potential of locking out these competitors altogether (Kotha [1998]). Thus, affiliate programs help attract a growing initial customer base, an essential ingredient for triggering the positive feedback mechanism in networked industries.

We operationalize Internet-based alliances using two variables. The first variable (*AOL*) identifies firms that had a comarketing alliance between the firm and AOL, the world's largest portal. We scan press releases made by both AOL and our sample firms since 1997. If an Internet firm has an advertising alliance with AOL, we code the variable *AOL* as 1 for every quarter during which the alliance is active, and 0 otherwise.

The second variable (*AFF*) captures the presence of an affiliate program. We collect this information by scanning firms' press releases. If a firm announced an affiliate program, we code the variable *AFF* as 1 for every quarter after the program initiation date, and 0 otherwise.

3.1.2. Media Visibility (VIS). The amount of attention the media dedicate to an Internet firm may be critical to generating customer traffic to the firm's Web site. In the offline world, consumer traffic depends on geographical location. However, Web consumers move easily and instantaneously across the Internet, guided primarily by their awareness of firms' Web sites, not geographical proximity. The greater the number of articles written about a firm, the more information online visitors have to draw on in forming impressions about a firm. Because media exposure is generally beyond the direct control of the firm, the information provided by the media also tends to have higher source credibility than a firm's own marketing efforts (Wartick [1992]).¹¹ Moreover, capturing the consumer's attention is a critical precursor to attracting Web traffic and standing out from the clutter of more than 1.6 million stores that operate on the Internet (Hoffman and Novak [2000]). Creating awareness about the firm is also essential for the success of a firm's viral marketing program. Viral marketing refers to information about company-developed products and services that is passed on by one user to another and is analogous to a viral infection that is passed between two people (Rayport and Jaworski [2001]). As more people are infected, they, in turn, pass on the virus (in this case information about the company) to others, and the network of people infected increases rapidly. Thus, viral marketing has the potential to trigger the positive feedback mechanism in networked environments.

We measure media visibility (*VIS*) as the total number of articles published about the Internet firm in the "Major Newspapers" database of the

¹¹ Mass communication research finds that rather than shaping how we think—that is, "in favor of" or "against" something or someone—the media influence what we think about—that is, it allocates our attention (Katz [1987]). Moreover, marketing researchers point out that consumers rely on media information in developing interpretation frames, within which they can make sense of their consumption experiences (Hirschman and Thompson [1997]).

Lexis/Nexis electronic database for quarterly periods for each firm. We select this database because it includes daily newspapers that reflect the focus of the current media and general public attention.

3.1.3. R&D and Marketing Expenditures (M&A). R&D expenses enable firms to build navigable Web sites that are easy to use. Simplifying the transaction process with well-designed check-out processes and innovative software tools such as e-mail alerts, chat rooms, and collaborative filtering can attract visitors to a firm's Web site. Marketing and advertising expenditures could generate Web traffic, and potential network advantages, to a firm's Web site by creating awareness of and acceptance for its products or services. Marketing expenditures enable a firm to differentiate itself from its competition primarily through a firm's Web site (or interface design). As familiarity with a site (and its interface design) increases, it inhibits customers from switching to other sites where learning the interface design would have to start once again (Smith, Bailey, and Brynjolfsson [1999]). Advertising helps promote awareness and the overall reputation of a firm and thus makes it difficult, over time, for customers to switch to competitors. We use quarterly *R&D* and marketing and advertising expenditures (*M&A*) reported in firms' 10-Qs in our empirical analysis.

3.1.4. Cash Constraints (CASH). The previous discussion suggests that firms can increase traffic, and hence network advantages, by adopting several strategies. However, financial constraints may prevent firms from devoting infinite resources just to expand their networks. We proxy for such financial constraints by the cash holdings (*CASH*), measured as short-term investments and cash equivalents, at the end of the quarter reported in the firm's 10-Q. The greater the *CASH*, the larger the Web-traffic-based network that the firm can achieve. Alternatively, the level of cash availability might constrain firms from acquiring network advantages higher than the one actually achieved by the firm.

3.1.5. Market Value of Equity (MVE). We hypothesize market value of equity to be a determinant of network advantages created by Web site traffic for three reasons. First, recent empirical evidence (DuCharme, Rajgopal, and Sefcik [2001], Demers and Lellewen [2001]) suggests that capital market events such as initial public offering can significantly heighten curiosity and interest about the company among the Web audience, leading to greater Web site traffic and thus potential network advantages that traffic brings. Second, high market capitalizations stemming from a high share price might provide the company currency to acquire other companies for their traffic in stock for stock takeovers. Third, a firm's ability to signal trust through its size likely engenders confidence among Web surfers and potential buyers and increases the prospects of attracting more traffic to a Web site.

We model the relation between *NTWK* and the hypothesized determinants as follows:

$$\begin{aligned}
NTWK_{jt} = & \delta_0 + \delta_1 AOL_{jt} + \delta_2 AFF_{jt} + \delta_3 VIS_{jt} + \delta_4 R\&D_{jt} + \delta_5 M\&A_{jt} \\
& + \delta_6 CASH_{jt} + \delta_7 MVE_{jt} + \delta_8 IND_{jt} + \delta_9 QTR_{jkt} + \eta_{jt}. \quad (4)
\end{aligned}$$

The industry and quarter dummies are introduced to account for uncontrolled omitted variables that vary with industry membership and time. Next, we reproduce the value-relevance equation (2) examined in section 3 here:

$$\begin{aligned}
MVE_{jt} = & \beta_0 + \beta_1 BVE_{jt} + \beta_2 E_{jt} + \beta_3 \Delta CC_{jt} + \beta_4 R\&D_{jt} + \beta_5 M\&A_{jt} \\
& + \beta_6 NTWK_{jt} + \beta_7 IND_{jkt} + \beta_8 QTR_{jkt} + \varepsilon_{jt}. \quad (5)
\end{aligned}$$

We estimate equations (4) and (5) as a system of simultaneous equations using the two-stage least squares (2SLS) procedure. This procedure has two useful features. First, we allow *both* *MVE* and *NTWK* to be *endogenous* variables. Second, although the determinants of traffic in the *NTWK* equation may not directly affect *MVE*, these variables have an indirect effect on *MVE* through their effect on *NTWK*. However, it is important to note that our discussion of the determinants of network advantages created by Web site traffic did not motivate a formal optimization model that completely incorporates the costs and benefits regarding the choice of each determinant. Thus, we view our models as heuristic depictions that capture some of the important determinants of network advantages.

Table 2 provides descriptive statistics about the exogenous factors that determine network advantages created by Web site traffic. There is significant dispersion in the extent of media visibility that firms are able to muster. The average firm in the sample is mentioned in the major newspapers 42.02 times in a quarter, whereas the median firm gets 7 mentions. The median firm spends \$8.76 million a quarter on marketing and advertising but only \$1.77 million on research and development. The marketing spending is substantial, especially when compared with negative earnings of \$11.20 million for the median firm. The median firm has \$58.34 million in cash relative to \$127.30 million in total assets. The relatively high cash levels probably reflect proceeds from initial public offerings awaiting deployment into operating or investing activities. We also note that 27% of the firm-quarters have AOL alliances and 39% have affiliate programs.

For descriptive purposes, we report the Pearson and Spearman correlations between *NTWK* and the hypothesized exogenous determinants of *NTWK* in table 4. When Spearman correlations are considered, *NTWK* is significantly correlated with all the hypothesized determinants of traffic. *NTWK* is not correlated with AOL alliance and affiliate program variable (*AFF*) when Pearson correlations are examined. Note in particular that *NTWK* exhibits a strong positive association with *CASH*, suggesting that cash availability can constrain growth of the network.

We report the simultaneous estimation of the network determinants equation (equation (4)) and valuation equation (equation (5)) in table 5. Results of equation (4) reported in panel A of table 5 show that entering into affiliate programs increases network advantages created by Web traffic. That is, the

TABLE 4
Correlation Statistics of Determinants of Network Effects

The sample consists of 434 observations over the seven quarters starting with the first quarter of 1999 and ending with the third quarter of 2000. The financial statement data are obtained from the EDGAR database on the SEC's Web site www.sec.gov, and stock prices are obtained from www.finance.yahoo.com and CRSP tapes. *NTWK* is $(UNVIS^2 - UNVIS)$, *UNVIS* is the average monthly unique visitors during a quarter, *MVE* is market value of equity, *VIS* is media visibility measured as the number of articles in leading newspapers and magazines, *R&D* is research and development expenditures, *M&A* is marketing and advertisement expenditures, *CASH* is cash and cash equivalents, *AOL* is a dummy variable for alliance with America Online, and *AFF* is a dummy variable for the existence of affiliate programs.

| Variables | <i>NTWK</i> | <i>AOL</i> | <i>AFF</i> | <i>VIS</i> | <i>R&D</i> | <i>M&A</i> | <i>CASH</i> | <i>MVE</i> |
|----------------|-------------|------------|------------|------------|----------------|----------------|-------------|------------|
| <i>NTWK</i> | | 0.18** | 0.23** | 0.49** | 0.42** | 0.49** | 0.49** | 0.56** |
| <i>AOL</i> | 0.01 | | 0.10* | 0.21** | 0.25** | 0.26** | 0.08 | 0.08 |
| <i>AFF</i> | 0.04 | 0.10* | | 0.18** | 0.13** | 0.11* | 0.13** | 0.17** |
| <i>VIS</i> | 0.71** | 0.20** | 0.10 | | 0.56** | 0.57** | 0.52** | 0.56** |
| <i>R&D</i> | 0.78** | 0.29** | 0.13** | 0.77** | | 0.62** | 0.39** | 0.38** |
| <i>M&A</i> | 0.41** | 0.29** | 0.12* | 0.65** | 0.89** | | 0.59** | 0.57** |
| <i>CASH</i> | 0.59** | 0.19** | 0.13 | 0.76** | 0.67** | 0.67** | | 0.74** |
| <i>MVE</i> | 0.78** | 0.08 | 0.02 | 0.77** | 0.51** | 0.51** | 0.67** | |

**Significant at the $\rho = 0.01$ level; *significant at the $\rho = 0.05$ level. Pearson correlation statistics are presented below the diagonal and Spearman correlation statistics are presented above the diagonal.

coefficient on *AFF* is positive and significant (coefficient 10.38, t -statistic = 1.81). Furthermore, the effect of media visibility (*VIS*) on *NTWK* is positive and significant (coefficient 0.43, t -statistic = 4.08), suggesting that attracting greater media visibility increases a firm's network advantage. However, the coefficients on *AOL* and *CASH* are not statistically significant in the multivariate model. One interpretation of this result is that the strategies used to create network advantages are not mutually exclusive. Consistent with this interpretation, the correlation between select determinants of *NTWK* is high. For example, the Pearson correlation between *M&A* and *CASH* is 0.67, and the Pearson correlation between *M&A* and *VIS* is 0.76. The coefficient on *MVE* is positive and statistically significant, indicating that larger (and hence more reputed) firms have stronger network advantages. The adjusted R^2 of the *NTWK* determinants equation is 58.22%, suggesting that the hypothesized exogenous determinants explain a substantial portion of the cross-sectional variation in *NTWK*.

Results of the second-stage valuation equation (5) are reported in panel B of table 5. Notice that the coefficient on *NTWK* is positive and statistically significant (coefficient = 39.28, t -statistic = 11.90). This indicates that if determinants of *NTWK* changed so as to cause network advantages to increase, such increases in *NTWK* would result in higher market value of equity. It is interesting to note that coefficients of three variables in the market value equation (*BVE*, *R&D*, and *M&A*) change in the simultaneous framework relative to the value relevance results reported earlier in section 3. The coefficients on *BVE* and *R&D* become insignificant, whereas the coefficient on

TABLE 5

Summary Regression Statistics of Two-Stage Least Squares Estimation of Determinants of Network Effects and the Relation Between Equity Market Values and Network Effects

The sample consists of 434 observations over the seven quarters starting with the first quarter of 1999 and ending with the third quarter of 2000. The financial statement data are obtained from the EDGAR database on the SEC's Web site www.sec.gov, and stock prices are obtained from www.finance.yahoo.com and CRSP tapes. *UNVIS* is the average monthly unique visitors during a quarter, *NTWK* is ($UNVIS^2 - UNVIS$), *E* is income before extraordinary items, *BVE* is book value of equity, *CC* is amount of contributed capital (i.e., par value + additional paid in capital), ΔCC is change in contributed capital, *MVE* is market value of equity, *VIS* is media visibility measured as the number of articles in leading newspapers and magazines, *R&D* is research and development expenditures, *M&A* is marketing and advertisement expenditures, *CASH* is cash and cash equivalents, *AOL* is a dummy variable for alliance with America Online, and *AFF* is a dummy variable for the existence of affiliate programs. Coefficients on the intercept, quarter dummies (*QTR*) and industry dummies (*IND*) are not reported for expositional convenience. Regression results are presented after deleting outlier observations represented by the absolute value of *R*-student statistic greater than 3.

Panel A: Determinants of Network Effects

$$NTWK_{jt} = \delta_0 + \delta_1 AOL_{jt} + \delta_2 AFF_{jt} + \delta_3 VIS_{jt} + \delta_4 R\&D_{jt} + \delta_5 M\&A_{jt} + \delta_6 CASH_{jt} + \delta_7 MVE_{jt} + \delta_8 IND_{jt} + \delta_9 QTR_{jkt} + \eta_{jt} \tag{4}$$

| Variable | Predicted Sign | Coefficient Estimate | t-statistic |
|----------------|----------------|----------------------|-------------|
| <i>AOL</i> | + | -0.90 | -0.12 |
| <i>AFF</i> | + | 10.38 | 1.81* |
| <i>VIS</i> | + | 0.43 | 4.08** |
| <i>R&D</i> | + | -0.94 | -1.04 |
| <i>M&A</i> | + | -0.34 | -1.10 |
| <i>CASH</i> | + | -0.06 | -1.20 |
| <i>MVE</i> | + | 0.01 | 3.19** |
| Adj. R^2 | | 58.22% | |

Panel B: Relation Between Equity Market Values and Network Effects

$$MVE_{jt} = \beta_0 + \beta_1 BVE_{jt} + \beta_2 E_{jt} + \beta_3 \Delta CC_{jt} + \beta_4 R\&D_{jt} + \beta_5 M\&A_{jt} + \beta_6 NTWK_{jt} + \beta_7 IND_{jit} + \beta_8 QTR_{jkt} + \varepsilon_{jt} \tag{5}$$

| Variable | Predicted Sign | Coefficient Estimate | t-statistic |
|----------------|----------------|----------------------|-------------|
| <i>BVE</i> | + | 0.85 | 1.00 |
| <i>E</i> | + | -8.52 | -2.39** |
| <i>R&D</i> | +/- | -43.27 | -0.90 |
| <i>M&A</i> | +/- | 57.56 | 3.26** |
| ΔCC | + | -0.02 | -0.01 |
| <i>NTWK</i> | + | 39.28 | 11.90** |
| Adj. R^2 | | 49.62% | |

**Significant at the $\alpha = 0.01$ level; *significant at the $\alpha = 0.05$ level. The *t*-statistics are one-tailed where the sign is predicted, two-tailed otherwise. The *t*-statistics are adjusted for White's (1980) correction for heteroskedasticity.

M&A turns positive and significant (coefficient = 57.56, *t*-statistic = 3.26). The revised results from the simultaneous system of equations highlight the potential for misleading inferences when the endogenous nature of *NTWK* is not considered (see also Greene [1993, p. 579]). Overall, our results imply that at least part of the value relevance of network advantages stems from the economic determinants of networks such as the presence of affiliate

referral programs (*AFF*), generation of media visibility (*VIS*), and larger firm size (*MVE*).

The methodology adopted here to address endogeneity is subject to three important caveats (see also Holthausen, Larcker, and Sloan [1995]). First, only network advantages and the market value of equity are treated as endogenous in the estimated equations. Other firm-specific variables are assumed to be exogenous or predetermined variables. Obviously, identification considerations require each endogenous variable to be associated with some unique set of exogenous variables (or instruments). We acknowledge that some of the instrumental variables (e.g., AOL alliance and cash balances) are themselves likely to be endogenous and we would need to specify a separate equation to explain the choice of endogenous variables. However, this would involve the difficult task of finding an exogenous variable for each such equation (Ittner and Larcker [2001]). Second, our variables are likely measured with error, leading to inconsistent estimates for the structural equation parameters and their standard errors. However, without greater knowledge of the correlation structure of the measurement error, it is difficult to estimate precisely the effect of these errors on our inferences. Third, it is likely that the system of equations is misspecified, because of correlated omitted variables and inappropriate zero restrictions on the coefficients between the exogenous instruments and the endogenous variables. For example, the extent of network advantages is possibly chosen in response to factors other than those hypothesized earlier. To the extent our analyses do not consider all the determinants of traffic, we face the possibility that our results are affected by unidentified omitted variable problems.

4. Time-Series and Cross-Sectional Variation in the Value Relevance of Network Effects

In this section we explore systematic variation in the value relevance of *NTWK*. That is, we allow the valuation coefficient on *NTWK* to vary (1) over time after the market crash in Internet stocks in April 2000 and (2) cross-sectionally based on a firm's business model. We develop our hypotheses and present our results on these two extensions in the following subsections.

4.1 APRIL 2000 CRASH

It is plausible that the value relevance of network advantages was affected by the April 2000 Nasdaq crash in Internet stocks. We set a dummy variable *POSTCRASH* to 1 (0) if the dependent variable, the market value of equity, is measured after (before) April 1, 2000. We augment equation (5) with an interaction of the *POSTCRASH* dummy and *NTWK*. As mentioned, we estimate the determinants of *NTWK* (equation (4)) and the value relevance regression (equation (5)) simultaneously. We continue to estimate the determinants of *NTWK* (equation (4)) and the value relevance of *NTWK* (equation (5)) in a simultaneous-equations framework. To conserve space,

we do not report results from estimating *NTWK* as those results are similar to those presented in panel A of table 5.

Results of estimating the augmented version of equation (5) are reported in panel A of table 6. The coefficient on *NTWK* remains positive and strongly significant (43.46, t -statistic = 18.71), though the coefficient on the interaction of *NTWK* and *POSTCRASH* is negative and significant, as expected (-14.39 , t -statistic = -4.53). Thus, the market appears to have downgraded the value per unit of network advantages by about a third in the post-crash period. Nonetheless, the market continues to value network advantages even after the April 2000 crash. The (untabulated) sum of coefficients on *NTWK* and the interaction term are reliably positive and significant (F -statistic = 18.04, $p < 0.00$).

4.2 BUSINESS MODELS

The previous analysis allows the valuation coefficient on network advantages to vary with time, that is, pre- and post-crash regime. In the following analysis, we allow the valuation coefficient on network effects to vary in the cross-section, by the nature of the firm's business model. This is because network effects are likely to be more important to certain business models such as auction sites and portals than to others (Amit and Zott [2001]).

A marginal buyer or a seller is better off going to an auction site with a large network. The larger the auction site, the better the selection and chances of finding what the buyer wants. eBay's auction site is more popular than any other (including free auction sites such as Yahoo Auctions) because of the large virtual community of buyers and sellers that it has created. In this case, a marginal buyer or seller has strong incentives to transact on eBay because this increases the probability of finding members who would take the other side of the trade.

Similar arguments apply in the case of portals and content community sites. Virtual markets enable online firms to create virtual communities in an attempt to bond participants to particular sites (Hagel and Armstrong [1997]). They enable frequent interactions on a wide range of topics and thus create loyalty among the community members and enhance transaction frequency (Amit and Zott [2001]). Once a new user has joined the community, it becomes more attractive for other potential users to patronize the site.¹² For individuals looking for a chat group, the larger the network of users at a portal or a content and community site, the greater the chances of finding other members with similar tastes with whom they can share ideas and further their sense of community.

However, online brokerage services (classified as financial services by Internet.com) and e-tailers are unlikely to achieve network externalities.

¹²The converse is also true—if a site is unattractive and is unable to attract members, it becomes less attractive for existing subscribers who may choose to drop out. Thus, a dangerous “vicious” cycle is set in motion that can, in extreme cases, eventually destroy the business (Shapiro and Varian [1999], Amit and Zott [2001]).

TABLE 6

Summary Regression Statistics of Two-Stage Least Squares Estimation of Determinants of Network Effects and the Relation Between Equity Market Values and Network Effects: Pre- and Post-Nasdaq Crash and Business Model Analyses

The sample consists of 434 observations over the seven quarters starting with the first quarter of 1999 and ending with the third quarter of 2000. The financial statement data are obtained from the EDGAR database on the SEC's Web site www.sec.gov, and stock prices are obtained from www.finance.yahoo.com and CRSP tapes. *UNVIS* is the average monthly unique visitors during a quarter; *NTWK* is (*UNVIS*² - *UNVIS*); *REACH* is the average proportion of unique visitors to total Web population during a quarter; *E* is income before extraordinary items; *BVE* is book value of equity; *CC* is amount of contributed capital (i.e., par value + additional paid in capital); ΔCC is change in contributed capital; *TA* is total assets; *SALES* is sales revenues; *MVE* is market value of equity; *POSTCRASH* represents a dummy variable that takes the value of 1 if the market value of equity is measured after April 1, 2000, 0 otherwise; *Content* represents a dummy variable that takes the value of 1 if the firm is a content and community site, 0 otherwise; *Portal* represents a dummy variable that takes the value of 1 if the firm is a portal, 0 otherwise; *Finserv* represents a dummy variable that takes the value of 1 if the firm is in the financial service industry, 0 otherwise; *Auction* represents a dummy variable that takes the value of 1 if the firm is an auction firm, 0 otherwise; and *Amazon* represents a dummy variable that takes the value of 1 if the firm is Amazon.com, 0 otherwise. Coefficients on the intercept, quarter dummies (*QTR*) and industry dummies (*IND*) are not reported for expositional convenience. Regression results are presented after deleting outlier observations represented by the absolute value of *R*-student statistic greater than 3. The regression results reported are obtained from simultaneously estimating the network determinants specification (equation (4)), to control for endogeneity and simultaneity. Results of equation (4) are not reported here for brevity.

Panel A: Pre- and Post-Crash Analysis

$$MVE_{jt} = \beta_0 + \beta_1 BVE_{jt} + \beta_2 E_{jt} + \beta_3 \Delta CC_{jt} + \beta_4 R\&D_{jt} + \beta_5 M\&A_{jt} + \beta_6 NTWK_{jt} + \beta_7 NTWK_{jt} * POSTCRASH_{it} + \beta_8 IND_{jit} + \beta_{9k} QTR_{jkt} + \epsilon_{jt} \quad (5)$$

| Variable | Predicted Sign | Coefficient Estimate | t-statistic |
|----------------------------|----------------|----------------------|-------------|
| <i>BVE</i> | + | 0.46 | 0.55 |
| <i>E</i> | + | -11.70 | -3.38** |
| <i>R&D</i> | +/- | -48.11 | -1.04 |
| <i>M&A</i> | +/- | 68.26 | 3.98** |
| ΔCC | + | -2.33 | -1.23 |
| <i>NTWK</i> | + | 43.46 | 18.71** |
| <i>NTWK * POSTCRASH</i> | - | -14.39 | -4.53** |
| Adj. <i>R</i> ² | | 64.21% | |

Panel B: Business Model Analysis

$$MVE_{jt} = \beta_0 + \beta_1 BVE_{jt} + \beta_2 E_{jt} + \beta_3 \Delta CC_{jt} + \beta_4 R\&D_{jt} + \beta_5 M\&A_{jt} + \beta_6 NTWK_{jt} * Content + \beta_7 NTWK_{jt} * Portal + \beta_8 NTWK_{jt} * Finserv + \beta_9 NTWK_{jt} * Etail + \beta_{10} NTWK_{jt} * Auction + \beta_{11} NTWK_{jt} * Auction + \beta_{12i} IND_{jit} + \beta_{13k} QTR_{jkt} + \epsilon_{jt} \quad (5)$$

| Variable | Predicted Sign | Coefficient Estimate | t-statistic | Coefficient Estimate | t-statistic |
|----------------------------|----------------|----------------------|-------------|----------------------|-------------|
| <i>BVE</i> | + | 2.93 | 4.40** | 3.61 | 5.22** |
| <i>E</i> | + | -9.72 | -3.77** | -9.68 | -3.80** |
| <i>R&D</i> | +/- | 71.88 | 1.90 | 36.30 | 0.93 |
| <i>M&A</i> | +/- | 24.66 | 2.00* | 26.11 | 2.14* |
| ΔCC | + | -1.09 | -0.79 | -1.49 | -1.08 |
| <i>NTWK * Content</i> | + | 4.50 | 1.10 | 3.63 | 0.90 |
| <i>NTWK * Portal</i> | + | 15.52 | 8.22** | 15.34 | 8.22** |
| <i>NTWK * Finserv</i> | 0 | 3.39 | 0.10 | -1.30 | -0.04 |
| <i>NTWK * Etail</i> | 0 | 28.61 | 4.33** | -15.65 | -1.03 |
| <i>NTWK * Auction</i> | + | 39.60 | 11.15** | 38.97 | 11.08** |
| <i>NTWK * Amazon</i> | + | | | 52.54 | 3.24** |
| Adj. <i>R</i> ² | | 64.15% | | 64.98% | |

**Significant at the $\alpha = 0.01$ level; *significant at the $\alpha = 0.05$ level. The *t*-statistics are one-tailed where the sign is predicted, two-tailed otherwise. The *t*-statistics are adjusted for White's (1980) correction for heteroskedasticity.

The value that a customer derives from transacting with a brokerage or an e-tailer is not directly related to the size of the network served by the firm. Research has shown that customers choose an online broker based on their personal attributes such as technological savvy, age, gender, and investment style but not on how many other clients are serviced by that brokerage house (Rangan [2001]). Shoppers appear to choose an e-tailer that has a wide product selection, competitive prices, responsive customer service, and easy-to-use Web sites (Smith, Bailey, and Brynjolfsson [1999], Evans and Wurster [1999]). The size of the network created by the e-tailer does not appear to be a first-order motivator for shoppers to patronize an e-tailer.

To evaluate whether the valuation of network advantages varies with industry type, we replace *NTWK* in equation (5) with an interaction of *NTWK* and a dummy that identifies the primary industry to which a sample firm belongs. The results of estimating this modified equation (5) are presented in the first column in panel B of table 6. Most of the *a priori* predictions about the differential importance of network advantages are borne out by the data. Consistent with predictions, the valuation coefficient on network advantages is positive and significant for auction sites (39.60, *t*-statistic = 11.15) and portals (15.52, *t*-statistic = 8.22). As expected, the market does not value network advantages for financial services sites (3.39, *t*-statistic = 0.10). Contrary to expectations, the market appears to value network advantages for e-tailers (28.61, *t*-statistic = 4.33). A closer examination of the data suggests that Amazon.com drives this anomalous result. When we allow Amazon.com to assume a separate valuation coefficient, we find that network advantages of e-tailers are not valued by the market (see second column of panel B, table 6).

Among the e-tailers, the market places a significant weight on the network advantages created only by Amazon.com (coefficient = 52.54, *t*-statistic = 3.24). This occurs for several possible reasons. Amazon.com enjoyed a significant first-mover advantage in book retailing. Many researchers argue that being first to market is an essential prerequisite to success in markets characterized by increasing returns (Arthur [1996], Hill [1997], Shapiro and Varian [1999]). A first mover can create switching costs for customers by developing brand awareness and reputation (Amit and Zott [2001], Rindova and Kotha [2001]). Amazon.com was also among the first to recognize the value of increasing returns to scale as noted by *The Economist* [1997, p. 9]:

People come to the site because it has the most reviews written by readers, and they often stop to write some of their own, attracting even more people. The more books you buy and the more information you give Amazon.com about your tastes, the better it will become at finding things you might like. It will send you an e-mail message when a book you are looking for (or might just be interested in) is coming out, hooking you ever more firmly.

As Amazon.com's network of customers increased in size, it became difficult for other competitors to be ubiquitous on the Internet, and Amazon.com locked out other entrants to the online segment of the book retailing

industry altogether.¹³ Moreover, Amazon.com pioneered a series of e-commerce innovations (e.g., one-click purchase, editors' service, the "eyes" program, the affiliate program) that helped attract new customers and create a virtual community (Kotha [1998]).

In sum, the previous analysis demonstrates that network advantages appear to be more valuable to certain business models (auctions and portals) than to others (e-tailers and financial services).

5. Do Analysts' Future Earnings Forecasts Reflect Network Advantages?

The value relevance of network advantages provides indirect evidence that network advantages are associated with improved future performance.¹⁴ In this section, we provide direct evidence by examining the association between network advantages and fundamentals using future earnings.

The impact of network advantages of Web traffic on a firm's future earnings is twofold: the demand effect and the supply effect. The demand effect exists when there is demand interdependence among customers as the welfare of users depends on other users in the network (Rohlf's [1974]). The greater size of the network increases a customer's ability to conduct more or varied transactions with other customers of the network. The resultant increase in the firms' revenue makes it more economical for a firm to offer new products or services. Such new services may result in higher revenues for the firm. Hence, we expect to observe a positive association between *NTWK* and future sales of firms.

Turning to the supply effect, as the size of the network increases, the marginal costs of servicing the installed base of customers becomes progressively lower. With a larger network, the technological and administrative costs of managing the network can be spread over a larger base of users. Hence, we expect future expenses to increase at a slower rate than future sales, thereby leading to a positive association between *NTWK* and future earnings.

The theoretical perspective adopted in specifying a link between earnings and network advantages draws from the production function perspective of

¹³ Currently, there are more than 400 online bookstores on the Internet, but none of them has been able to compete with Amazon.com in driving traffic to their Web sites. Moreover, two well-endowed physical retailers—Barnes and Noble and Borders—have been unable to match Amazon.com's success in acquiring market share in online book retailing. In fact, Borders is partnering with Amazon.com in the industry, having unsuccessfully tried to compete for online customers.

¹⁴ Alternatively, network effects may be value relevant because they proxy for nondiversifiable risk. In untabulated results, we did not find strong evidence to support that interpretation. In particular, we use stock return volatility during the quarter as the proxy for nondiversifiable risk. In estimating the relation between return volatility and *NTWK*, we control for firm size (proxied by the natural logarithm of market value of equity) and book-to-market ratio. We find only a weak (that too, negative) association between stock return volatility and *NTWK*.

the firm discussed in Lev and Sougiannis [1996]. Following research in economics (Mairesse and Sassenou [1991], Hall [1993]), Lev and Sougiannis [1996] argue that earnings of a firm are a function of tangible assets and intangible assets:

$$Earnings = f(\text{tangible assets}, \text{intangible assets}). \quad (6)$$

We proxy for tangible assets with the total assets of a firm and view network advantages created by traffic, *NTWK*, as the key intangible asset for our sample firms. We also consider R&D and M&A expenses to control for intangible assets created by such expenses. Following Aboody, Barth, and Kasznik [1999], we introduce the market-to-book ratio, *MB*, as a control for potential effects of risk and growth (Fama and French [1992]). Hence, we estimate the impact of network effects on future earnings using the following specification:

$$\begin{aligned} FUTEARN_{jt+n} = & \gamma_0 + \gamma_1 TA_{jt} + \gamma_2 R\&D_{jt} + \gamma_3 M\&A_{jt} + \gamma_4 MB_{jt} + \gamma_5 \hat{NTWK}_{jt} \\ & + \gamma_{6i} IND_{jit} + \gamma_{7k} QTR_{jkt} + \kappa_{jt}. \end{aligned} \quad (7)$$

FUTEARN in equation (7) refers to the analyst forecasts of future earnings for the sample firm.¹⁵ Industry and quarter dummies are added to control for unmodeled variation in future earnings that covary with industry membership and time. \hat{NTWK} refers to the fitted value of *NTWK* obtained from the determinants equation (4). Thus, we control for the endogeneity of network effects while estimating the effects of network on future earnings.

To fully appreciate the effect of network advantages on future earnings, we decompose future sales (*FUTSALES*) and expense component (*FUTEXP*) of *FUTEARN* in the following two specifications. We derive forecasted expenses as the difference between forecasted sales and forecasted earnings.

$$\begin{aligned} FUTSALES_{jt+n} = & \lambda_0 + \lambda_1 TA_{jt} + \lambda_2 R\&D_{jt} + \lambda_3 M\&A_{jt} + \lambda_4 MB_{jt} + \lambda_5 \hat{NTWK}_{jt} \\ & + \lambda_{6i} IND_{jit} + \lambda_{7k} QTR_{jkt} + \kappa_{jt}. \end{aligned} \quad (8)$$

$$\begin{aligned} FUTEXP_{jt+n} = & \nu_0 + \nu_1 TA_{jt} + \nu_2 R\&D_{jt} + \nu_3 M\&A_{jt} + \nu_4 MB_{jt} + \nu_5 \hat{NTWK}_{jt} \\ & + \nu_{6i} IND_{jit} + \nu_{7k} QTR_{jkt} + \kappa_{jt}. \end{aligned} \quad (9)$$

In these two equations, *FUTEARN* (*FUTSALES*) refers to analysts' consensus forecasts of earnings (sales) one year and two years ahead from the IBES tapes measured one month after traffic numbers related to the last month of a particular quarter are reported. For example, for a fiscal quarter ending in March where Web traffic numbers are reported in April, we use analyst forecasts made in May. Thus, we assume that analysts update their forecasts of future earnings and sales within one month of the release of the traffic numbers related to the last month of the quarter. As discussed

¹⁵ Because the e-commerce sector is in its infancy we do not have actual realized earnings for more than one year. Hence, we use forecasted future earnings in the empirical specifications.

before, $FUTEXP$ is the difference between $FUTSALES$ and $FUTEARN$. Analyst forecasts in the IBES tapes are reported in per share terms. We multiply the forecasted number per share with the number of shares outstanding for the firm at a date closest to the date of the forecast.

The IBES tapes do not contain analyst forecasts for all firms in our sample. In fact, we could find one-year-ahead earnings forecasts for 350 of the possible 434 firm-quarters and two-year-ahead earnings forecasts for 215 of the possible 434 firm-quarters. However, sales forecasts are only available for an even smaller set of firms. We could find one-year-ahead sales forecasts for 267 firm-quarters and two-year-ahead sales forecasts for 135 firm-quarters. To enable a comparison of the earnings results with those related to sales and expenses, we report the results of equations (7)–(9) only for the subsample where sales forecasts are available.¹⁶

Table 2 reports descriptive data about analysts' forecasts. It is interesting to observe that analysts expect two-year-ahead earnings for the median firm to be negative although losses two years out are expected to be smaller than losses one year out. Table 7 reports the results of estimating equations (7)–(9) for one-year and two-year forecasts. Consistent with expectations, we find that \hat{NTWK} exhibits a strong positive association with one-year-ahead and two-year-ahead earnings. The coefficient on \hat{NTWK} for the one-year and two-year earnings regressions is 0.17 (t -statistic of 7.45 and 6.88 in the one-year and two-year-ahead regressions, respectively). When future earnings are decomposed into future sales and expenses, we find that \hat{NTWK} is strongly related to future sales one year ahead (coefficient = 0.15, t -statistic = 2.10) but not to future sales two years ahead (coefficient = 0.10, t -statistic = 0.72). Moreover, \hat{NTWK} does not appear to be related to either one-year-ahead or two-year-ahead expenses (see columns 3 and 6). In sum, a combined reading of table 7 shows that network advantages increase future sales more than future expenses, leading to greater future earnings. The strong association between network advantages and future earnings corroborates the value relevance of \hat{NTWK} documented in section 3.

6. Concluding Remarks

In response to calls for accounting research on the value created by network effects (Healy and Palepu [2001]), we provide some of the first evidence that network advantages constitute an important intangible asset that is valued by the stock market although such assets are unrecognized in the financial statements. For a sample of business-to-consumer Internet firms, we find that network advantages created by Web site traffic have substantial explanatory power for stock prices over and above traditional summary accounting measures such as earnings and equity book value. Furthermore,

¹⁶ Untabulated sensitivity analyses confirm that the reported results hold under two alternative cases: (1) when the larger sample of earnings forecasts is considered and (2) when the cash component of assets is included as an additional variable in the specification.

TABLE 7

Regression Results Examining the Relation Between Network Advantages and Forecast of Future Earnings, Revenues, and Expenses After Controlling for the Determinants of Network Effects

The sample consists of 434 observations over the seven quarters starting with the first quarter of 1999 and ending with the third quarter of 2000. Financial analysts' forecasts of one-year-ahead (two-year-ahead) earnings and sales are available for 267 (135) observations. The financial statement data are obtained from the EDGAR database on the SEC's Web site www.sec.gov, stock prices are obtained from www.finance.yahoo.com and CRSP tapes, and analysts forecasts are obtained from IBES. \widehat{NTWK} is the predicted value of $NTWK$ from the network determinants regression (equation (4)); $NTWK$ is $(UNVIS^2 - UNVIS)$; $UNVIS$ is the average monthly unique visitors during a quarter; TA is total assets; MB is market-to-book ratio; $R\&D$ is research and development expenditures; $M\&A$ is marketing and advertisement expenditures; $FUTEARN_{t+1,t+2}$ is IBES earnings forecast for one and two years, respectively; $FUTSALES_{t+1,t+2}$ is IBES sales forecast for one and two years ahead, respectively; and $FUTEXP_{t+1,t+2}$ is IBES expense forecast for one and two years ahead, respectively, determined as the difference between $FUTEARN$ and $FUTSALES$. Coefficients on the intercept, quarter dummies (QTR), and industry dummies (IND) are not reported for expositional convenience. Regression results are presented after deleting outlier observations represented by the absolute value of R -student statistic greater than 3.

$$FUTEARN_{jt+n} = \gamma_0 + \gamma_1 TA_{jt} + \gamma_2 R\&D_{jt} + \gamma_3 M\&A_{jt} + \gamma_4 MB_{jt} + \gamma_5 \widehat{NTWK}_{jt} + \gamma_{6i} IND_{jit} + \gamma_{7k} QTR_{jkt} + \kappa_{jt} \quad (7)$$

$$FUTSALES_{jt+n} = \lambda_0 + \lambda_1 TA_{jt} + \lambda_2 R\&D_{jt} + \lambda_3 M\&A_{jt} + \lambda_4 MB_{jt} + \lambda_5 \widehat{NTWK}_{jt} + \lambda_{6i} IND_{jit} + \lambda_{7k} QTR_{jkt} + \kappa_{jt} \quad (8)$$

$$FUTEXP_{jt+n} = \nu_0 + \nu_1 TA_{jt} + \nu_2 R\&D_{jt} + \nu_3 M\&A_{jt} + \nu_4 MB_{jt} + \nu_5 \widehat{NTWK}_{jt} + \nu_{6i} IND_{jit} + \nu_{7k} QTR_{jkt} + \kappa_{jt} \quad (9)$$

| Variable | Pred. Sign | $FUTEARN_{t+1}$ | $FUTEARN_{t+2}$ | $FUTSALES_{t+1}$ | $FUTSALES_{t+2}$ | $FUTEXP_{t+1}$ | $FUTEXP_{t+2}$ |
|------------------|------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|
| TA | + | 0.03 (4.85)** | 0.03 (5.16)** | -0.04 (-1.27) | -0.05 (-1.20) | -0.06 (-3.53)** | -0.07 (-2.56)** |
| $R\&D$ | ? | -3.90 (-2.42)* | -0.97 (-0.40) | 41.40 (4.81)** | 67.94 (5.88)** | 45.29 (10.52)** | 68.91 (7.96)** |
| $M\&A$ | ? | -0.91 (-1.48) | -1.10 (-1.71)* | 4.40 (1.31) | 1.50 (0.28) | 5.31 (2.73)** | 2.61 (0.70) |
| MB | ? | 0.27 (2.23)* | 0.028 (2.63)** | 0.00 (0.01) | -0.24 (-0.45) | -0.27 (-0.38) | -0.52 (-0.44) |
| \widehat{NTWK} | + | 0.17 (7.45)** | 0.17 (6.88)** | 0.15 (2.10)* | 0.10 (0.72) | -0.02 (-0.29) | -0.07 (-0.52) |
| Adj. R^2 | | 50.26% | 65.68% | 81.41% | 80.67% | 80.81% | 79.26% |

**Significant at the $\alpha = 0.01$ level; *significant at the $\alpha = 0.05$ level. The t -statistics are one-tailed where the sign is predicted, two-tailed otherwise. The t -statistics are adjusted for White's (1980) correction for heteroskedasticity.

such network advantages are strongly associated with one-year-ahead and two-year-ahead earnings forecasts provided by equity analysts. Our value-relevance results are robust to treating network advantages as endogenously determined. In particular, we find that part of the value relevance of network advantages stems from factors such as the presence of affiliate referral programs, media visibility, and firm size.

Our study is subject to several limitations. First, our inferences about the value relevance of network advantages created by e-commerce firms may not readily generalize to other industries. However, the nature of the intangible asset created by network advantages is highly specific to the domain studied. Hence, accumulation of evidence about the nature of network effects in other domains would be an interesting avenue for future research. For example, Healy and Palepu [2001] suggest an investigation into the network advantages created by the bottling network of the Coca-Cola Company. Second, we assume that market participants value intangible assets or non-GAAP leading indicators of future earnings in an unbiased manner. However, recent research questions the validity of this assumption. For example, Rajgopal, Shevlin, and Venkatachalam [2002] find that the market overweights order backlog in relation to its contribution of future earnings. A comprehensive evaluation of whether the market fully appreciates the contribution of other nonfinancial leading indicators to future earnings might be an interesting extension of the results documented here.

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