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An Approach to the Measurement of Intangible Assets in Dot Com Based on Web Metrics and Financial Information

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ABSTRACT

A sample of 76 firms that operate in the Internet is studied in order to explore forms of identifying and measuring intangible assets in this area of business. The firms meet three conditions: operate in the Internet, have available accounting information, and be quoted in the stock exchange. Data was obtained on two successive years for four web metrics indicators, 30 ratios that combine accounting and web traffic information, 31 accounting ratios, a measure of stock exchange performance, and a measure of efficiency based on Data Envelopment Analysis. Modelling relied on multivariate statistical approaches: Factor Analysis, Scaling techniques, multivariate regression, and hierarchical cluster analysis. Two intangible assets were identified: one was related to internal structure and was associated with managerial efficiency; and another one was associated with external image and customer loyalty. Comparison between the two years found many changes, confirming the view that this is a very dynamic sector, although the main conclusions remained unchanged.

KEY WORDS

Internet, Dot Com, intangible assets, financial ratios, non-financial indicators, strategic groups, multidimensional scaling, multivariate statistics, DEA.

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1. INTRODUCTION

The third computing revolution has been characterised by the emergence of a new way of doing business: the dot com company. The traditional inputs that are required in the production process, the four m's (men, machines, money and materials), are no longer sufficient to describe a dot com company. In the dot com company new inputs in the form of intangible assets have taken a fundamental role. The objective of a company in this new economy continues to be the same as the objective of a traditional company: to make profit for its shareholders. It could be argued that how it is achieved has been insufficiently researched.

Intangible assets are particularly important in the dot com world. These include such diverse terms as intellectual capital, human capital, internal organisation, customer loyalty, brand names, etc. It is, therefore, important to acknowledge and value such intangible assets, both to improve internal decision making, and to prove its potential to the outside world. Thus, new indicators need to be developed to complement traditional measures of performance based only on financial information. Pioneering work in the study of intangible assets and intellectual capital has been done by Brooking (1996), Sveiby (1997), Edvinsson and Malone (1997), and Stewart (1998). In parallel with these theoretical studies, there have been many reports of empirical work on intangible assets. Examples are Aboody and Lev (1998), Barth and Clinch (1998), Lev (1999), Kristen and Gregory (1999), and Deng et al (1999).

When a new line of business appears in the market, particularly one with low barriers of entry, it is common to observe that many companies are created at the early stages although few of them reach maturity. Take, for example, the automotive business, which emerged at the end of the XIX century. Out of the hundreds of new firms created at that time one could name Benz, Panhard, Mors, Renault. Some of these are still household names, but most went by the roadside. To have a good product is not enough to guarantee survival. Who would have predicted the disappearance of a mythical name such as Hispano-Suiza or Oldsmobile? Now, one hundred years later, half a dozen players hold most of the motorcar market. A similar dynamic is taking place in the Internet world: many firms have emerged, some have failed, many will go, and, probably, only a few will survive.

What are the characteristics of firms in the Internet sector? Is there a variety of behaviour patterns? If we define a strategic group as a group of firms that adopt similar strategies when faced with sectorial challenges, as in Hunt (1972), we can identify various groups in the dot com area. How are such groups related to intangible assets? This paper will attempt to identify and measure intangible assets on the basis of financial and non-financial information. To do this, we need to identify the relevant non-financial information in a dot com company. This is an aspect that has been recently studied; examples are Amir and Lev (1996) in the wireless communications industry; Hand (2000) in U.S. Internet Stocks; and Jorion and Talmor (2001) in emerging industries.

Many dot com companies are very young, and there has not been enough time to develop a history of useful financial data. This is where non-financial indicators become important. Some non-financial performance indicators have been proposed. Examples are the number of unique visitors, page hits, or reach. These indicators will be defined below. Some of these indicators are really trying to measure intangible assets such as brand name or loyalty. Can performance indicators, such as Internet traffic measures, provide us with a way to measure intangible assets?

A further set of questions relates to the efficiency by which inputs in a dot com company are converted into output. This was explored by means of Data Envelopment Analysis, a Linear Programming based approach to comparative efficiency measurement; Norman and Stocker (1991).

This study will use accounting information, traffic measures, and ratios that combine both on a sample of 76 dot com companies for the years 1999 and 2000. Information on stock market performance was also included in the model. Section 2 describes the sample and its characteristics. Section 3 is devoted to the variables included and also contains a discussion on indicators of Internet traffic intensity. Section 4 gives a summary account of DEA efficiency modelling. Section 5 reports the analysis, which is based on multivariate statistical methods. In particular, principal components analysis, hierarchical cluster analysis, scaling methods and property fitting techniques. These tools will serve to convert observable variables into measurements of intangible factors, and will serve to identify strategic groups. A conclusion section completes the paper.

2. FIRMS IN THE SAMPLE

To be included in the sample, companies had to satisfy three conditions: belong to the Internet sector and have available web traffic measurements, be listed in the stock market as an Internet company, and publish accounting information in the Securities Exchange Commission (SEC).

It is not always easy to assess if a company is in the Internet sector. This can be established using several criteria such as the origin of the revenues –commissions, advertising revenues, on line sales -, the nature of business –which expands from Internet portals to E-tailers-, or on who are the nature of the commercial partners -some operate from business to business, or "B2B"; other, from business to consumer, or "B2C"-. Some firms do not operate at all in the Internet. These are known as "Brick and Mortar". Other firms, known as "Pure Plays" operate solely in the Internet. Many, however, are some way between these two extremes, "Brick and Click".

Even within firms devoted to Internet business (Net firms), it is possible to identify many business models. The Internet Stock List, whose web address is (http://www.internetstocklist.com), classifies net firms into a series of categories such as: Search/portals, gateways to the Internet, which obtain finance from advertising; Content/community, which try to cater for individuals with shared interests, sometimes financed through advertising revenues and sometimes through membership fees; E-tailers, which engage in retail sales through the net; Financial services via the Internet; E-commerce enablers, which sell software enabling electronic commerce; Security, specialising in software for electronic security; Performance software, which also specialise in software for the net; Internet services, specialising in services such as web site hosting; Advertising, specialists in marketing through the net; Consultants/designers, providing consultancy on Internet matters; Speed/bandwidth, concerned with improved net performance; ISP, provide Internet access. These groups can be really further classified into three kinds of companies: those that provide the basic infrastructure for the net, those that provide contents for websites, and those that try to sell through the net.

The first condition for inclusion in the sample of companies was that the company should belong to the Internet sector and that it should have available web traffic measurements (web metrics). Such web traffic indicators are collected, processed, and published by several digital media audience firms. The data used in this study was obtained from Netscoreonline (http://www.netscoreonline.com). Netscoreonline uses panel samples to obtain the data, and claims that its panels include over 1.5 million people. Other firms that provide similar data are Nielsen-Netratings and Mediametrix. The data contains two observations for each company for the dates 31st March 1999 and 31st March 2000. These dates are chosen in order to avoid end of year

effects relating to the holiday period of Christmas and the New Year. It has the further advantage of linking with financial information, which tends to be published around these dates.

The second condition for inclusion in the sample is to be listed in the stock exchange during the years 1999 and 2000. This was found by checking with the Internet Stock List. Stock prices for the 31st March 1999 and for the 31st March 2000 were obtained from Barchart.com. The data was adjusted for capital splits and ex-dividend position. The companies that during this period were involved in processes of mergers or takeovers were excluded from the sample.

The third condition was that accounting information should be available for the years 1999 and 2000. Annual reports and accounts were collected from Edgaronline.com. This website collects its information from the Securities and Exchange Commission (SEC).

A total of 76 firms were found to meet all the required conditions. For a list of the companies involved see Table 1. Table 1 shows the name of the company, the stock exchange ticker, the web address for the company, and the standard industrial classification (SIC) code. Despite meeting all conditions, it is difficult to think of some of the companies included in the sample as dot com companies. Examples are Bell Atlantic (BEL), a communications firm, and American Express (AXP), the financial services company. These companies operate through the Internet but cannot be described as pure dot com companies. They were not excluded from the sample, as the methodology used in the analysis, scaling models, is robust to the presence of outliers. One could, in fact, argue that by leaving them in the sample we may learn more than by removing them.

Table 1 about here

3.VARIABLES IN THE MODEL

From Netscoreonline.com, information was obtained on reach, page hits, unique visitors, and time spent. These variables are defined by Netscoreonline as follows.

> "Reach: Measures the proportion of Internet-using machines visiting a given domain. It is expressed as the total number of machines visiting the specified domain divided by the number of machines visiting any site on the Internet over the analysis period.
>
> Page Hits: Measures the opportunity for a page to appear in a browser window as a direct result of a visitor's interaction with a website.
>
> Unique Visitors: Provides an unduplicated count of all individually identified machines that made a visit to a selected domain during a given analysis period.
>
> Time Spent: Measured in seconds, the elapsed time between the first page request at a domain and the last page request at the same domain within a given visit."

Reach was used directly as a variable in the study (V1). Three other variables were obtained by forming ratios. Their definions, in the words of Netscoreonline, are:

Pages per Visitor (V2), "calculated by dividing the total number of page hits at a specific domain by the number of unique visitors to that domain during the analysis period".

Seconds per Visitor (V3), "calculated by dividing the sum of the elapsed time between the first page request at a domain and the last page request at the same domain across all visits by the number of unique visitors to the domain during the analysis period".

Seconds per Visit (V4), "calculated by dividing the sum of the elapsed time between the first page request at a domain and the last page request at the same domain across all visits by the number of visits to the domain during the analysis period".

Variables 5 to 34 combine data obtained from Netscoreonline with information from the balance sheet and the profit and loss accounts. The particular accounting items used are: revenues, selling and marketing expenses, gross profit, cash flow, number of employees, total assets, total operating expenses, total liabilities, and R&D expenses. See Table 2 for the complete list of variables and their definitions.

Table 2 about here

In this paper we consider a web metric an output of a dot com company, as most of these firms aim at having an inpact in the Internet. In order to make such an impact, dot coms have liabilities, employ staff, engage in research, spend in marketing, etc. As a result of such way of operating, they obtain revenues and profit. Ratios 5 to 34 are, in a way, measuring productivity and efficiency in the sense that they relate accounting information to web impact. However, what dot coms aim to achieve depends on the type of activity in which they engage. For example, an internet portal, whose main source of income is publicity (banners) is crucially interested in page hits; while a community services site would be more interested in obtaining many unique visitors, as its popularity would bring with it advertising sponsorship or membership fees. Thus, these ratios depend on the particular business niche in which the dot com company operates, and may reflect strategic differences. Demers and Lev (2000) argue that web metrics "plays an important economic role" in e-tail, content/communities, financial news/services, portal and services. Financial ratios were not included in the estimation stage. Nayyar (1989) defends this way of approaching the problem of strategic group identification, as a strategic group organizes itself in

order to achieve financial success, and it would be wrong to add pure financial ratios to the classification model.

Section 5 will further elaborate on these issues by using variables 1 to 34 in order to find visualizations of the data set that will reveal intangible asset issues. Such visualizations will take the form of statistical maps. An attempt will be made to relate statistical maps to pure accounting information, for this purpose a series of 31 accounting ratios have been calculated, these are contained in variables 35 to 65. These ratios cover profitability, liquidity, cost structure and financial structure.

Variable 66 gives a measure of stock market performance. It is a dichotomous variable which attempts to measure if the firm outperforms the dot com market (defined as the average for the companies in the sample). If returns between the 31st March 2000 and the 31st March 1999, after adjusting for all applicable splits and dividend distributions, were higher than the average for the 76 firms, this variable took the value 1; otherwise it took the value zero.

A further variable (V67), that attempts to measure productive efficiency, was also used. The rationale for such variable and the way in which it was calculated is the subject of the next section.

4. EFFICIENCY MEASUREMENT

Productive efficiency can be considered to measure an internal intangible asset associated with management. An attempt was made to measure production efficiency by means of Data Envelopment Analysis (DEA). A firm is a production unit that uses inputs in order to generate outputs. It is possible to use too many inputs to produce a given quantity of output, or to generate less output than possible for a given quantity of input. If, given the amounts of inputs used, no increase in output is possible, it is said that the firm is efficient and that it is operating on the production efficiency frontier; Fare et al (1994). The traditional way of studying efficiency is through production function analysis but, in recent times, DEA has proven to be invaluable as an approach for the study of productive efficiency. Introductions to DEA can be found in Land (1991), and Norman and Stocker (1991).

DEA has proven to be particularly valuable in the assessment of performance when outputs other than profit are involved; this is why it is quickly becoming an important analysis tool in public sector management; Ganley and Cubbin (1992). Efficiency, as calculated through DEA is often

interpreted as a measure of quality in the provision of services, or managerial efficiency in not-for-profit organizations. It is an ideal tool to measure the achievement of intangible objectives.

A dot com company employs staff, takes loans, spends money, and acquires assets (inputs) in order to have an impact on the web. This impact is reflected in web metrics (outputs). Of course, this is a partial view of the complex world of Internet companies. It would be true of an Internet portal, but it would be open to question in the case of B2B companies. It can be argued that a company such as an Internet portal would be interested in maximizing efficiency thus defined, while other companies will not be primarily interested in this objective.

For each company, a DEA measure of efficiency was obtained by treating total operating expenses, total assets, number of employees, and total liabilities as inputs in the DEA model. Reach, unique users, page hits, and time spent were treated as outputs. The model estimated was the one proposed by Charnes et al (1978), also known as the CCR model. Table 3 shows DEA efficiency estimates for each company.

Table 3 about here

The efficiency measure takes values between 0 and 100. Efficient firms have an efficiency rating of 100. The firms that were found to be 100% efficient in 1999 are: BOUT, ADBE, CGLD, EBAY, KOOP, INSP, LFMN, UPRO, SWBD, and YHOO. These firms are known to be Internet leaders, particularly EBAY and YHOO. The firms that appeared most often as comparators for inefficient firms, a measure of up to what point they can be treated as benchmarks, were CGLD (48), EBAY (39), BOUT (26), INSP (22), and UPRO (22). The numbers in brackets refer to the number of times this firm has been taken to be a comparator for an inefficient firm. Firms YHOO, LFMN, KOOP, and ADBE appear to be efficient, but they do not serve as comparators. This is the standard situation with firms that specialize in a particular business niche. They are known as self-comparators in the DEA literature, since they only become efficient because they cannot be compared to any other firm. The lowest values for the efficiency variable were found in the cases of APX, BELL, BLS, DELL, GTW, GTE, LUV, FON, SPLS and VRSN. This group includes companies such as computer manufacturers, financial services providers, and telephone companies. It would be tempting to remove them from the sample, since the low efficiency ratings suggest that they cannot be really be considered to be dot com companies, but we resisted the temptation to do it. The explanation being that these are companies that operate in the dot com environment and

could be considered to belong to special strategic groups. This is a subject that will be explored with the help of scaling techniques.

The DEA model was also run with year 2000 data. Comparing with 1999, EBAY, LFMN, UPRO, SWBD, and YHOO remained 100% efficient. Companies that were efficient in 1999 and became inefficient in 2000 are: BOUT (84%), ADBE (2%), CGLD (83%), KOOP (38%), and INSP (32%). The numbers in brackets are the comparative efficiency in the year 2000. Firms that became efficient in 2000 having been inefficient in 1999 were: ASKJ (66%), APTM (66%), HSTD (95%), IPRT (50%), MYPT (72%), ONHN (22%), TVLY (59%). The numbers in brackets are the efficiency in year 1999. Amongst those that were inefficient in 1999 and remained inefficient in 2000 there were also variations in efficiency, but most changes were small; see Table 3. The DEA algorithm relies on multiple comparisons. Thus, a previously efficient firm may appear inefficient just because another firm has found a better way of converting inputs into outputs. The world of efficiency is a dynamic one. To remain efficient, a firm has to be ahead of all possible competitors. As an example, consider the case of Adobe (ADBE) and Travelocity (TVLY). If one looks at the inputs and outputs of ADBE in 1999 and 2000, very little change is found: this company has stayed still. But TVLY has now overtaken it, because with little change in its inputs, has had a dramatic increase in outputs; TVLY had 84 employees in 1999 and the same number in 2000 but the number of pages viewed by its visitors doubled from one year to the next, reflecting the increasing importance that travel agents have in electronic commerce. ADBE has done nothing apparently wrong: in 1999 it was successfully distributing the popular Acrobat Reader®, and the same thing remained true in the year 2000.

5. INTANGIBLE ASSET IDENTIFICATION AND MEASUREMENT

The approach followed will be to compare firms in order to see up to what point they are similar or different on the basis of the first 34 variables described above for the years 1999 and 2000. Measures of dissimilarity will be obtained between pairs of companies, and statistical maps will be produced from such measures. These statistical maps will reflect the strategic profiles of behavior, and will be interpreted using appropriate statistical tools.

The relevant statistical toolkit contains scaling models and other related multivariate statistical techniques. Two sets of data are available, one for the year 1999 and one for the year 2000, something that introduces a temporal perspective in the analysis. This temporal aspect has long been difficult to deal with. There are various ways of dealing with this problem. Some researchers

take a static temporal perspective, analyze a single year, and then see how the results change over time; Frazier and Howell (1983), Hawes and Criettenden (1984). However, if data for more than one year is available, the possibility of changes over time should be explored. A standard way of proceeding is to do separate analyses for each data set, and compare the results; Flavian et al (1998), Serrano-Cinca (1998). A more general approach that overcomes the time aspect by providing a more general treatment of the data set is the three-way scaling model developed by Carroll and Chang (1970), INDSCAL. The name three-way relates to the structure of the data, as we have firms, years, and web impact variables. In this study the two approaches will be followed: data for 1999 and for 2000 will be analysed independently and the results will be compared.

This section will be divided into several subsections. First, a summary description of scaling models will be given. Results from two-way multidimensional scaling will form the second subsection. Interpretation will form the next subsection. The last subsection will concentrate on evolution over time.

5.1 THE MODEL

We have chosen to use scaling models because they visualise the main characteristics in the data so that any relationship that may exist in the data is made explicit and revealed in a statistical map. Scaling models have traditionally been applied in areas where relationships between entities are based on qualitative information, or on counts. This happens in Psychology, Sociology, Politics, and even History. Applications in the analysis of management policy and in Accounting and Finance are: Green and Maheshwary (1969), Moriarity and Barron (1976), Belkaoui and Cousineau (1977), Rockness and Nikolai (1977), Frank (1979), Libby (1979), Belkaoui (1980), Brown (1981), Emery et al (1982), Bailey et al (1983), Mar-Molinero and Ezzamel (1991), Mar-Molinero et al (1996), Mar-Molinero, and Serrano-Cinca (2001), and Serrano-Cinca et al. (1999 and 2001). Scaling models have also been applied to strategic group analysis; Day et al (1987), and Hodgkinson et al (1996).

Scaling models start with a measure of dissimilarity between two entities. In this particular case, the measure of dissimilarity will reflect how similar or different two dot com companies on the basis of the 34 variables used to describe each of them. For each one of the years, a matrix is created which contains companies as rows and columns, the value in the cell being the dissimilarity measure between the company at the beginning of the row and the top of the column. This matrix is symmetric; i.e., the dissimilarity between company i and company j is assumed to be the same as

the dissimilarity between company j and company i. Two such matrices are created from the data, as we have information for the years 1999 and 2000. Thus the data is three-way: companies, variables, and year.

When the different data sets are independently explored, the data set becomes two-way: variables and companies. The standard scaling model for the analysis of two-way data is Kruskal's (1964) Ordinal Multidimensional Scaling (MDS). A good account of this model can be found in Kruskal and Wish (1978). MDS plots companies as a map in the space (configuration) in such a way that if the variables that describe two companies are similar, the companies are plotted next to each other in the space. There are various tools that measure the quality of the representation, although the most common measure of fit is a statistic, stress, which does not differ much in its rationale from the coefficient of determination in multiple regression analysis.

Implementing scaling models is a process of several stages. Each one of the variables from which they are estimated is measured in different units. If the variables that enter the algorithm are measured in their original units, the importance that each one of them has in the final result depends on the units chosen, something that makes the results data dependent. To avoid it, variables were standardized to zero mean and unit variance.

Next, dissimilarities between dot com companies were calculated by taking the Euclidean distance between standardized variables. If a variable was not available for a company, the measure of dissimilarity was based only on the remaining variables. In the common case of two-way data there is a parallel between Principal Components Analysis (PCA) and Scaling methods based on the metric of Euclidean distance between standardized data; Chatfield and Collins (1980). But MDS has a crucial advantage over PCA: PCA plots companies only if full information is available for the company, while MDS is robust to missing data. Thus, if maps had been created with PCA, they would have contained only 53 points, since the value of at least one variable was missing for 21 firms.

A common problem when working with company data is the presence of outliers, or extreme cases. It is usual practice to use some statistical test to identify them, and then remove them; the issues relating to outlier detection and removal have been discussed by Ezzamel and Mar Molinero (1990). Scaling models are robust to the presence of outliers, and there is no need to remove them, but if these are left in the data, the resulting statistical maps are more cluttered and less attractive to view. Nevertheless, outliers can be important, as they may reveal important features, which would not have been observed otherwise. The option taken here was to identify discordant companies, leave them in the data set, estimate the model, observe the position of such companies in the

common map, study their special features and assess if they are related to some distinctive strategic behaviour, and, finally, explore the bulk of the companies in order to reveal the main features of the generality of the data.

Extreme observation identification was based on Tchebytchev's inequality, as in Ezzamel and Mar Molinero (1990). For each variable, the companies that reported a standardized value greater than three were identified as extreme cases. Table 4 shows the companies identified in this way and the ratios involved.

Table 4 about here

We used Principal Components Analysis (PCA) in order to assess the dimensionality of the data. This was done by treating dissimilarity matrices as correlation matrices, and observing how many eigenvalues take values greater than 1.0. Two PCAs were performed, one using 1999 data and one using 2000 data. In both cases six eigenvalues were found to have values over 1.0, and the analysis was carried out in a six dimensional space. Very little variation was found between the two years. The percentage of the variance explained by the six eigenvectors was 89%.

Considering that two-years is a very short period, no great change would normally be expected in the data. But one should not assume that strategic groups are time invariant, a subject that has been extensively studied; Mintzberg (1978). Changes in strategic group membership may be the result of firms adapting to a changing environment and be guided by external influences, or may originate from changes in management orientation within the firm; Flavian and Polo (2000).

In the present study, the configuration is a set of points in six dimensions, which is impossible to comprehend other than by mathematical methods. We have projected this configuration on pairs of two dimensions and studied the projections, and will comment on the results by referring to such projections.

A regression-based approach, property fitting or Pro-Fit, was used to interpret the results; Schiffman et al. (1981). Besides the 34 variables used to construct the configuration (internal analysis), financial ratios were used as "properties" (external analysis) in Pro-Fit. The identification of strategic groups was made with the help of hierarchical cluster analysis, as is common practice; Flavian and Polo (2000), Houthoofd and Heene (1997). Differences between strategic groups were interpreted by making reference to the projections and to the results of Pro-Fit analysis.

5.2 MULTIDIMENSIONAL SCALING ANALYSIS

Two separate ordinal MDS analyses were carried out: one using data for the year 1999 and another one using data for the year 2000. The results for the year 1999 will be described in detail here. Rather than dwell on the findings obtained for the year 2000, which are largely the same as for the year 1999, we will comment on the changes observed and their significance.

A value of 0.056 was found for Stress 1 for the year 1999, the equivalent figure for the year 2000 being 0.049. These values are described as "good" in Kruskal's (1964) verbal classification, and suggest that the configurations contain a story worth listening to. Configurations are a set of points on a sixth dimensional space. We show here only the results for the year 1999. It has long been known -see, for example, Thom (1989)- that even if many variables, or dimensions in our case, are involved in a model, only a small number of them may be relevant in a particular study. This was also found in this case. For this reason, rather than give all the projections on to pairs of dimensions, only projection on Dimension 1 and Dimension 2 is shown here. This can be seen in Figure 1.

Figure 1 about here

As was expected, given the presence of extreme observations, most companies in Figure 1 appear cluttered in a small area of the map. A few companies are clearly visible. Normally, meaning is associated with the dimensions, and this is a subject that will be pursued below, so that if a company appears far from the crowd in a particular dimension, it can be interpreted as having a high value of the characteristic measured by that dimension. It is to be noticed that LFMN, ADBE, EBAY, UPRO, YHOO, and KOOP are associated with large positive values of Dimension 1. Companies associated with large positive measurements in Dimension 2 are EBAY, YHOO, and UPRO. A distinctive group on the lower left hand side of Figure 1 is formed by the Brick-and-Click companies FON, GTE, AXP, and BELL. These companies are associated with negative values in both Dimension 1 and Dimension 2.

Examining projections on two dimensions can be deceptive, as two points may be far apart in the space but project next to each other in the configuration. This is why it is recommended to supplement a MDS analysis with the results of Cluster Analysis; Arabie et al (1987) and Chatfield and Collins (1980). Companies were clustered using the same standardized 34 variables and the

same measure of dissimilarity that had been employed to build the MDS configuration. Ward's clustering method was employed as it maximizes within group homogeneity and between group heterogeneity. The dendrogram was calculated, and several distinctive groups were found. In particular, a very large cluster was present, which was associated with the bulk of the companies. Cluster analysis grouped together GTE, FON, AXP, and BEL. It paired YHOO and EBAY. NXTL, ADBE, and LFMN were best viewed as single case clusters. This is consistent with their position in the configuration.

5.3 INTERPRETATION OF RESULTS

In each dimension of the configuration, a number of companies have shown up as being distinctive. In order to assess what is special about these companies meaning has to be attached to the axes. This was done by means of Pro-Fit analysis.

The idea behind Pro-Fit analysis is as follows. If a characteristic of the data is associated with position in the map, it can be conjectured that there is a relationship between the position on the map, as measured by the coordinates of the point, and the characteristic under investigation (property). Thus, the value that the property takes is a function of the coordinates of the point. As a first approximation this relationship is assumed to be a linear one, and a regression model is built in which the dependent variable is the value of the property and each coordinate is an explanatory variable. The extent to which the property is or is not well explained by the location of the point is measured by the coefficient of determination, R^2. It is possible to represent the results of the regression as a directional vector through the map, in such a way that the value of the property grows in the direction of the vector. For a mathematical proof see Mar Molinero (1991).

Variables were taken one at a time and treated as properties. The 34 variables on which the configuration was estimated (the first four being web metrics and the remaining 30 being ratios involving web metrics and financial information) were first treated as properties. This is known as Internal Analysis. Next, the DEA efficiency measure was treated as a property. Finally, the 38 financial ratios and stock market performance were also treated as properties. This use, at the interpretation stage, of variables that were not involved in model building is known as external analysis. External analysis was expected to allow us to link corporate strategy to financial success and to stock market performance.

Statistical results for Pro-Fit analysis are shown in Table 5. Not all the variables on which Pro-Fit analysis was performed have been plotted as directional vectors in Figure 1. Only those for which R^2 was greater than 60% are shown. Directional vectors that will be used to interpret the configuration are given in Figure 2. This includes the 34 variables involved in internal analysis, and the results of DEA. We could say that Figure 2 contains the compass that will help us to navigate through Figure 1.

Table 5 about here

Figure 2 about here

Most vectors point towards the right hand side of Figure 2. Recalling the parallel between PCA and MDS, the first dimension captures the first principal component, which is often taken as a general indicator of the main features in the data. The directional vector associated with DEA results follows the positive direction of Dimension 1 indicating that this dimension is related to productive efficiency. Also in the positive direction of Dimension 1, but on the positive side of Dimension 2, one finds a set of vectors related to ratios with the number of page hits in the numerator, and various expenditure items from the profit and loss account in the denominator (V25, V29, and V30). Continuing on the positive side of Dimension 1, but on the negative side of Dimension 2, one finds vectors corresponding to ratios with unique users or reach in the numerator, and various expenditure items in the denominator (V7, V11, V12, V16, V20, and V21).

It appears that Dimension 1 can be interpreted as efficiency as calculated by the DEA algorithm and the way in which this efficiency is obtained. DEA used web metrics as outputs, and various accounting items as inputs. Firms that achieve high web metrics with low expenditure or with a cheap infrastructure will be identified as efficient by the DEA algorithm. Ratios involving a web metric in the numerator and an accounting item in the denominator can be viewed as partial performance indicators. DEA combines all aspects of performance into a single measure.

Figure 1 shows that there are various ways of achieving efficient use of resources. A possibility, as in the top right hand side quadrant, is aim for a high number of page hits, as is the case with YHOO, EBAY, and UPRO. EBAY is the leader in Internet auctions, and its visitors spend long periods of time connected. YHOO, the leading Internet portal and directory, is visited in order to conduct searchers or obtain information on the most diverse subjects. UPRO is a popular games destination. These companies were identified as having 100% efficiency in section 4. A second

way of achieving a high level of efficiency is to concentrate on obtaining fidelity from unique users. This happens in the lower right-hand side quadrant of Figure 1. Firms in this quadrant are KOOP and LFMN. LFMN caters for various communities where users can access specialized information and resources. KOOP offers its users specialized medical information. These two firms were also identified as 100% efficient in Section 4. Using 1999 data, ADBE is also 100% efficient according to DEA and is situated in the efficient region of the MDS map. Dimension 1, thus measures an internal organization intangible asset that can be labeled "management efficiency". It is to be noticed that this intangible asset can be measured in two different ways, which appear to be equivalent: management efficiency rankings can be computed either through DEA, or through the value of the coordinate in Dimension 1.

The above discussion opens the way to the interpretation of Dimension 2. Towards the top of this dimension appear page hits per user (V2), and average time spent per user (V3). Both are pure web metric variables. It has also been argued that towards the top of Figure 1 we have firms that attempt to attract customers and keep them operating in their servers. They offer popular general services that everybody knows and anyone can access. They attract passing birds that take the opportunity to rest from their journey. This is an external structure intangible asset that could be labeled "audience retention". Towards the bottom of Figure 1 we find highly specialized companies whose aim is customer loyalty. This is another external structure intangible asset: "customer loyalty". Thus, Dimension 2 is associated to two different ways of creating an external intangible asset: image/customer.

It is worth thinking for a moment on a group of companies situated on the left hand side of Dimension 1, and towards the bottom of Dimension 2. This is the group formed by the communication companies GTE, FON, and BEL; and the financial services provider AXP. Both DEA and the position along Dimension 1 reflect the fact that, if efficiency is measured by the way in which the use of financial resources are used to produce web metrics, these are very inefficient firms. At the same time, they are profitable firms. Already, in section 2, we questioned whether these firms could be considered as dot com companies. This suggests a way of reading position on the lower left hand quadrant of Figure 1: it contains companies whose business is not the Internet, but use the Internet as a way of doing business.

Dimension 3 was associated with V8 (gross profit/reach), v17 (gross profit/unique visitors), V24 (revenues/page hits), 26 (gross profit/page hits), V32 (revenues/time spent), and V33 (gross profit/time spent). It can be deduced from this that this dimension is relating web metrics to revenues and profit.

The position on Dimension 4 appeared to be related to the structure of costs within the firm. Important ratios are V7, V11, V12, V16, V20, V21. These ratios have web metrics in the numerator, and costs in the denominator (R&D, selling and marketing costs, total operating expenses).

Dimension 5 was interpreted by making reference to cash flow considerations.

Financial ratios (V35 to V65) were also the subject of Pro-Fit analysis. The idea was to see if the firms that chose a particular strategic approach had a distinctive financial ratio structure. A question of interest is whether the position of the firm in the configuration is in any way related to financial success as traditionally measured by profitability ratios. However, the results of the relevant regression were very poor, with adjusted R^2 below 0.1 in most cases, indicating that no strategic way of organizing the firm gives a profitability advantage, and that the information provided by web metrics is of a different nature from the information captured by financial ratios. However, the reverse is not the case: Trueman et al (2000b) find that Web metrics can improve the prediction of future revenues.

In order to find out if stock market performance was in any way explained by the position of the firm in the configuration, a logistic regression exercise was performed, with variable V66 as the dependent variable, and the coordinates of firms in the configuration as covariates. Some effect was found, as the classification accuracy of the model was near 85% but, when examined in detail, this quality of fit was found to be related to missing data and to the presence of the previously discussed companies on the lower left hand quadrant in Figure 1.

Figure 3 plots DEA efficiency versus returns. The horizontal axis measures DEA efficiency for full model, using year 2000 data; the vertical axis shows adjusted returns between March 2000 and March 2001. No clear pattern emerges from this figure, which confirms the lack of correlation mentioned earlier. But this figure shows that firms can be divided in several groups according to their performance in the stock exchange: HSTD is highly valued in the markets and is DEA efficient; Southwest Airlines (LUV) is valued in the stock exchange and DEA inefficient, a common characteristic of the "Brick and Click" group of companies. A small group of firms, which includes Travelocity (TVLY), Ebay, About (BOUT) and particularly UPRO, SWBD, YHOO, ASKJ, IPRT, ASKJ, IPRT, LFMN and MYPT are DEA efficient and not valued by the markets.

Figure 3 about here

Hand (2000) finds that web traffic does not drive Net stock prices, but his sample includes firms such as the computer communications equipment manufacturer CISCO. We think that this is a topic that should be analyzed within particular strategic groups and not in the market as a whole as represented by the full sample. Demers and Lev (2000), on the other hand, study only business-to-consumer -B2C- Internet companies' share prices. Trueman et al (2000a) analyse only e-tailers and portal and content/community firms. Keating et al (2001), who give a literature review, also concentrate on a specific sector of business: infrastructure firms.

5.4 TIME EVOLUTION

There are various ways in which time evolution can be explored by means of scaling methods. Two-way MDS configurations are invariant to rotation. Thus, even if two configurations are topologically equivalent to each other in the space, they may project differently on to sets of two dimensions, and we may conclude that there has been a great deal of change when this has not really been the case. There are techniques that can be used to compare configurations, but this involves rotations and changes of scale. One such technique is Procrustes analysis; Goodall (1991). Another approach is to use a three-way model that includes time as an extra characteristic of the data set. Several scaling models are available for the representation of three way data; Tucker's (1966) extension of Factor Analysis, the PARAFAC model of Harshman (1970), and Ramsay's (1982) MULTISCALE, and Carroll and Chang's (1970) INDSCAL. See Kiers (1998) for a literature review.

A first attempt at incorporating the time effect was to construct a dissimilarity matrix between companies for the year 1999, an dissimilarity matrix between companies for the year 2000, and estimate the common map from INDSCAL. However, INDSCAL expects the relative position of the points in the space to remain largely unchanged, something that does not happen in this case. Take DEA efficiency as an example. Companies whose DEA efficiency changes, migrate through the configuration along Dimension 1 and change relative position with respect to the companies whose efficiency does not change. Thus, the attempt to use INDSCAL in this way was not successful.

Two approaches to time evolution were taken. The first one was simply to repeat the analysis with year 2000 data. This involved producing a new configuration, repeating the Pro-Fit analysis, repeating the cluster analysis, and re-interpreting the results. When this was done, Dimension 1 was again found to be associated with DEA efficiency, and was interpreted in the same way as it

was in the case of 1999 data, as measuring the intangible asset "management efficiency". The companies that were situated towards the right hand side of Dimension 1 changed. ADBE lost its position as an extreme case and joined the bulk of the firms, as would be expected from the results of the DEA analysis. TVLY, on the other hand, left its position within the bulk of companies and became an extreme case. In fact, all the companies whose DEA efficiency had increased moved towards the right hand side of the configuration, and all the companies whose DEA efficiency had decreased moved towards the left. Changes were found, however, when Dimension 2 was studied. This dimension was found to have rotated 180 degrees: dot com companies aiming at the passing bird were now situated towards the bottom of this dimension, while specialized companies aiming at attracting customers and keeping their loyalty, were situated towards the top of this dimension. This did not affect to the interpretation of this dimension, which continued to be related to image as an intangible asset.

The previous way of dealing with the time dynamics is perfectly appropriate, but requires a great deal of effort because all the dimensions have to be reinterpreted, all Pro-Fit analyses need to be redone, and a new cluster analysis performed, which is not a trivial amount of work. This brings us to a second, more pragmatic way of assessing evolution over time. Companies were taken one at a time and added as an extra point in the configuration obtained from 1999 data. In this way, it was possible to assess, taking 1999 as a basis, what had changed for this company between 1999 and 2000. An example of this type of analysis, albeit in the context of bank failure, can be seen in Mar Molinero and Serrano Cinca (2001) who studied the path to bankruptcy of a particular bank, using as the basis for the study a previously existing configuration. This approach is particularly useful to detect the changes in strategy for individual companies. Different research questions require different approaches to modelling: different horses perform well in different courses.

6. CONCLUSIONS

This paper has been concerned with dot com companies, intangible assets, efficiency measurement, and strategic patterns of behaviour. A sample of 76 companies that shared the characteristics of operating in the Internet, publishing annual accounts, and be listed in the stock exchange was taken. The study was performed using year 1999 and year 2000 data.

The study was based on web traffic measures, ratios that involved the relationship between web metrics and accounting items, pure accounting ratios, and a measure of stock exchange performance.

The issue of efficiency was addressed by means of Data Envelopment Analysis. Comparative efficiency thus calculated was used as another variable in the analysis.

Modelling was based on multivariate statistical methods, in particular Multidimensional Scaling, which has the property of visualizing the main features of the data through statistical maps. Such maps were interpreted with the help of hierarchical cluster analysis, and Property Fitting, a regression based approach.

The statistical maps were built in a six dimensional space, but the first two dimensions were found to be of particular relevance, and could be interpreted as measurements of intangible assets. The first dimension was found to be related to an intangible asset of internal structure identified as management efficiency. The second dimension was found to be associated with an intangible asset of external structure identified as customer/image. This second dimension had two aspects. On one direction it identified companies that attracted and kept the passing customer, and on the other direction it identified companies that provided specialised services for subscribers.

Pure financial ratios, and the measure of stock market performance, were found not to add anything to the interpretation of the results. Thus, it was concluded, that there are different ways in which a firm can operate in the Internet, and there are different financial structures that can be associated with a firm, but that the two measure independent aspects of the firm.

Evolution over time was also explored. Substantial change was found between the two years, confirming the view that this is a very dynamic sector. Nevertheless, the main interpretation of the results as being related to an internal and an external intangible asset remained unchanged. Suggestions were made on how to study change for individual companies using the methodology described in this paper.

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No	Name	Ticker	Web address	SICCODE
1	ABOUT COM INC	BOUT	http://www.about.com	SIC-7370 Services-Computer Programming, Data Processing
2	ADOBE SYSTEMS INC	ADBE	http://www.adobe.com	SIC-7372 Prepackaged Software
3	ALLOY ONLINE INC.	ALOY	http://www.alloy.com	SIC-5961 Catalog & Mail-Order Houses
4	AMAZON COM INC	AMZN	http://www.amazon.com	SIC-5961 Catalog & Mail-Order Houses
5	AMERICAN EXPRESS	AXP	http://www.americanexpress.com	SIC-6199 Finance Services
6	AMERITRADE HOLDING CORP	AMTD	http://www.ameritrade.com	SIC-6211 Security Brokers
7	ASK JEEVES INC	ASKJ	http://www.ask.com	SIC-7389 Business Services
8	AUDIBLE INC	ADBL	http://www.audible.com	SIC-7389 Business Services
9	AUDIOHIGHWAY	AHWYQ	http://www.audiohighway.com	SIC-7374 Computer Processing
10	AUTOBYTEL COM INC.	ABTL	http://www.autobytel.com	SIC-5900 Retail
11	AUTOWEB COM	AWEB	http://www.autoweb.com	SIC-7500 Auto repair, services and garages
12	BARNESANDNOBLE COM INC	BNBN	http://www.barnesandnoble.com	SIC-5735 Retail-Record & Prerecorded Tape Stores
13	BELL ATLANTIC CORP	BEL	http://www.bell.com	SIC-4813 Telephone Communications
14	BELLSOUTH	BLS	http://www.bellsouth.com	SIC-4813 Telephone Communications
15	BIGSTAR ENTERT INC	BGST	http://www.bigstar.com	SIC-5961 Catalog & Mail-Order Houses
16	BUY COM INC	BUYX	http://www.buy.com	SIC-5734 Computer & Computer Software Stores
17	CDNOW INC/PA	CDNW	http://www.cdnow.com	SIC-5735 Record & Prerecorded Tape Stores
18	CISCO SYSTEMS INC	CSCO	http://www.cisco.com	SIC-3576 Computer Communications Equipment
19	CNET NETWORKS INC	CNET	http://www.cnet.com	SIC-7812 Motion Picture and Video Tape Production
20	COOLSAVINGS COM INC	CSAV	http://www.coolsavings.com	SIC-7389 Business Services
21	CROSSWALK	AMEN	http://www.crosswalk.com	SIC-7371 Computer Programming Services
22	CYBERGOLD INC	CGLD	http://www.cybergold.com	SIC-7311 Advertising Agencies
23	DELL COMPUTER CORP	DELL	http://www.dell.com	SIC-3571 Electronic Computers
24	DOUBLECLICK INC	DCLK	http://www.doubleclick.com	SIC-7310 Services-Advertising
25	DRKOOP CPM INC	KOOP	http://www.drkoop.com	SIC-8090 Miscellaneous Health and Allied Services
26	EARTHLINK INC	ELNK	http://www.earthlink.com	SIC-7370 Services-Computer Programming, Data Processing
27	EBAY INC	EBAY	http://www.ebay.com	SIC-7389 Business Services
28	EDGAR ONLINE	EDGR	http://www.edgaronline.com	SIC-7389 Business Services
29	EFAX	EFAX	http://www.efax.com	SIC-3577 Computer Peripheral Equipment, NEC Plotter Controll
30	EGGHEAD COM INC/DE	EGGS	http://www.egghead.com	SIC-5961 Catalog & Mail-Order Houses
31	EGREETINGS NETWORK INC	EGRT	http://www.egreetings.com	SIC-7389 Business Services
32	FASHIONMALL	FASH	http://www.fashionmall.com	SIC-5949 Sewing, Needlework, and Piece Goods Stores
33	FATBRAIN	FATB	http://www.fatbrain.com	SIC-5990 Retail Stores
34	FREESHOP COM INC	APTM	http://www.freeshop.com	SIC-7389 Business Services
35	GATEWAY INC	GTW	http://www.gateway.com	SIC-3571 Electronic Computers
36	GOTO COM INC	GOTO	http://www.goto.com	SIC-7389 Business Services
37	GTE CORP	GTE	http://www.gte.com	SIC-4813 Telephone Communications, Except Radiotelephone
38	HEADHUNTER NET INC	HHNT	http://www.headhunter.net	SIC-7389 Business Services
39	HOMESTEAD COM INC	HSTD	http://www.homesteadbank.com	SIC-6035 Savings and loan associations
40	HOTJOBS COM LTD	HOTJ	http://www.hotjobs.com	SIC-7389 Business Services
41	INFOSPACE INC	INSP	http://www.infospace.com	SIC-7374 Computer Processing and Data Preparation
42	INSWEB CORPORATION	INSW	http://www.insweb.com	SIC-7389 Business Services
43	INTEL	INTC	http://www.intel.com	SIC-3674 Semiconductors and Related

				Devices
44	IPRINT COM INC	IPRT	http://www.iprint.com	SIC-7389 Services-Business Services
45	IVILLAGE	IVIL	http://www.ivillage.com	SIC-2721 Periodicals, Paper
46	JFAX COM INC	JCOM	http://www.j2.com	SIC-4822 Telegraph & Other Message Communications
47	LIFEMINDERS INC	LFMN	http://www.lifeminders.com	SIC-7389 Services-Business Services
48	LOOKSMART LTD	LOOK	http://www.looksmart.com	SIC-7374 Computer Processing and Data Preparation
49	MAPQUEST COM INC	MQST	http://www.mapquest.com	SIC-7374 Computer Processing and Data Preparation
50	MARKETWATCH COM INC	MKTW	http://www.marketwatch.com	SIC-7374 Computer Processing and Data Preparation
51	MCAFEE COM CORP	MCAF	http://www.mcafee.com	SIC-7389 Business Services
52	MEDICONSULT COM INC.	MCNS	http://www.mediconsult.com	SIC-7310 Services-Advertising
53	MEDSCAPE INC	MDLI	http://www.medscape.com	SIC-7374 Computer Processing and Data Preparation and
54	MOTHERNATURE COM INC	MTHR	http://www.mothernature.com	SIC-5412 Retail-Convenience Stores
55	MUSICMAKER COM	HITS	http://www.musicmaker.com	SIC-5961 Retail-Catalog & Mail-Order Houses
56	MYPOINTS COM INC	MYPT	http://www.mypoints.com	SIC-7370 Services-Computer Programming, Data Processing
57	NBC INTERNET INC	NBCI	http://www.nbci.com	SIC-7389 Business Services
58	NEXTCARD INC	NXCD	http://www.nextcard.com	SIC-6141 Personal Credit Institutions
59	NEXTEL COMMUNIC INC	NXTL	http://www.nextel.com	SIC-4812 Radiotelephone Communications
60	NOVELL INC	NOVL	http://www.novell.com	SIC-7372 Services-Prepackaged Software
61	ONHEALTH NETWORK CO	ONHN	http://my.webmd.com	SIC-7372 Services-Prepackaged Software
62	PRODIGY COMMUNIC. CORP	PRGY	http://www.prodigy.com	SIC-7370 Services-Computer Programming, Data Processing, Etc.
63	SOUTHWEST AIRLINES CO	LUV	http://www.southwest.com	SIC-4512 Air Transportation, Scheduled
64	SPORTSLINE COM INC	SPLN	http://www.sportsline.com	SIC-7374 Services-Computer Processing & Data Preparation
65	SPRINT CORP	FON	http://www.sprint.com	SIC-4813 Telephone Communications (No Radiotelephone)
66	STAPLES INC	SPLS	http://www.staples.com	SIC-5940 Retail-Miscellaneous Shopping Goods Stores
67	SWITCHBOARD INC	SWBD	http://www.switchboard.com	SIC-7389 Services-Business Services
68	THE STREET COM	TSCM	http://www.thestreet.com	SIC-2711 Newspapers: Publishing or Publishing & Printing
69	THEGLOBE COM INC	TGLO	http://www.theglobe.com	SIC-7310 Services-Advertising
70	TICKETMASTER	TMCS	http://www.ticketmaster.com	SIC-7990 Services-Miscellaneous Amusement & Recreation
71	TRVELOCITY COM INC	TVLY	http://www.travelocity.com	SIC-6770 Blank Checks
72	UBID INC	UBID	http://www.ubid.com	SIC-5961 Retail-Catalog & Mail-Order Houses
73	UPROAR INC	UPRO	http://www.uproar.com	SIC-7374 Services-Computer Processing & Data Preparation
74	VERISIGN INC	VRSN	http://www.verisign.com	SIC-7371 Services-Computer Programming Services
75	WOMEN	WOMN	http://www.women.com	SIC-2741 Miscellaneous Publishing
76	YAHOO INC	YHOO	http://www.yahoo.com	SIC-7373 Services-Computer Integrated Systems Design

Table 1. Companies in the sample

V1 Reach
V2 Page Views per User
V3 Avg. time spent per user
V4 Avg. time spent per page
V5 Reach/Number of employees
V6 Revenues/Reach
V7 Reach/Selling & Marketing Expenses
V8 Gross Profit/Reach
V9 Reach/Cash Flow
V10 Reach/Total Assets
V11 Reach/R&D Expenses
V12 Reach/Total Operating Expenses
V13 Reach/Total Liabities
V14 Unique Visitors/Number of employees
V15 Revenues /Unique Visitors
V16 Unique Visitors/Selling & Marketing Expenses
V17 Gross Profit/Unique Visitors
V18 Unique Visitors/Cash Flow
V19 Unique Visitors/Total Assets
V20 Unique Visitors/R&D Expenses
V21 Unique Visitors/Total Operating Expenses
V22 Unique Visitors/Total Liabilities
V23 Page views/Number of employees
V24 Revenues/Page Views
V25 Page views/Selling & Marketing
V26 Gross Profit/Page Views
V27 Page Views/Cash Flow
V28 Page Views/Total Assets
V29 Page Views/R&D Expenses
V30 Page Views/Total Operating Expenses
V31 Page Views/Total Liabilities
V32 Revenues/Hours
V33 Gross Profit/Hours
V34 Hours/Total Operating Expenses
V35 Cash Flow / Total Assets
V36 Total Current Assets/ Total Assets
V37 Cash Flow/Revenues
V38 Total Current Assets/Revenues
V39 Cash Flow/Total Current Liabilities
V40 Total Current Assets/Total Current Liabilities
V41 Revenues/Property and Equipment
V42 Revenues/Total Assets
V43 Net Profit/Revenues
V44 Net Profit/(Total Assets-Current Assets)
V45 Net Profit/Total Assets
V46 Gross Profit/Revenues
V47 Gross Profit/Revenues
V48 Gross Profit/(Total Assets-Current Assets)
V49 Profit from Operations/ Total Assets
V50 Net Profit/Total liabilities
V51 Net Profit/ Shareholders´equity
V52 Net Profit/Cash Flow
V53 Total Liabilities/Shareholders´equity
V54 Total Liabilities/Total Assets
V55 Total Current liabilities/Total Liabilities
V56 Interest income/Revenues
V57 Interest income/Total Liabilities
V58 R&D Expenses/Revenues
V59 Selling and Marketing Expenses/Revenues
V60 General and Adm. Expenses/Revenues
V61 Total Operating Expenses/Revenues
V62 Revenues/Number of Employees
V63 Net Profit/Number of Employees
V64 Total Liabilities/Number of Employees
V65 R+D Expenses/Number of Employees
V66 Stock market performance
V67 DEA Efficiency

Table 2. Variables in the study

NAME	*Ticker*	*Score 1999*	*Score 2000*
ABOUT COM INC	BOUT	100.00%	84.32%
ADOBE SYSTEMS INC	ADBE	100.00%	2.00%
ALLOY ONLINE INC.	ALOY	33.85%	19.22%
AMAZON COM INC	AMZN	5.86%	5.45%
AMERICAN EXPRESS	AXP	0.01%	0.01%
AMERITRADE HOLDING CORP	AMTD	0.76%	1.10%
ASK JEEVES INC	ASKJ	66.26%	100.00%
AUDIBLE INC	ADBL	14.33%	6.33%
AUDIOHIGHWAY	AHWYQ	12.93%	34.27%
AUTOBYTEL COM INC.	ABTL	6.60%	7.09%
AUTOWEB COM	AWEB	11.24%	21.04%
BARNESANDNOBLE COM INC	BNBN	7.93%	7.92%
BELL ATLANTIC CORP	BEL	0.01%	0.01%
BELLSOUTH	BLS	0.03%	0.03%
BIGSTAR ENTERTAINMENT INC	BGST	75.57%	27.84%
BUY COM INC	BUYX	12.64%	15.43%
CDNOW INC/PA	CDNW	25.76%	31.72%
CISCO SYSTEMS INC	CSCO	8.77%	4.96%
CNET NETWORKS INC	CNET	23.95%	16.83%
COOLSAVINGS COM INC	CSAV	66.56%	89.05%
CROSSWALK	AMEN	24.43%	11.14%
CYBERGOLD INC	CGLD	100.00%	83.17%
DELL COMPUTER CORP	DELL	0.12%	0.20%
DOUBLECLICK INC	DCLK	3.49%	11.93%
DRKOOP CPM INC	KOOP	100.00%	37.80%
EARTHLINK INC	ELNK	7.28%	4.56%
EBAY INC	EBAY	100.00%	100.00%
EDGAR ONLINE	EDGR	13.96%	9.59%
EFAX	EFAX	14.27%	15.49%
EGGHEAD COM INC/DE	EGGS	10.76%	7.76%
EGREETINGS NETWORK INC	EGRT	53.89%	49.11%
FASHIONMALL	FASH	71.76%	14.69%
FATBRAIN	FATB	2.33%	2.50%
FREESHOP COM INC	APTM	65.78%	100.00%
GATEWAY INC	GTW	0.13%	0.54%
GOTO COM INC	GOTO	86.38%	50.67%
GTE CORP	GTE	0.02%	0.02%
HEADHUNTER NET INC	HHNT	79.07%	46.94%
HOMESTEAD COM INC	HSTD	95.03%	100.00%
HOTJOBS COM LTD	HOTJ	15.38%	12.87%
INFOSPACE INC	INSP	100.00%	32.70%
INSWEB CORPORATION	INSW	1.98%	15.66%
INTEL	INTC	1.78%	0.17%
IPRINT COM INC	IPRT	50.44%	100.00%
IVILLAGE	IVIL	18.33%	16.68%
JFAX COM INC	JCOM	3.06%	5.83%
LIFEMINDERS INC	LFMN	100.00%	100.00%
LOOKSMART LTD	LOOK	42.02%	35.44%
MAPQUEST COM INC	MQST	34.68%	82.55%
MARKETWATCH COM INC	MKTW	39.38%	29.35%
MCAFEE COM CORP	MCAF	53.24%	37.76%
MEDICONSULT COM INC.	MCNS	13.27%	6.14%

MEDSCAPE INC/MEDICALOGIC	MDLI	2.59%	6.46%
MOTHERNATURE COM INC	MTHR	9.73%	24.09%
MUSICMAKER COM	HITS	10.28%	9.75%
MYPOINTS COM INC	MYPT	71.65%	100.00%
NBC INTERNET INC	NBCI	10.12%	3.42%
NEXTCARD INC	NXCD	23.32%	12.23%
NEXTEL COMMUNICATIONS INC	NXTL	0.01%	0.03%
NOVELL INC	NOVL	0.07%	0.08%
ONHEALTH NETWORK CO	ONHN	21.59%	100.00%
PRODIGY COMMUNICATIONS CORP	PRGY	5.37%	23.39%
SOUTHWEST AIRLINES CO	LUV	0.07%	0.21%
SPORTSLINE COM INC	SPLN	22.52%	29.26%
SPRINT CORP	FON	0.02%	0.03%
STAPLES INC	SPLS	0.07%	0.25%
SWITCHBOARD INC	SWBD	100.00%	96.95%
THE STREET COM	TSCM	12.56%	9.65%
THEGLOBE COM INC	TGLO	25.69%	44.86%
TICKETMASTER ONLINE	TMCS	6.41%	16.76%
TRAVELOCITY COM INC	TVLY	59.04%	100.00%
UBID INC	UBID	39.76%	25.31%
UPROAR INC	UPRO	100.00%	100.00%
VERISIGN INC	VRSN	0.87%	3.50%
WOMEN	WOMN	11.03%	38.72%
YAHOO INC	YHOO	100.00%	100.00%

Table 3. DEA efficiency estimates.

Ticker	*1999*	*2000*
ADBE	V7 V11 V12 V16 V20 V21 V25 V30 V34	
ALOY	V11 V20 V29	V11 V20 V29
AXP	V11 V20 V24 V26 V29 V32 V33	V11 V20 V29
AMTD	V11 V20 V29	V11 V20 V29
BEL	V6 V7 V11 V15 V16 V17 V20 V24 V25 V26 V29 V32	V6 V7 V8 V11 V15 V16 V17 V20 V24 V25 V26 V29 V32 V33
BLS	V7 V11 V16 V20 V25 V29	V7 V11 V16 V20 V25 V29
CNET	V11 V20 V29	V11 V20 V29
AMEN	V11 V20 V29	V11 V20 V29
KOOP	V9 V10 V18 V19 V27 V28	
ELNK	V11 V20 V29	V11 V20 V29
EBAY	V2 V3 V23 V25 V29 V30 V31 V34	V2 V3 V25 V29 V30 V31
EGGS	V11 V20 V29	V11 V20 V29
EGRT	V9 V18 V27	
GTW	V11 V20 V29	V29 V20 V11
GTE	V6 V8 V11 V20 V29	V29 V20 V11
HHNT	V11 V20 V27 V29	V29 V20 V11
HSTD	V7 V11 V16 V20 V25 V29	V5 V7 V9 V11 V12 V14 V16 V18 V20 V21 V23 V25 V27 V29 V30 V34
INSP	V5 V14	
INTC	V7 V16 V25	V6 V7 V8 V15 V16 V17 V25 V26 V33
IPRT		V7 V16
LFMN	V9 V10 V13 V18 V19 V22 V28	V11 V20
MKTW	V9 V18	
MCAF	V27 V18 V9	
NXCD	V11 V20 V29	V11 V20 V29
NXTL	V7 V8 V11 V16 V17 V20 V25 V26 V29 V33	V11 V20 V29
PRGY		V3
LUV	V7 V11 V16 V20 V25 V29	V7 V11 V16 V20 V25 V29
SPLN		V29
FON	V24 V32	V11 V20 V24 V29 V32
SPLS	V11 V20 V29	V29 V20 V11
TVLY	V9 V18 V27	V9 V10 V18 V19 V27 V28
UPRO	V4 V13 V22 V31 V34	V31
WOMN		V4
YHOO	V1 V2 V3 V31	V1 V2 V3 V25

Table 4. Outliers. Variables involved.

	Directional cosines						*F*	*Adj. R square*
	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6		
V_1	0.28	0.63	-0.11	0.32	-0.63	0.00	17.31	0.566
	(3.990)**	(7.332)**	(-1.265)	(3.212)*	(-4.815)**	(1.658)		
V_2	0.35	0.66	0.34	0.50	0.27	-0.07	206.25	0.943
	(15.450)* *	(23.792)**	(11.882)**	(15.512)**	(6.378)**	(-1.525)		
V_3	0.32	0.67	0.41	0.41	0.00	-0.32	58.31	0.821
	(7.485)**	(12.773)**	(7.644)**	(6.735)**	(2.562)*	(-3.638)**		
V_4	0.00	-0.02	0.29	-0.30	0.04	-0.91	8.97	0.389
	(-0.070)	(-0.236)	(3.311)*	(-3.075)*	(0.309)	(-6.257)**		
V_5	0.36	0.30	-0.42	0.22	-0.56	0.49	23.54	0.643
	(6.585)**	(4.516)**	(-6.140)**	(2.861)*	(-5.443)**	(4.251)**		
V_6	-0.21	-0.29	0.66	0.12	0.04	-0.64	9.12	0.394
	(-2.325)	(-2.707)*	(5.957)**	(0.961)	(0.257)	(-3.486)**		
V_7	0.62	-0.29	0.14	-0.70	-0.02	0.13	123.27	0.914
	(20.104)**	(-7.098)**	(3.038)**	(-12.821)**	(-0.310)	(2.026)		
V_8	-0.13	-0.26	0.50	0.48	-0.34	-0.57	43.11	0.771
	(-2.940)*	(-4.936)**	(9.090)**	(7.773)**	(-4.250)**	(-6.263)**		
V_9	0.42	-0.40	-0.41	0.38	0.60	0.03	96.67	0.889
	(14.744)**	(-11.518)**	(-11.439)**	(9.476)**	(11.317)**	(0.470)		
V_{10}	0.54	-0.54	-0.43	0.27	0.16	-0.37	48.87	0.793
	(10.262)**	(-8.498)**	(-6.594)**	(3.735)**	(1.674)	(-3.393)*		
V_{11}	0.63	-0.12	-0.01	-0.73	-0.15	0.18	67.92	0.874
	(14.413)**	(-1.693)	(-0.117)	(-7.617)**	(-1.606)	(1.612)		
V_{12}	0.67	-0.30	0.12	-0.61	-0.23	0.11	59.50	0.824
	(14.164)**	(-5.241)**	(1.976)	(-9.106)**	(-2.605)*	(1.092)		
V_{13}	0.47	-0.22	-0.47	0.01	-0.56	-0.44	52.31	0.804
	(9.734)**	(-3.790)**	(-7.711)**	(0.168)	(-6.235)**	(-4.417)**		
V_{14}	0.36	0.30	-0.42	0.22	-0.56	0.49	23.49	0.643
	(6.579)**	(4.508)**	(-6.137)**	(2.865)*	(-5.434)**	(4.249)**		
V_{15}	-0.04	-0.47	0.70	0.18	0.01	0.50	13.39	0.498
	(-0.475)	(-4.565)**	(6.722)**	(1.548)	(0.084)	(2.897)*		
V_{16}	0.62	-0.29	0.14	-0.70	-0.02	0.13	122.45	0.914
	(20.057)**	(-7.085)**	(2.992)*	(-12.751)**	(-0.316)	(1.999)		
V_{17}	-0.04	-0.31	0.45	0.65	-0.52	0.00	30.95	0.706
	(-0.672)	(-4.572)**	(6.370)**	(8.212)**	(-4.944)**	(-1.166)		
V_{18}	0.42	-0.40	-0.41	0.38	0.60	0.03	99.30	0.891
	(14.952)**	(-11.668)**	(-11.577)**	(9.614)**	(11.485)**	(0.475)		
V_{19}	0.00	0.00	0.00	0.00	-1.00	0.00	48.74	0.792
	(10.247)**	(-8.485)**	(-6.583)**	(3.736)**	(1.682)	(-3.391)**		
V_{20}	0.63	-0.12	-0.01	-0.73	-0.16	0.18	68.05	0.874
	(14.433)**	(-1.698)	(-0.127)	(-7.603)**	(-1.630)	(1.598)		
V_{21}	0.68	-0.30	0.12	-0.61	-0.23	0.11	59.76	0.825
	(14.209)**	(-5.255)**	(1.953)	(-9.106)**	(-2.614)*	(1.086)		
V_{22}	0.47	-0.22	-0.47	0.01	-0.56	-0.44	52.35	0.804
	(9.741)**	(-3.791)**	(-7.711)**	(0.169)	(-6.238)**	(-4.417)**		
V_{23}	0.41	0.67	0.28	0.52	0.16	0.09	77.90	0.860
	(10.935)**	(14.465)**	(5.891)**	(9.754)**	(2.332)	(1.185)		
V_{24}	-0.06	-0.44	0.53	0.28	-0.10	0.66	23.04	0.638
	(-0.972)	(-6.078)**	(7.077)**	(3.309)**	(-0.947)	(5.345)**		
V_{25}	0.86	0.42	0.29	-0.02	0.02	0.07	94.12	0.890
	(20.596)**	(7.605)**	(4.561)**	(-0.262)	(0.222)	(0.761)		
V_{26}	-0.04	-0.37	0.47	0.63	-0.48	0.10	72.08	0.850
	(-0.964)	(-8.194)**	(10.275)**	(12.073)**	(-7.054)**	(1.261)		

$\mathbf{V_{27}}$	0.39	-0.16	-0.23	0.45	0.74	0.14	32.80	0.726
	(9.147)**	(-2.994)*	(-4.377)**	(7.483)**	(9.268)**	(1.626)		
$\mathbf{V_{28}}$	0.60	-0.36	-0.39	0.42	0.32	-0.28	50.78	0.799
	(12.139)**	(-6.003)**	(-6.336)**	(6.065)**	(3.551)**	(-2.754)*		
$\mathbf{V_{29}}$	0.51	0.54	0.49	0.42	0.13	-0.14	67.10	0.872
	(11.270)**	(7.407)**	(5.153)**	(4.234)**	(1.280)	(-1.250)		
$\mathbf{V_{30}}$	0.78	0.52	0.28	0.17	-0.02	0.08	120.54	0.905
	(21.865)**	(12.030)**	(6.172)**	(3.376)**	(-0.370)	(1.014)		
$\mathbf{V_{31}}$	0.49	0.45	-0.16	0.24	-0.58	-0.37	41.17	0.763
	(9.521)**	(7.125)**	(-2.509)*	(3.347)**	(-5.991)**	(-3.431)**		
$\mathbf{V_{32}}$	-0.04	-0.41	0.44	0.30	-0.13	0.73	25.00	0.658
	(-0.728)	(-6.123)**	(6.524)**	(3.944)**	(-1.275)	(6.470)**		
$\mathbf{V_{33}}$	-0.02	-0.39	0.47	0.64	-0.47	0.00	69.37	0.845
	(-0.644)	(-8.452)**	(9.787)**	(11.878)**	(-6.561)**	(3.383)**		
$\mathbf{V_{34}}$	0.80	0.36	0.35	-0.19	-0.21	-0.17	61.16	0.828
	(15.442)**	(5.677)**	(5.405)**	(-2.645)*	(-2.143)	(-1.619)		
DEA	0.73	0.19	-0.39	0.15	-0.37	0.35	48.89	0.793
	(14.478)**	(3.178)*	(-6.257)**	(2.061)	(-3.972)**	(3.345)**		

** Significant at the 0.01 level. * Significant at the 0.05 level

Table 5. Pro-Fit Analysis. Regression results

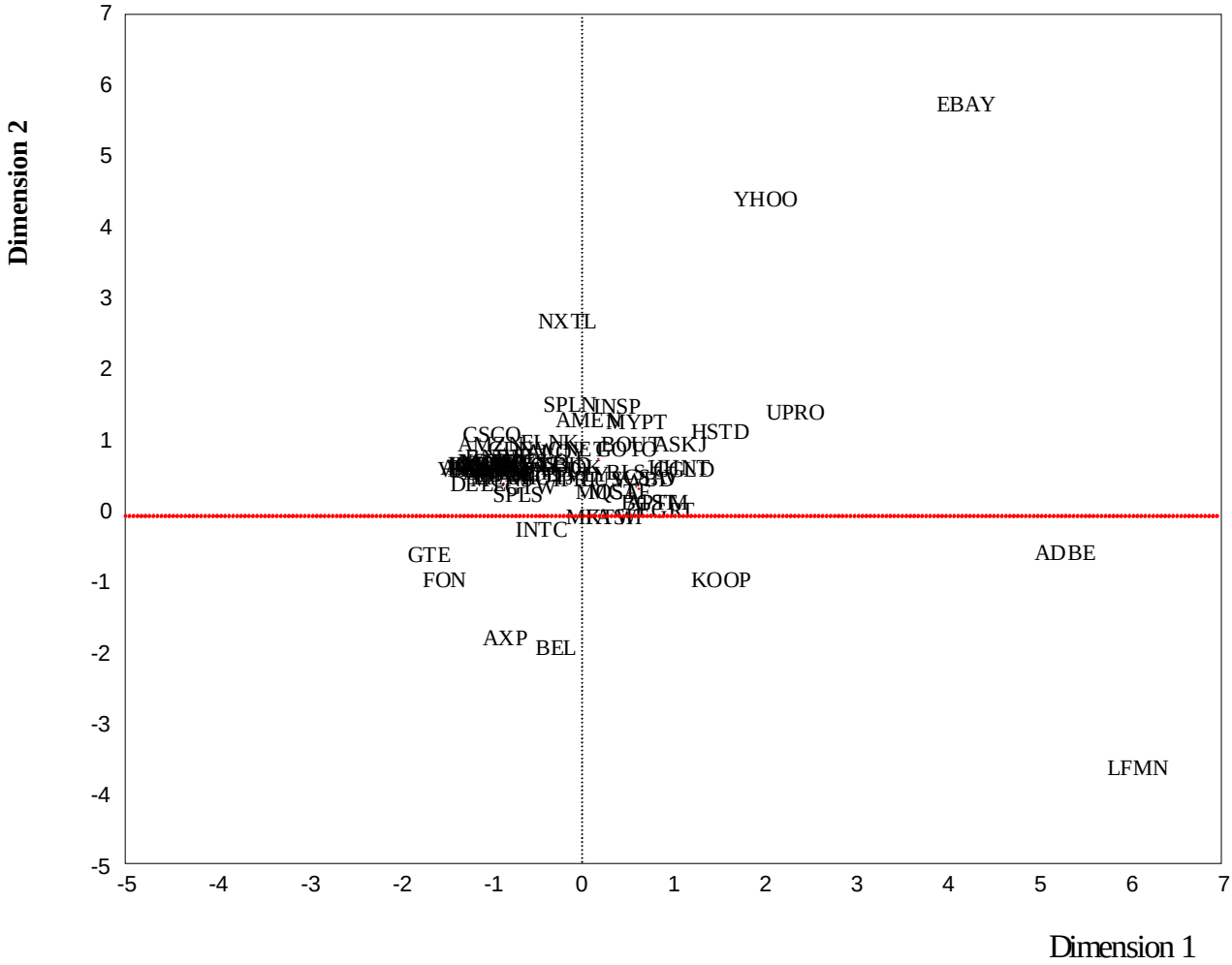

Figure 1. Multidimensional scaling results. Projection on Dimension 1 and Dimension 2. As argued in the text, most companies plot in a small area and their names overlap. The interesting companies are the ones whose name can be clearly read.

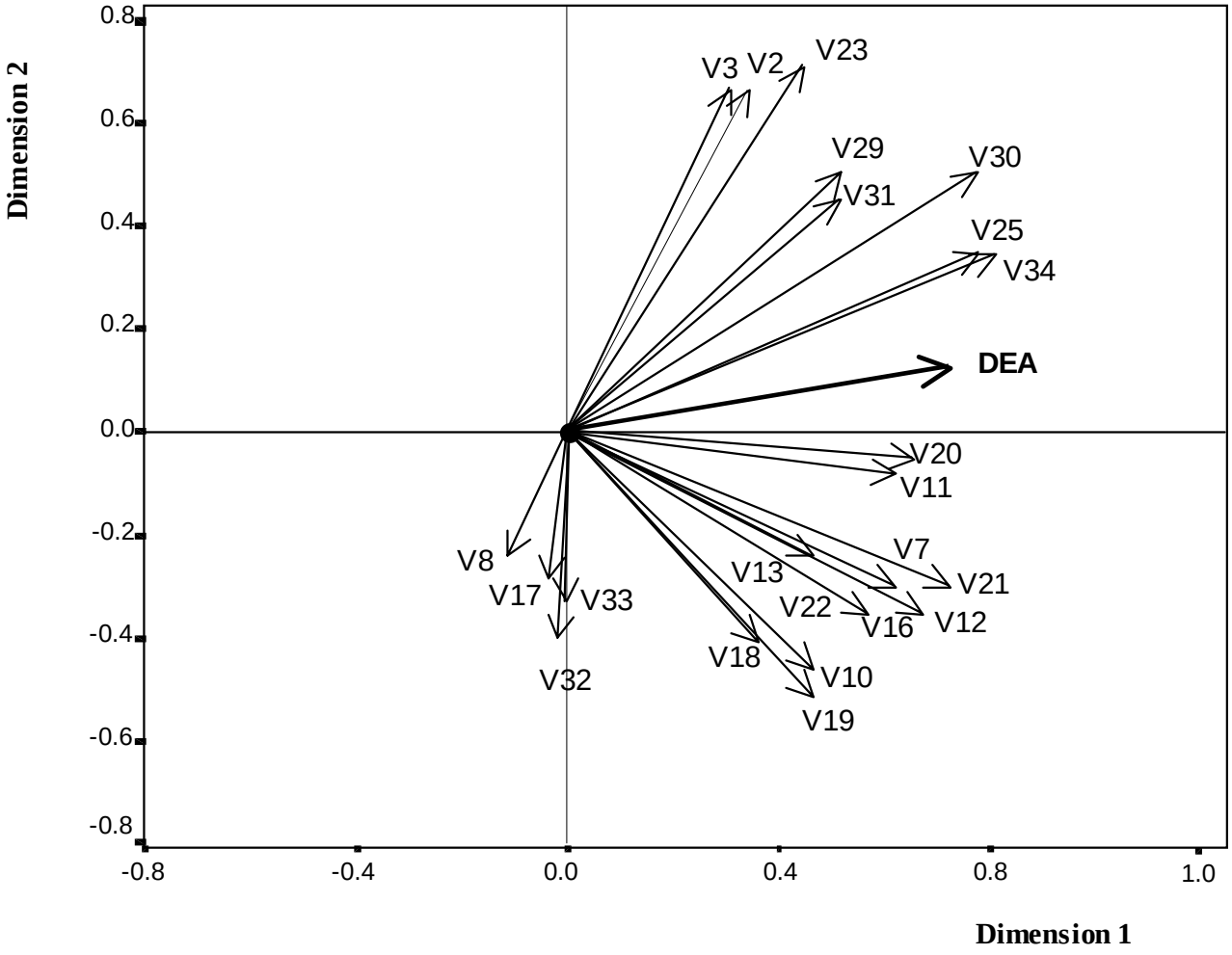

Figure 2. ProFit Analysis. Vectors for each variable. Dimension 1 and 2.

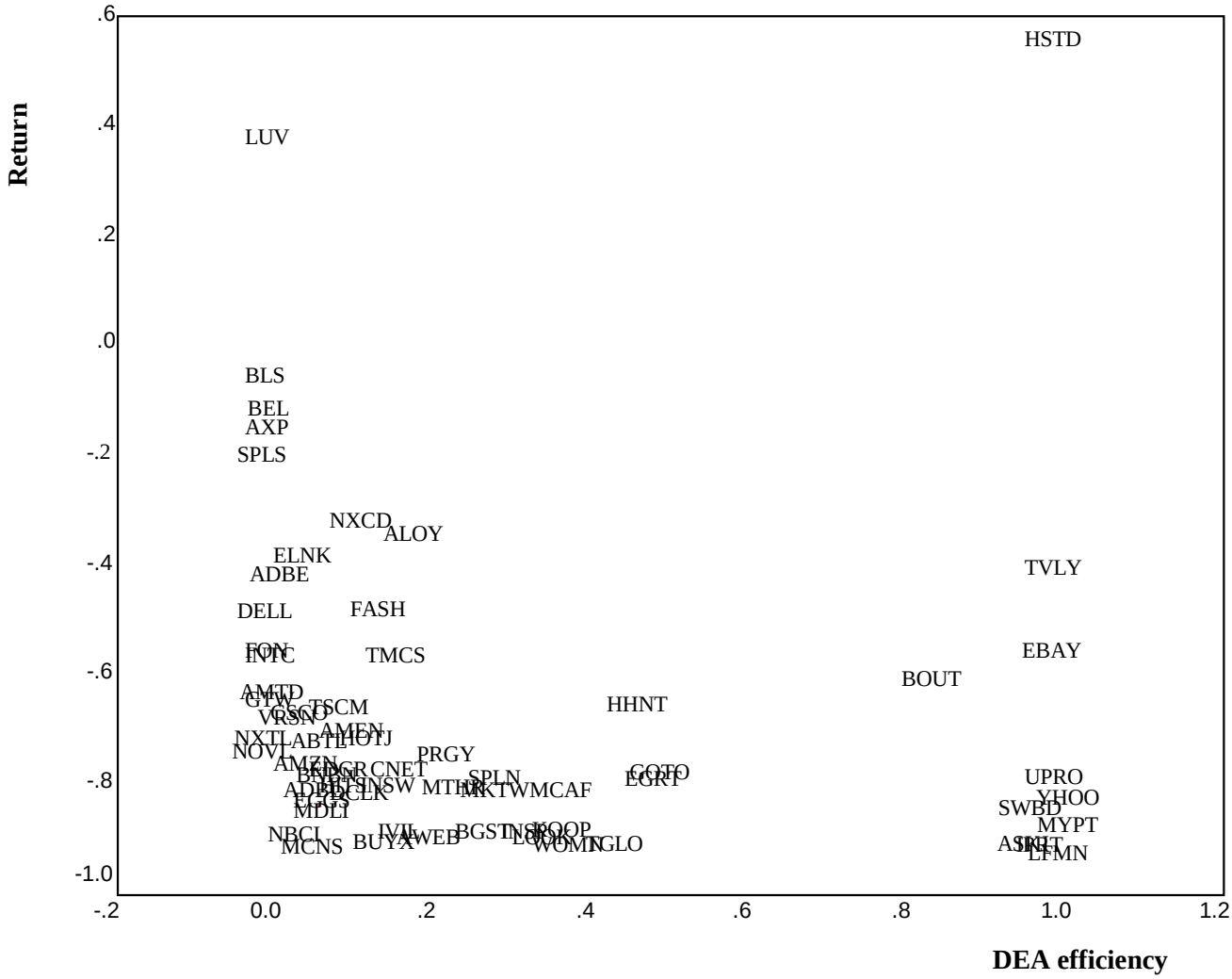

Figure 3. DEA efficiency versus stock exchange performance. As argued in the text, most companies plot in a small area and their names overlap. The interesting companies are the ones whose name can be clearly read.