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Web Search Volume as a Predictor of Academic Fame:

An Exploration of Google Trends

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Abstract

Searches conducted on Web search engines reflect issues of interest to users and to society in general. Google Trends, which provides information about the queries searched by users of the Google Web search engine, is a rich data source from which a wealth of information can be mined. We investigated the possibility of using Web search volume data from Google Trends to predict academic fame. As queries are language dependent, we studied universities from two countries with different languages, the U.S. and Spain. We found a significant correlation between the search volume of a university name and the university's academic reputation or fame. We also examined the effect of some Google Trends features, namely limiting the search to a specific country or topic category, on the search volume data. Finally, we examined the effect of university sizes on the correlations found to gain a deeper understanding of the nature of the relationships.

Keywords: Webometrics, Web search volume, Google Trends, university rankings

1. Introduction

The Web is becoming more diverse and complex, offering various types of data that can be exploited for Webometrics research. Many studies have examined the potential of Web search data to forecast or provide information about social phenomena in a more timely manner than traditional reports or indexes. Every day people search for information about issues of interest or concern to them. Because search topics reflect real issues of concern to society, search queries can and have been analyzed to study offline social, political, and economic phenomena such as inflation, consumer behavior, diseases, and political choices. We conducted a study to find out if Google Trends data can be used in studies of higher education. Specifically, we aimed to find out if the number of Web searches for a university, as reported in Google Trends data, is related to the university's academic reputation or fame

A brief introduction to Google Trends is necessary to provide context for the study. Google Trends at www.google.com/trends/ is a service that provides information about the queries searched by users of the Google Web search engine. Other search engines publish lists of the most popular search terms; however, Google Trends is the only service that supplies information on-demand, allowing the user to specify a term (not just top search terms) and to find out the search volume of that term. One can also specify parameters, such as country, time period, and topic category, in order to find more specific search volumes. Google (2013a) explains that the Google Trends query index is made by computing a portion of all Web searches done worldwide for particular terms relative to the total number of searches done over time. Only terms with a significant search volume are reported in order to avoid reporting identifiable information.

Because Google Trends data are indexed by query terms and are thus language dependent, we decided to carry out our study in two different languages in order to compare the results. We chose to study universities in the U.S. and Spain. English and Spanish are the top two Latin alphabet languages in the world and two of the five official languages of the United Nations. According to Internet World Stats (2011), English is the top language in the world by number of users (565 millions), followed by Chinese (510 millions), and Spanish (165 millions). According to StatCounter Global Stats, during 2011 Google served 79.7% of searches in the U.S. (StatCounter 2013a) and 96.5% in Spain (StatCounter 2013b). As Google is the most commonly used search engine in each of the two countries, Google Trends data will reflect the largest portion of the Web searches completed in each country.

Our study follows the line of previous Webometrics research that correlated university ranking data with inlink counts (Aguillo, Granadino, Ortega, & Prieto, 2006; Thelwall & Harries, 2003), URL citation counts (Thelwall, 2011; Vaughan & Yang, 2012), and organization title mention data (Thelwall & Sud, 2011). In addition to analyzing the relationship between Google Trends data and university ranking data, our study also explored features of Google Trends, such as limiting the search to a country or to a topic category, to determine if these features can be used to improve the quality of Google Trends data for our study and perhaps for future Webometrics studies. Accordingly, our research questions are as follows:

1. Can Google Trends search volume data be used to estimate academic fame?
2. Is worldwide search volume a better estimator than domestic search volume?
3. Will limiting the search in Google Trends to a specific category improve the accuracy of search volume data?
4. How do search volume data compare with inlink data in correlating with university ranking data?
5. How well does Google Trends work in the Spanish environment?

In this study, the concept of academic reputation or fame is operationalized by scores in accepted university rankings. The rational is that universities ranked higher are usually better known and more

famous. So investigating research question 1 is essentially equivalent to examining the correlation between Google Trends search volume data and university ranking data. If there is a significant correlation, then search volume data can be used to estimate academic fame. Research question 4 also requires university ranking data. Thus, we collected this data for both sets of universities as detailed in section 3.1.

2. Literature review

Many studies have explored the relationships between Web search data and diverse social phenomena. The main question such studies have pursued is whether or not the queries people use when searching for a topic of interest can be used to predict the phenomena to which they relate. Although academic researchers have very limited access to search engine query logs as pointed out by Bar-Ilan (2007), they seized upon the few opportunities in which logs were available. Spink, Wolfram, Jansen and Saracevic (2001) analyzed Web queries by users of the Excite search engine to examine search topics and behavior (e.g., query length and page viewing patterns). Using a longitudinal study of Excite query logs, Spink, Jansen, Wolfram and Saracevic (2002) found that search topics had shifted from entertainment and sex to commerce and people.

Researchers have also studied query logs from a specific Website rather than a search engine. For example, Lambert (2008) examined the queries submitted to a community information Website to determine the types of information needed by the community. Ravid, Bar-Ilan, Rafaeli and Baruchson-Arbib (2007) analyzed log files from the Website of the Israeli Citizens' Advice Bureau. Specifically, they examined queries submitted to search engines that led traffic to the site, which provided them with insight about users' actual information needs. Ortiz-Cordova and Jansen (2012) analyzed referral keywords from search engines to a popular Spanish music Website that relies on contextual advertising as its business model. The authors classified queries to identify high revenue-generating customers.

Google Trends data, which are based on Google search queries, have been used in numerous studies. In economics, it was found that queries are often correlated with various economic variables (McLaren & Shanbhoge, 2011). Studies have explored the feasibility of using Web search terms to make short-term predictions of economic phenomena. Choi and Varian (2009, 2012) described how to use Google Search Insights data to predict economic indicators related to unemployment benefits, automobile demand, and tourism. They concluded that Google Trends may be more helpful in explaining the present rather than in predicting the future. This conclusion is similar to that of Ginsberg, Mohebbi, Patel, Brammer, Smolinski and Brilliant (2009), who found that instead of forecasting, Web search data can be used to monitor social phenomena and to provide more timely information than traditional data. On the other hand, Jun, Yeom & Son (2013) found that brand-focused search of hybrid cars exhibited a superior ability to forecast sales volume of these cars compared to macro-indicators such as GDP growth or WTI prices.

Several studies have examined the use of Google search data for measuring consumer sentiment and sales (Radinsky, Davidovich & Markovitch, 2009; Huang & Penna, 2009; Kholodilin, Podstawski & Siliverstovs, 2010; Vosen & Schmidt, 2011). In the housing industry, Wu and Brynjolfsson (2010) found evidence that search data can be informative with respect to future housing transactions and prices. In addition, the query "foreclosure" was found to be highly correlated with the number of U.S. home foreclosures (Webb, 2009). Google Trends data have also been used to analyze unemployment in Germany (Askitas & Zimmermann, 2010), Israel (Suhoy, 2009), and the U.S. (D'Amuri & Marcucci, 2010, 2012; Baker & Fradkin, 2011). In finance, Preis, Reith and Stanley (2010) found a correlation between transaction volumes of S&P 500 companies and search volume of the company names. Da, Engelberg and Gao (2011) used Google search data as a proxy for investors' attention to stocks and showed that the data could be used to predict stock price movement. Guzman (2011) tried to predict inflation using Google data.

As can be seen from the above review, the most common applications of Google search data in social science to date have been in economics, finance, and business, though there have also been studies in

other fields, including media and technology (Rech, 2007), the entertainment industry (Goel, Hofman, Lahaie, Pennock & Watts, 2010), and politics (Reilly, Richey & Taylor, 2012). We did not, however, find any studies using Google Trends data in the higher education sector, which is our area of study.

Our study aims to find out if Google Trends data can be used to estimate or predict academic fame by testing the correlation between search volume data and university ranking data. Vaughan (2008), a conference abstract, reported a preliminary attempt to establish this relationship. She selected the top 100 universities in the 2007 edition of Times Higher Education–QS World University Rankings, searched the names of these universities in Google Trends, and correlated the Google Trends data with the university ranking scores. No relationship was found when all universities were included, but a relationship was detected between Google Trends data and academic quality rankings if only the North American universities were included. Our current study makes major methodological improvements on Vaughan's preliminary effort.

3. Methodology

3.1 Universities in the study

QS produces an annual ranking of world universities which includes many U.S. universities. We selected the top 50 U.S. universities from the 2011 QS World Universities Ranking (QS, 2011), which was the most current ranking at the time of data collection (summer 2012). We did not use the QS ranking to select Spanish universities for the study because the ranking included very few Spanish universities. There is no comparable ranking of Spanish universities published regularly by the government or media, but rankings have been prepared by researchers. We chose to use the ranking "Shanghai Ranking Expanded" for Spanish and Latin American universities prepared by Docampo (2012) for the year 2011. This ranking replicates the methodology of the Shanghai Academic Ranking of World Universities (Docampo, 2013). We selected the 56 Spanish universities included in this ranking. We chose Docampo's ranking over other rankings because it uses an internationally recognized methodology. For both U.S. and

Spanish universities in the study, we also collected data on student and faculty population sizes which were used to normalize the Google Trends search volume data. We were not able to find the faculty size for one U.S. university, Emory University, so there are 49 universities in that normalization calculation.

3.2 Selection of search terms

It is very important to decide what term to search for in Google Trends for each university, because different terms have different search volumes. For example, the relative search volumes of "Harvard" and "Harvard University" were 55 and 8 respectively, shown by the height of the two bars to the left of the curves represent the relative search volumes of the two terms. Mousing over the bars displays the numbers of 55 and 8 respectively. This means that far more Google users searched for "Harvard" than "Harvard University." We found that, in general, short forms or acronyms had higher search volumes than the corresponding complete names of universities. This makes sense, as people are more likely to enter "Harvard" instead of "Harvard University" in the Google search bar. In fact, entering "Harvard" in the Google search bar brings up a link to the Harvard University homepage before one finishes typing the word "University." Earlier studies discussed the importance of selecting the most appropriate search term and used various methods of term selection. McLaren & Shanbhoge (2011) selected search terms based on intuition, while Pelat, Turbelin, Bar-Hen, Flahault & Valleron (2009) selected queries through a brainstorming process.

Vaughan (2008), a preliminary attempt at the current study, searched the full name of the university in Google Trends. Based on Vaughan's experience in that study and the extensive testing we undertook during the current study, we developed the following term selection method. We entered the complete name of the university, the appropriate acronym, and other possible alternative forms of the name in Google Trends, compared their search volumes, and chose the one with the highest search volume. We had to choose one term for data collection rather than adding up search volume data of multiple terms because Google Trends did not provide actual search volume data but rather relative rankings of search

volumes. The rationale for our approach is that the higher the search volume, the more people used that particular term to search for the university. By using the term with the highest search volume, we will therefore capture the largest portion of searches for that university. However, we did not use an acronym if it could be confused with another entity. For example, the acronym for the University of Southern California is USC, but USC is also the acronym for "university student council," so we did not use the acronym in this case. Our choice of search term also took into account other factors, such as the search parameter of worldwide vs. domestic (details in the next paragraph), and we used the most appropriate search parameter for each country in the study. Appendix 1 and Appendix 2 show the terms searched for in Google Trends for the U.S. and the Spanish universities respectively.

3.3 Google Trends search parameters

Google Trends provides several search parameters. The default search is "Worldwide" but one can limit the search to a specific country. We collected some of our data using each of the two parameters (worldwide and domestic) and compared them (details in 4.1). The default time frame in Google Trends is 2004–present. We limited all of our searches to the year 2011 to match the year on which the university quality ranking data were based.

The default category in Google Trends is "All Categories," but one can choose to limit the search to a specific category, such as "Jobs & Education." There are many categories and subcategories, and a subcategory can have a deeper level of subcategories. Google Trends recommends categories based on the search terms entered. For example, if you enter Harvard University as the search term, Google Trends recommends the "Jobs & Education" category. If you choose this category, then Google Trends further recommends the subcategory "Education."

Google Trends determines categories based on search patterns. If a search term can be used in multiple contexts, such as the name of an animal but also the name of a clothing brand, Google Trends looks at

"broad search patterns among people who search for the animal versus those who search for the clothing brand. Specifically, people looking for the clothing brand may have also looked for clothing items in the few searches immediately before and after, while people looking for the animal may have looked for other animals in related searches" (Google, 2013b). Therefore, limiting the search to a category can potentially focus the search to more relevant data. However, suggested categories are determined by an algorithm, and the effectiveness of this algorithm will affect the quality of Google Trends data. We investigated the effectiveness of the algorithm and thus the usefulness of limiting the search to categories as research question 3 (Will limiting the search in Google Trends to a specific category improve the accuracy of search volume data?).

3.4 Obtaining ranking scores in Google Trends

Google Trends does not report the absolute search volume of a single term but does report the relative search volumes for up to five multiple terms. For each group of universities (U.S. and Spain) in the study, we obtained relative Google Trends search volume ranking scores as follows: we entered up to five universities at a time and recorded their relative ranking scores, we then entered a different group of universities, some of which overlapped with the previous group, and we recorded the relative ranking scores again. Through this repeated process of relative comparison, we were able to obtain relative ranking scores for all universities in the study. See Appendix 1 and Appendix 2 for the ranking scores.

3.5 Inlink data collection

Research question 4 (How do search volume data compare with inlink data in correlating with university ranking scores?) calls for the collection of inlink data. Currently, among the major search engines (Google, Bing, and Yahoo!) only Google provides inlink search capability, but Google's inlink search cannot be used for this study because it only reports a sample of inlinks indexed (Google, 2013c) and the sampling method is not disclosed. In addition, Google's inlink search only retrieves inlinks to a specific page, not to a site or a domain. For the purpose of this study, we need to find inlinks to the entire

university Website to correlate with the quality ranking of the university. Alexa's "Sites Linking In" metric meets this requirement, so we collected inlink data from Alexa. In fact, Vaughan & Yang (2012) found that Alexa's inlink data were better than that of Yahoo! as an estimate of academic quality. Data collection in Alexa is straightforward: simply enter the URL of the university Website and retrieve the number of inlinks. The only issue that needs to be considered is URL aliases and redirects. Alexa recognizes some alias and redirects, e.g., it recognizes that www.illinois.edu and www.uiuc.edu are both URLs of the University of Illinois at Urbana-Champaign. For alternative URLs that Alexa did not recognize, we used the URL with the highest number of inlinks. Inlink data for the U.S. and Spanish universities are presented in Appendix 1 and Appendix 2 respectively.

4. Results

4.1 Examining Correlations

We carried out correlation tests to address our research questions. We used Spearman rather than Pearson correlation tests because both the university ranking scores and the Google Trends data are ordinal data. Table 1 summarizes the results.

Table 1. Correlations between university ranking data and Web data

Country of university ranking	Number of Universities	Google Trends, All Categories		Google Trends, Specific Categories			Alexa Internet Inlink count
		Worldwide	Domestic	Jobs & Education	Education	Colleges & Universities	
U.S.	50	0.53	0.49	0.61	0.60	0.57	-0.55
Spain	56	0.43	0.59	0.44	0.41	0.44	-0.69
All correlations are significant at the 0.01 level (2-tailed).							

To address research questions 1 and 2, we collected data without limiting to specific topic categories (i.e., using the default "All Categories") and using each of the two search parameters, worldwide and domestic. As Table 1 shows, there are significant correlations ($p<0.01$) between Google Trends search volumes and

university rankings for both the U.S. and the Spanish universities. Therefore, the answer to research question 1 (Can Google Trends search volume data be used to estimate academic fame?) is yes. However, the answer to research question 2 depends on the country: for the U.S. universities, Google Trends worldwide data correlated more strongly with university quality rankings than Google Trends domestic data, while domestic data are more strongly correlated with academic rankings in the case of the Spanish universities. This finding is plausible because most of the U.S. universities in the study are world renowned; therefore, there is likely to be a large number of Web searches for these universities conducted worldwide. In contrast, Spanish universities do not enjoy the same level of international fame and attention, so there will be fewer searches for these universities outside Spain.

To investigate research question 3 (i.e., to find out if limiting the Google Trends search to a specific category improves the correlation), we collected data in three categories: "Jobs & Education," "Education," and "Colleges & Universities." These three categories are consecutive in specificity: "Education" is a subcategory of "Jobs & Education" while "Colleges & Universities" is a subcategory of "Education." We wanted to determine whether searching in a more specific category helps remove noise and therefore improves the accuracy of the data. For example, does searching for Apple specifically as an IT company by limiting the search to the "Computers & Electronics" category remove the noise created by search results related to apple as a fruit?

Because we found that worldwide data are more highly correlated with academic rankings for the U.S. universities and domestic data more highly correlated with academic rankings for the Spanish universities, we carried out our searches using those corresponding settings (i.e., worldwide for U.S. universities and domestic for Spanish universities). Table 1 shows that for the U.S. universities, limiting to the first level category "Jobs & Education" helped improve the accuracy of the data so that the correlation improved from 0.53 to 0.61. However, moving into the more specific categories of "Education" and "Colleges & Universities" did not further improve the correlation. This suggests that the algorithm that Google Trends

uses to classify search interest is effective but only at the first level of specificity. This is not surprising as correct classification into more specific categories is more challenging. For the Spanish university, however, limiting to any specific category did not improve the correlation, suggesting that using the current algorithm in this topic is not effective in the Spanish environment.

To examine research question 4 (How do search volume data compare with inlink data in correlating with university ranking data?), we compared the correlation between university ranking data and Google Trends data with the correlation between university ranking data and inlink data. Note that correlations with Alexa inlink data are negative because universities with lower scores in the quality ranking, i.e. better universities, generally have higher inlink counts. Table 1 shows that for the U.S. universities, the highest correlation achieved with Google Trends data (0.61) is better than the correlation achieved with the Alexa inlink data (-0.55). For the Spanish universities, inlink data outperformed Google Trends data. So the answer to research question 4 is again country dependent.

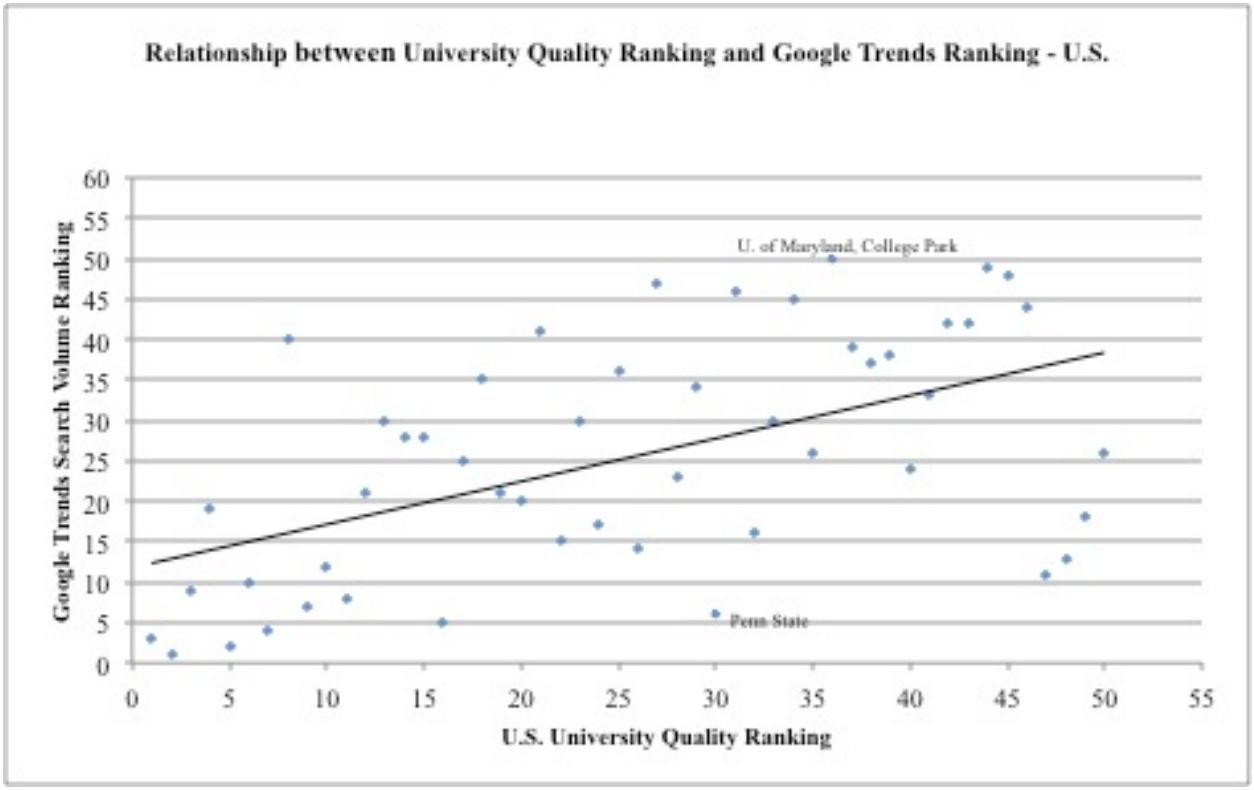
The findings described above reveal the answer to research question 5 (How well does Google Trends work in the Spanish environment?). Google Trends data did correlate with the ranking of the Spanish universities so Google Trends data can be used to estimate academic fames. However, this correlation is not as high as the correlation with inlink data, so Google Trends data are less useful than inlink data in the Spanish environment. As previously stated, limiting the search to a specific category was not helpful at all in the Spanish case. Overall, Google Trends did not seem to work as well in the Spanish environment as in the U.S. environment. Whether this is due to language or search volume is not clear and needs further research.

4.2 Examining Outliers

To provide further insight into the findings reported above, we plotted the two ranking scores (university ranking and Google Trends ranking) and examined outliers to investigate factors affecting Google Trends

data and the correlations we found. Fig. 1 plots the correlation between the U.S. university ranking and the ranking based on Google Trends data without limiting the search to a specific category. An outlier is Penn State (Pennsylvania State University). Penn State's university ranking was 30th among the 50 U.S. universities in the study; however, its Google Trends search volume ranking was 8th, representing a high degree of interest in this university among Google searchers.

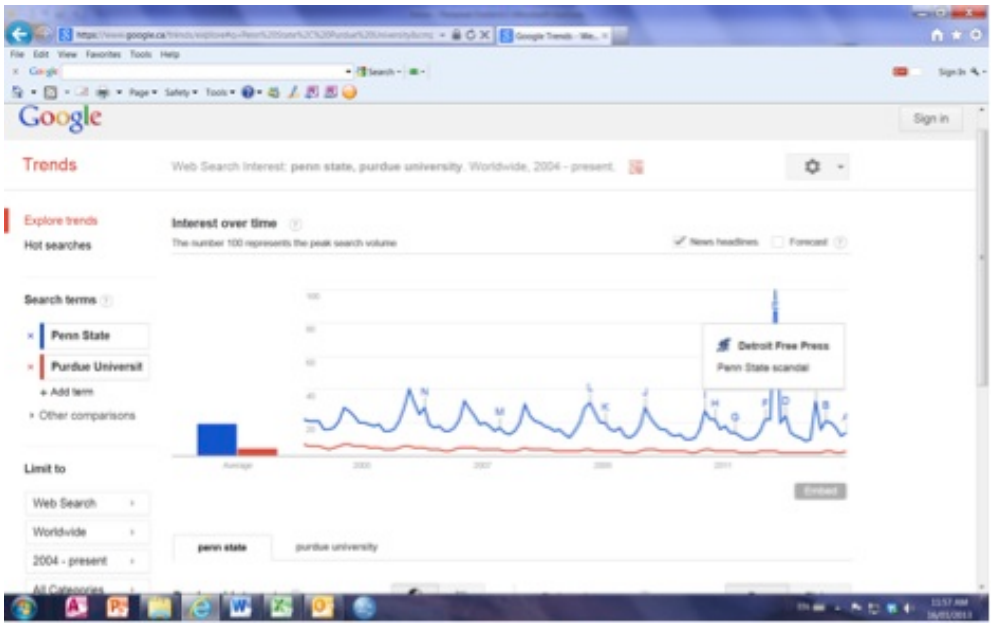
Figure 1 Correlation between the U.S. university ranking and the Google Trends search volume ranking



We compared the Google Trends search volumes of Penn State and Purdue University (29th in university ranking), as shown in Fig. 2. It is clear that there was a huge spike in Penn State's search volume in 2011. Mousing over the spike displays the notation "Penn State scandal." Clicking the item leads one to a news article in the Detroit Free Press about the scandal, in which Jerry Sandusky, a former Penn State assistant football coach, was alleged to have sexually assaulted eight boys. The average search volumes of the two

universities in 2011 (as represented by the heights of the two bars) were 9 and 1 for Penn State and Purdue respectively. If we did not limit the search to the year 2011, the universities' search volumes were 20 and 4 (i.e. a difference of 5 times rather than 9 times). This is because the effect of the 2011 spike in search volume is smoothed out by "normal" data in other years. Here we see a potential problem of limiting the search to a particular year: search volume data is more susceptible to unusual spikes. On the other hand, limiting to a particular year (in this case 2011) has the potential to create a better match between university ranking data for a particular year (2011) and Google Trends data. This was our rationale for limiting the search to 2011.

Figure 2 Search volumes of "Penn State" and "Purdue University" in Google Trends



When we limited the search to the category "Jobs and Education," Penn State's ranking in Google Trends changed from 8th to 15th and the contrast between Penn State and Purdue became 32 to 13 (about 2.5 times as opposed to 9 times when the search was not limited to the category). This change is likely a result of the fact that many searches for the Penn State scandal were not classified into the "Jobs & Education" category, as they should not be. In fact, when limiting the search, a message pops up that reads "Less than 25% per cent of searches for 'penn state' belonged in the Jobs & Education category". This shows the effectiveness of Google Trends' algorithm for classifying searches into topical categories

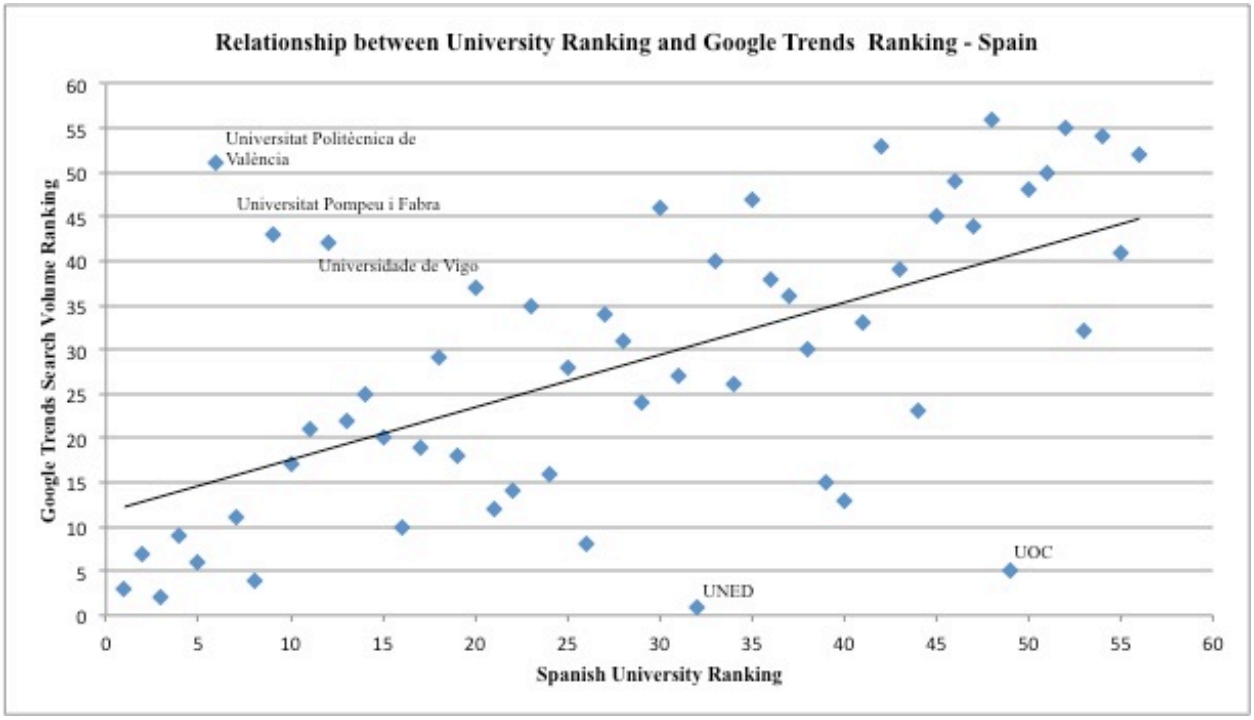
and explains why the correlation between university quality data and Google Trends data was higher when the search was limited to this category (0.61 vs. 0.55 as shown in Table 1).

Not all outlier problems can be mitigated by limiting the search to a category or a particular year. For example, University of Maryland, College Park is also an outlier (see Fig. 1) in that it is ranked last (50^{th}) based on Google Trends search volume data, much lower than its university ranking of 36^{th}. Limiting the search to the "Jobs & Education" category did not change its Google Trends ranking. In this case, the problem is caused by the long name (University of Maryland College Park) used in collecting Google Trends data. We were not able to use an appropriate shorter name without confusing the university with another organization. For example, the shorter name University of Maryland could cause confusion with the University of Maryland, Baltimore.

Fig. 3 plots the correlation between the Spanish university ranking and the ranking based on Google Trends data without limiting the search to a specific category. Universitat Politècnica de València, Universitat Pompeu i Fabra, and Universidade de Vigo are outliers above the regression line. They are among the 12 top universities according to the Spanish university ranking (6th, 9^{th}, and 12th respectively) but their Google Trends rankings are relatively low (51st, 43rd, and 42nd respectively). The three universities share a common character. They belong to regions with two official languages, which results in the search volume being divided between several potential terms. Although acronyms were used when searching for Universitat Pompeu i Fabra and Universidade de Vigo, alternative search terms in the two languages reduced the search volume for the selected terms for these universities. For example, for Universidade de Vigo, the average search volume of the three possible terms of "UVIGO," "Universidad Vigo," and "Universidade Vigo" were 62, 23 and 6 respectively. This means that for each 100 searches using UVIGO there were 37 and 9.7 searches done using the alternative terms of "Universidad Vigo" and "Universidade Vigo" respectively. The Google Trends ranking score is particularly low (51st) for the Universitat Politècnica de València relative to its university ranking (6th). In addition to the bilingual

factor described above, the use of the full name instead of an acronym as the search term is another factor that resulted in reduced search volume. We did not use the acronym UPV for this university because another Spanish university, Universidad del País Vasco, has the same acronym.

Figure 3 Correlation between the Spanish university ranking and the Google Trends search volume ranking



The two outliers below the regression line are Universidad Nacional de Educación a Distancia (UNED) and Universitat Oberta de Catalunya (UOC). Their position as outliers can be explained by the nature of their activities as distance and virtual universities, which results in them having a remarkable online presence and very high Google Trends ranking scores relative to their university ranking scores.

4.3 Normalization of Google Trends Data

If the search for a university name in Google were mainly done by people belong to the university, then the size of the university can affect the search volume. Further, if the university ranking is correlated with the size in that higher ranking universities tend to be large ones, then the correlation between the university ranking and the search volume data could be a spurious relationship with size being the

underlying cause. To find out if the significant correlations found in the study are genuine, we normalized Google Trends data by the student and faculty sizes of the university and then calculated correlations between university rankings and the normalized search volume data. For Spanish universities, there are no longer significant positive correlations between the university ranking and the search volume data. For the U.S. universities, all correlations remain significant as shown in Table 2.

Table 2. Correlations between U.S. university ranking data and the normalized Google Trends data

Type of Normalization	Google Trends, All Categories		Google Trends, Specific Categories		
	Worldwide	Domestic	Jobs & Education	Education	Colleges & Universities
Normalized by Student Size	0.55	0.56	0.62	0.61	0.60
Normalized by Faculty Size	0.49	0.46	0.56	0.56	0.55
All correlations are significant at the 0.01 level (2-tailed).					

For the Spanish universities, there is a significant correlation between the university ranking and the size of the university (-0.71 for student size and -0.81 for faculty size; both $p<0.01$). In other words, higher ranking universities tend to be larger ones. So the correlations between the university ranking and the search volume data without normalization could be attributed to the university size. In contrast, there is no significant correlation between the university ranking and the university sizes for the U.S. universities (0.26 for student size and 0.14 for faculty size; both $p>0.05$), i.e. higher ranking universities do not tend to be larger universities. For example, student sizes of Harvard and MIT are 21,200 and 11,189 respectively, below the average of 28,494 for the U.S. universities in the study. The search volumes of these two top ranking universities were among the highest (3rd and 1st respectively).

5. Discussion and Conclusions

The study found a significant correlation between a university's academic fame and the search volume of the university name. In general, more famous universities, i.e. higher ranking universities, attracted more attention from Google searchers (i.e., users are more likely to be searching for these universities). This is true for both the U.S. and the Spanish universities in the study. These results parallel findings from earlier Webometrics studies that reported significant correlations between university ranking and inlinks to the university Website (Thelwall, 2001) as well as URL citations to the university (Thelwall, 2011, Vaughan & Yang, 2012). Vaughan & Yang (2012) analyzed the top 50 U.S. universities in the 2011 QS world university ranking and found the correlation coefficient between university rankings and URL citation counts to be 0.58, which is comparable to the correlation coefficient between university rankings and Google Trends data from this study (see Table 1). The current study also found that Google Trends data correlate with university ranking slightly better than inlink counts for U.S. universities. All of these results demonstrate the value of Google Trends data for Webometrics research, particularly at a time when inlink data sources are scarce.

The study further examined the nature of the correlations found by analyzing the effect of the university size on the correlations. We found that the correlations for the Spanish universities could be attributed to the university sizes, i.e. the larger search volume for the higher ranking universities is the result of more people from within those university searching for it. However, the correlations for the U.S. universities are likely to be genuine, i.e. there were more searches for the more famous universities regardless of the university sizes. An examination of the country origins of the searches further explains the difference between the two sets of normalized data. For the U.S. universities, large portions of searches originated from outside the country, which explains why there were so many searches for the small but famous universities. For the Spanish universities, very little amount of searches originated from outside Spain, even for top ranking universities. These findings reflect the international positions of the two sets of universities. No Spanish university made to the top 150 world universities in the QS 2011 ranking (QS,

2011). In contrast, among the top 100 universities, 31 were in the U.S. This also explains the finding that for the U.S. universities, Google Trends data (not normalized) collected using the worldwide setting correlated with the university rankings more strongly than data collected using a country limit. For the Spanish universities, the opposite is true.

To summarize, the study found that for the U.S. universities, search volume data do correlate with university ranking data and thus can be used to estimate the academic fame of a university. The correlation is significant even after the size of the universities is accounted for. Worldwide search data are more useful than the domestic data. Limiting the search volume data to the category of "Jobs & Education" helps to reduce noise and thus improve the quality of data. However, these conclusions do not apply to the Spanish universities. This could be attributed to the lack of fame of Spanish universities. Considering that large amount of data are needed for meaningful patterns to emerge, this might also be the result of insufficient search volume (Spain is much a much smaller country and the Spanish language is much less used on the Internet than English is). If this is true, then search volume data are useful only for large entities. Further research is needed to clarify this issue.

The significance of the findings from this study is twofold. On a theoretical level, we gained an understanding of the nature of search volume data. The correlation between search volume data and the university rankings shows that search volume data are not chaotic and meaningless but have patterns, which suggests that there are opportunities for further data mining. On a practical level, the findings suggest that search volume data could be viewed as supporting evidence of university ranking data. Although university rankings are usually readily available, they are sometime controversial. Different organizations use different ranking criteria and thus produce different ranking results and universities receiving unfavorable rankings complain.

A limitation of the study is that it only included universities from two countries. Although the two countries provide an effective contrast in terms of language, culture and geographical location, they may not be representative of these variables. Universities in another English speaking country may be different

from that of U.S. Similarly, findings from the Spanish universities in the study may not be generalizable to other non-English speaking countries.

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Appendix 1 U.S. Universities

QS Ranking				Term searched in Google Trends	Ranking by Google Trends, general category		Ranking by Google Trends, specific category			Alexa Internet Inlink count
World Ranking	Ranking within the U.S.	Name	Main URL		worldwide	domestic	Jobs & education	Education	Colleges & universities	
2	1	Harvard University	www.harvard.edu	Harvard	3		1	1	1	123957
3	2	Massachusetts Institute of Technology (MIT)	www.mit.edu	MIT	1		7	7	24	133747
4	3	Yale University	www.yale.edu	Yale	9		5	5	4	61444
8	4	University of Chicago	www.uchicago.edu	University of Chicago	19		15	15	20	45299
9	5	University of Pennsylvania	www.upenn.edu	PENN	2		6	6	6	63361
10	6	Columbia University	www.columbia.edu	Columbia University	10		8	8	7	60205
11	7	Stanford University	www.stanford.edu	Stanford	4		2	2	3	125048
12	8	California Institute of Technology (Caltech)	www.caltech.edu	Caltech	40		49	49	49	30238
13	9	Princeton University	www.princeton.edu	Princeton	7		3	3	2	45389
14	10	University of Michigan	www.umich.edu	University of Michigan	12		10	10	9	74798
15	11	Cornell University	www.cornell.edu	Cornell	8		14	14	14	87411
16	12	Johns Hopkins University	www.jhu.edu	Johns Hopkins	21		20	21	18	32138
19	13	Duke University	www.duke.edu	Duke University	30		29	29	29	38534
21	14	University of California, Berkeley (UCB)	www.berkeley.edu	UC Berkeley	28		17	17	16	100551
24	15	Northwestern University	www.northwestern.edu	Northwestern University	28		23	23	26	29210

34	16	University of California, Los Angeles (UCLA)	www.ucla.edu	UCLA	5		4	4	4	65430
39	17	Brown University	www.brown.edu	Brown university	25		22	22	20	20140
41	18	University of Wisconsin-Madison	www.wisc.edu	UW Madison	35		31	31	31	58948
43	19	Carnegie Mellon University	www.cmu.edu	CMU	21		25	25	22	53426
44	20	New York University (NYU)	www.nyu.edu	New York University	20		26	27	28	50044
55	21	University of North Carolina, Chapel Hill	www.unc.edu	UNC Chapel Hill	41		38	38	36	38650
56	22	University of Washington	www.washington.edu	University of Washington	15		12	12	11	69193
61	23	University of Illinois at Urbana-Champaign	www.illinois.edu	UIUC	30		21	20	15	68875
70	24	Boston University	www.bu.edu	Boston University	17		17	19	18	28676
76	25	University of Texas at Austin	www.utexas.edu	UT Austin	36		48	48	49	66116
77	26	University of California, San Diego (UCSD)	www.ucsd.edu	UCSD	14		9	9	7	47720
78	27	Washington University in St. Louis	www.wustl.edu	WUSTL	47		44	44	42	26145
84	28	Georgia Institute of Technology	www.gatech.edu	Georgia Tech	23		26	26	25	28131
85	29	Purdue University	www.purdue.edu	Purdue University	34		34	34	32	48993
94	30	Pennsylvania State University	www.psu.edu	Penn State	6		15	15	16	53019
99	31	Dartmouth College	www.dartmouth.edu	Dartmouth College	46		41	41	39	22105
101	32	University of California, Davis	www.ucdavis.edu	UC Davis	16		13	13	12	38556
102	33	University of Minnesota	www.umn.edu	University of Minnesota	30		24	23	23	63650
107	34	University of Southern California	www.usc.edu	University of Southern California	45		42	41	41	43759
111	35	Ohio State University	www.osu.edu	Ohio State	26		28	28	27	44722

				University						
113	36	University of Maryland, College Park	www.umd.edu	University of Maryland College Park	50		50	49	47	44595
114	37	Emory University	www.emory.edu	Emory University	39		39	40	40	20114
116	38	University of Pittsburgh	www.pitt.edu	University of Pittsburgh	37		34	35	34	34488
117	39	Rice University	www.rice.edu	Rice University	38		37	36	35	30043
118	40	University of California, Santa Barbara (UCSB)	www.ucsb.edu	UCSB	24		17	17	13	29793
126	41	University of Virginia	www.virginia.edu	University of Virginia	33		33	33	32	49921
128	42	University of Rochester	www.rochester.edu	University of Rochester	42		44	45	43	16766
131	43	Vanderbilt University	www.vanderbilt.edu	Vanderbilt University	42		39	39	38	23192
142	44	University of Colorado at Boulder	www.colorado.edu	University of Colorado Boulder	49		47	47	46	32159
145	45	Case Western Reserve University	www.case.edu	Case Western Reserve	48		46	46	45	17334
148	46	University of California, Irvine	www.uci.edu	UC Irvine	44		43	43	44	34534
158	47	Texas A&M University	www.tamu.edu	Texas A&M	11		36	37	37	37480
161	48	University of Florida	www.ufl.edu	University of Florida	13		11	10	9	41716
162	49	University of Illinois, Chicago (UIC)	www.uic.edu	UIC	18		31	32	47	19456
163	50	University of Arizona	www.arizona.edu	University of Arizona	26		30	30	29	46071

Appendix 2 Spanish Universities

Shanghai replication Ranking	Name	Main URL	Term searched in Google Trends	Ranking by Google Trends, general category		Ranking by Google Trends, specific category			Alexa Internet Inlink count
				worldwide	domestic	Jobs & education	Education	Colleges & universities	
1	Universitat de Barcelona	www.ub.edu	UB	7	3	2	2	4	10898
2	Universidad Autónoma de Madrid	www.uam.es	UAM	10	7	16	17	11	6208
3	Universidad Complutense de Madrid	www.ucm.es	UCM	12	2	8	8	18	19277
4	Universitat de Valencia	www.uv.es	UV	5	9	27	26	23	9863
5	Universitat Autònoma de Barcelona	www.uab.es	UAB	9	6	19	19	13	7070
6	Universitat Politécnica de Valencia	www.upv.es	Politecnica Valencia	50	51	36	35	20	10353
7	Universidad del País Vasco	www.ehu.es	EHU	25	11	41	40	35	7144
8	Universidad de Granada	www.ugr.es	UGR	18	4	13	14	21	13090
9	Universitat Pompeu i Fabra	www.upf.edu	UPF	24	43	25	24	12	12692
10	Universidad de Zaragoza	www.unizar.es	UNIZAR	29	17	34	37	31	7025
11	Universitat Politècnica de Catalunya	www.upc.edu	UPC	4	21	10	11	9	15106
12	Universidade de Vigo	www.uvigo.es	UVIGO	44	42	20	18	7	5002
13	Universidad de Sevilla	www.us.es	Universidad Sevilla	33	22	22	21	12	11051

14	Universidade de Santiago de Compostela	www.usc.es	USC	2	25	12	12	7	4595
15	Universidad de Oviedo	www.uniovi.es	UNIOVI	31	20	4	5	1	4211
16	Universidad Politécnica de Madrid	www.upm.es	UPM	16	10	38	38	32	16322
17	Universidad de La Laguna	www.ull.es	ULL	20	19	7	7	29	3481
18	Universitat Rovira i Virgili	www.urv.es	URV	36	29	29	28	26	3286
19	Universidad de Castilla la Mancha	www.uclm.es	UCLM	29	18	6	6	2	5415
20	Universidad de Cantabria	www.unican.es	UNICAN	42	37	23	22	10	4964
21	Universitat de Alacant	www.ua.es	UA	3	12	32	33	25	7005
22	Universidad de Valladolid	www.uva.es	UVA	6	14	43	44	39	7302
23	Universidad de Murcia	www.um.es	Universidad Murcia	41	35	21	20	8	5913
24	Universidad de Salamanca	www.usal.es	USAL	22	16	5	4	3	6385
25	Universidad de Alcalá de Henares	www.uah.es	UAH	23	28	42	41	38	4790
26	Universidad de Málaga	www.uma.es	UMA	1	8	31	32	33	8879
27	Universidad Miguel Hernández de Elche	www.umh.es	UMH	40	34	15	15	5	2515
28	Universitat de les Illes Balears	www.uib.es	UIB	32	31	48	46	41	4390
29	Universidad de Córdoba	www.uco.es	UCO	15	24	9	9	37	3556
30	Universidad de Navarra	www.unav.es	UNAV	47	46	28	27	14	4808

31	Universidad Carlos III de Madrid	www.uc3m.es	UC3M	37	27	11	10	30	5181
32	Universidad Nacional de Educación a Distancia	www.uned.es	UNED	8	1	1	1	15	6402
33	Universitat de Girona	www.udg.edu	UDG	17	40	18	16	5	3215
34	Universidade da Coruña	www.udc.es	UDC	21	26	47	47	49	3046
35	Universidad de Extremadura	www.unex.es	UEX	46	47	52	52	47	4458
36	Universidad de Jaén	www.ujaen.es	UJAEN	43	38	44	43	36	3870
37	Universidad de Huelva	www.uhu.es	UHU	27	36	46	45	45	3262
38	Universitat Jaume I de Castelló	www.uji.es	UJI	21	30	40	39	36	5470
39	Universidad Rey Juan Carlos I	www.urjc.es	URJC	28	15	3	3	28	6013
40	Universidad de Cádiz	www.uca.es	UCA	14	13	14	13	6	6731
41	Universidad Pablo de Olavide	www.upo.es	UPO	26	33	49	48	46	1412
42	Universidad Pública de Navarra	www.unavarra.es	Universidad Publica Navarra	52	53	50	49	27	1487
43	Universidad de Almería	www.ual.es	UAL	19	39	24	23	44	1645
44	Universidad de Las Palmas de Gran Canaria	www.ulpgc.es	ULPGC	35	23	39	39	42	6911
45	Universitat de Lleida	www.udl.es	UDL	38	45	30	30	40	1404
46	Universidad Politécnica de Cartagena	www.upct.es	UPCT	48	49	27	25	48	1760
47	Universidad de León	www.unileon.es	UNILEON	45	44	37	36	51	4879

48	Universidad CEU Cardenal Herrera	www.uchceu.es	Universidad Cardenal Herrera	54	56	53	53	50	508
49	Universitat Oberta de Catalunya	www.uoc.edu	UOC	11	5	26	25	19	9470
50	Universidad de Burgos	www.ubu.es	UBU	30	48	30	29	16	1085
51	Universidad de la Rioja	www.unirioja.es	Universidad Rioja	49	50	35	34	22	5529
52	Universitat Ramon Llull	www.url.es	Universitat Ramon Llull	53	55	51	51	34	2883
53	Universidad de Deusto	www.deusto.es	DEUSTO	39	32	17	17	17	2529
54	Universitat Internacional de Catalunya	www.uic.es	UIC	13	54	52	50	43	770
55	Universidad Católica de Murcia	www.ucam.edu	UCAM	34	41	33	31	20	937
56	Universidad Pontificia de Comillas	www.upcomillas.es	UPCOMILLAS	51	52	45	42	24	1283