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Selling blood and gametes during tough economic times: insights from Google search

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Abstract

Introduction—To use Google Insights search volume and publicly available economic indicators to test the hypothesis that sperm, egg, and blood donations increase during economic downturns and to demonstrate the feasibility of using Google search volume data to predict national trends in actual sperm, egg, and blood donations rates.

Materials and methods—Cross-correlation statistical analysis comparing Google search data for terms relating to blood, egg, and sperm donations with various economic indicators including the S&P 500 closing values, gross domestic product (GDP), the U.S. Index of Leading Indicators (U.S. Leading Index), gross savings rate, mortgage interest rates, unemployment rate, and consumer price index (CPI) from 2004–2011. A secondary analysis determined the Pearson correlation coefficient between Google search data with actual sperm, egg, and blood donation volume in the U.S. as measured by California Cryobank, the National Assisted Reproductive Technology Surveillance System, and the National Blood Collection and Utilization Survey, respectively. Significance of cross-correlation and Pearson correlation analysis as indicated by p value.

Results—There were several highly significant cross-correlation relationships between search volume and various economic indicators. Correlation between Google search volume for the term “sperm donation,” “egg donation,” and “blood donation” with actual number of sperm, egg and blood donations in the United States demonstrated Pearson correlation coefficients of 0.2 ($p > 0.10$), −0.1 ($p > 0.10$), and 0.07 ($p > 0.10$), respectively. Temporal analysis showed an improved correlation coefficient of 0.9 ($p < 0.05$) for blood donation when shifted 12 months later relative to Google search volume.

Conclusion—Google search volume data for search terms relating to sperm, egg, and blood donation increase during economic downturns. This finding suggests gamete and bodily fluid donations are influenced by market forces like other commodities. Google search may be useful for predicting blood donation trends but is more limited in predicting actual semen and oocyte donation patterns.

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Keywords

Google; commodification; economy; gametes

Introduction

The commodification of human tissues refers to the economic valuation of bodily goods as determined by market forces. For example, men and women in the United States can sell their sperm and eggs, respectively, to infertile couples hoping to have children. Remuneration for this genetic material is based on supply and demand. Egg donors of Asian or Jewish heritage are more sought after compared to others because there are so few donors from these backgrounds.[1] Overall, it is estimated that the sperm banking industry generates estimated $100 million annually in the United States suggesting the economic importance of the industry.[2–4]

However, less is understood how the national economic climate can impact gamete and blood cryopreservation practices. Indeed, during periods of economic recession, people are frequently driven to seek alternative sources of income. Given the numerous cryopreservation facilities around the country, tracking donations at a national level is challenging.

Since its incorporation in 1998, Google has established itself as one of the most frequently used search engines in the world which currently accounts for over 60% of all US online search queries.[5] Recently, data from Google search queries has been found to be highly correlated with the seasonal incidence of various health conditions ranging from influenza to kidney stones.[6–9] This relationship is explained as people afflicted by these ailments may use Google search to learn about the evaluation and management of their symptoms. Furthermore, by analyzing the temporal trend of these queries, one can obtain real time information about the incidence of certain disease/conditions. For instance, using Google search volume data, one can detect regional influenza outbreaks 7–10 days earlier than traditional surveillance programs.[8]

We hypothesized that Google search volume for terms related to sperm, egg and blood donations would correlate with national donations and would vary in time based on national economic indicators. Our goal was to use Google Insights search volume (GIS) data and publicly available economic indicators to test the hypothesis that sperm, egg, and blood donations increase during economic downturns.

Materials and methods

Data collection

We used Google Insights to determine normalized search volume in the U.S. for terms relating to sperm, egg, and blood donations from 2004–2011 on a quarterly basis. When querying Google search volume data for a particular search term, the output is normalized against the total number of searches, which results in a relative score between 0 and 100. We then collected data of several economic indicators during that same time period including

the S&P 500, gross domestic product (GDP), the U.S. Index of Leading Indicators (U.S. Leading Index), gross savings rate, mortgage interest rates, unemployment rate, and consumer price index (CPI). These data were accessed online from Federal Research Economic Data[10].

To validate our Google search volume data, we used other sources to estimate the number of donations. Blood donation data was obtained from National Blood Collection and Utilization Survey, which determines the amount of blood collected in the United States on a biennial basis.[11] To assess sperm donations, we attained data from California Cryobank (CCB) which operates one of the larger cryofacilities in the country with branches around the U.S. Data regarding the number of semen donations was available from 2006–2011 so analyses of these trends were restricted to this time period. Data regarding oocyte donor cycles was attained from the Centers for Disease Control and Prevention's National Assisted Reproductive Technology Surveillance System (NASS). Institutional Review Board approval was not needed as we did not work with any identifiable patient characteristics or have direct contact with any patients for this work.

Statistical analysis

We used a cross-correlation function to determine the significance of the relationship of the search volume with each economic indicator as a function of time. Cross-correlation involves correlating two different functions, each of which varies with time. This statistical method has been widely used to determine spatial similarity between signals in mostly engineering applications, and has more recently been used to study human movement.[12–13] Time periods were divided into 3 month units and correlation against each economic indicator was performed. We also calculated correlation coefficients comparing the GIS search volume data with actual blood, sperm, and egg donation rates. P values < 0.05 were considered statistically significant. All analyses were performed on SAS (Version 9.4, Cary, NC, USA).

Results

When examining GIS search volume, several terms were correlated with economic indicators, Table 1. Egg donation search volume was negatively correlated with S&P 500, GDP, U.S. Leading Index, unemployment rate and CPI but positively correlated with mortgage interest rates. Sperm donation GIS data was negatively correlated with S&P 500 and U.S. Leading Index while no other significant relationships were identified. Blood donation search volume was negatively correlated with S&P 500, U.S. Leading Index, gross savings rate, mortgage interest rates but positively correlated with unemployment rate and CPI.

When examining the relationship between GIS volume and S&P 500; sperm, egg and blood donation all showed an increase around the start of the Great Recession which began in 2007, Figure 1; $p < 0.05$).

Using actual sperm donation from CCB, we identified a similar increase in donation queries after the start of the Great Recession ($r = -0.5$, $p < 0.01$, Figure 2). In contrast, egg donation

from the CDC showed no significant change in volume around the Great Recession ($r = -0.1$, $p > 0.10$, Figure 2).

Correlation between GIS volume for the term “sperm donation” with actual number of sperm donations provided at California Cryobank demonstrated a Pearson correlation coefficient of 0.2 ($p > 0.10$). Comparison of the GIS volume for the term “egg donation” with actual number of oocyte donor cycles in the United States yielded a Pearson correlation coefficient of −0.1 ($p > 0.10$). Comparison of GIS volume for the term “blood donation” with actual volume of blood donations in the United States demonstrated a Pearson correlation coefficient of 0.07 ($p > 0.10$). Interestingly, when the blood donation volume was shifted 12 months later relative to the Google search volume, the Pearson correlation coefficient increased to 0.9 ($p < 0.05$). However, time sensitivity analysis comparing GIS search volume for sperm or egg donation compared to actual donation volume did not demonstrate any significant changes in the strength of correlation up to 12 months in both directions.

Discussion

We have shown for the first time that Google search volume for terms related to sperm, egg, and blood donations increased significantly during the most recent economic recession starting at the end of 2007. We hypothesize that the search volume increase at this time was economically motivated as sperm, egg, and blood donations are often treated as commodities. Indeed, we did establish a similar relationship with sperm donations from a large US sperm bank as well as national blood donation data (when adjusted for time lag in data collection).

Several studies have shown that financial incentive is a very powerful motivator for sperm and egg donors.[14–15] Although most people are not directly financially compensated for whole blood donations, blood drives often offer gifts such as movie tickets, clothing, and even food to donors in order to encourage donations.

We demonstrated significant associations between gamete and blood search terms and various economic indicators. However, there was only a modest correlation coefficient of 0.2 when comparing GIS search volume for the term “sperm donation” with annual data from California Cryobank. Temporal analysis with the cross-correlation function did not show any significant changes in the strength of correlation up to 12 months in both directions. It is important to note that online search of sperm donation may represent both those who wish to donate and those who wish to use sperm. The same is likely true for egg donation as well. As the economic motivations may be different for each, the GIS volume may not accurately reflect the donor pool exclusively. Indeed, the fertility rate varies based on economic conditions.[16] Moreover, the data of actual sperm donation volume is from a single cryofacility with distinctive geographic locations (i.e. California, Boston, New York) and may not reflect the overall trend of sperm donations in the United States as it is unclear how much this single company contributes to the total sperm donation rate.

We also anticipated a poor correlation between our egg donation search volume and actual egg donation rates during this period for similar reasons. Our study demonstrated a correlation coefficient of −0.1 for this comparison without any significant changes demonstrated with temporal analysis. Kawwass et al recently published a study illustrating trends in oocyte donation in the United States between 2000 and 2010.[17] Their data demonstrates that there was a steady increase in number of oocyte donor cycles in that time period with a slight dip in 2009 during the economic recession. Again, this is likely explained by the fact that assisted reproductive technology can be quite expensive and these services are in lower demand during periods of economic downturn. So, although there may be more people seeking to donate their eggs during these times, they are unable to do so because the demand for these eggs is lower. GIS is unable to differentiate those seeking to donate versus acquire oocytes.

When comparing GIS search volume for the term “blood donation” with actual donation data from the National Blood Collection and Utilization Survey, we demonstrated no significant association. This may reflect that fact that online search is not a typical precursor to blood donation. In many cases it may be a more spontaneous act of benevolence.[18–19] However, we noted a much stronger correlation coefficient of 0.9 when temporally shifting the blood donation volume by 12 months, which suggests that Google search data may be a useful predictor of blood donation trends and are not subject to necessary lags in current reporting practices.

Cross-correlation of actual sperm and egg donation volumes in the United States with the S&P 500 showed correlation coefficients of −0.5 and −0.1, respectively, Figure 2. With the stronger cross-correlation of sperm donation with the S&P 500 compared to egg donation, one may gather that sperm donation is possibly more economically motivated than egg donation. However, this could also reflect the lower barrier to sperm donation compared to oocyte donation as it is a less involved and time-consuming procedure with fewer risks.

Several additional limitations warrant mention. As multiple comparisons were made in our statistical analysis, some findings may have occurred by chance alone. However, even with conservative corrections (i.e. Bonferroni), many of our comparisons would still demonstrate significant cross-correlation relationships. We also do not have an accurate measure of sperm donation rates in the U.S. as these are not tracked as closely as oocyte donation rates.

Conclusions

Data from tissue banks as well as GIS demonstrate that gamete and blood donations are influenced by market forces. Similar to other commodities, the interest in selling one’s body fluids varies with the U.S. economy. During a recessionary economy there is an increase in the online search for sperm, egg, and blood donation. In contrast, online search for gamete and blood donation declines in times of an expansionary economy.

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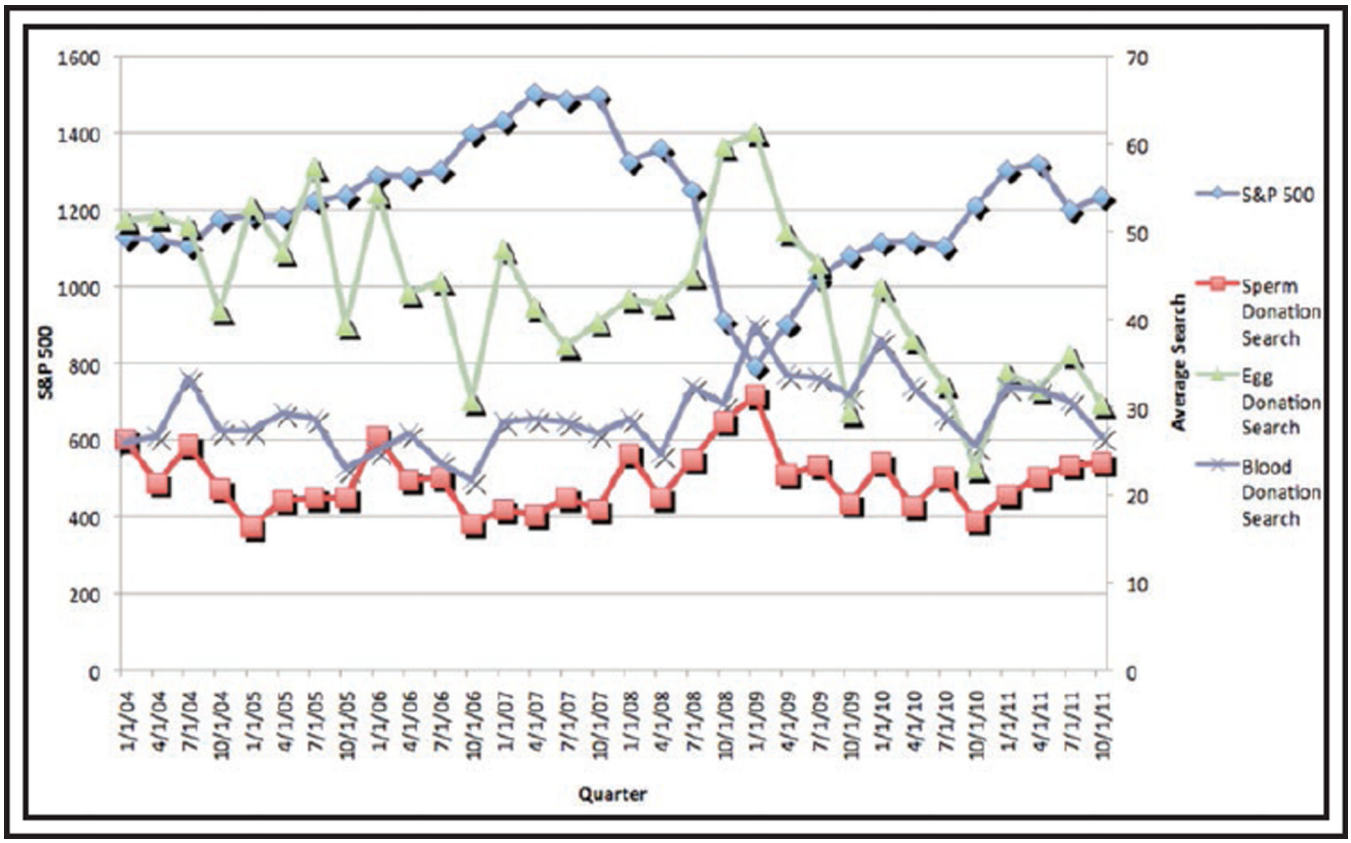

Figure 1.
Quarterly Google Search Volume for Blood, Egg, and Sperm Donation and S&P 500 from 2004–2011.

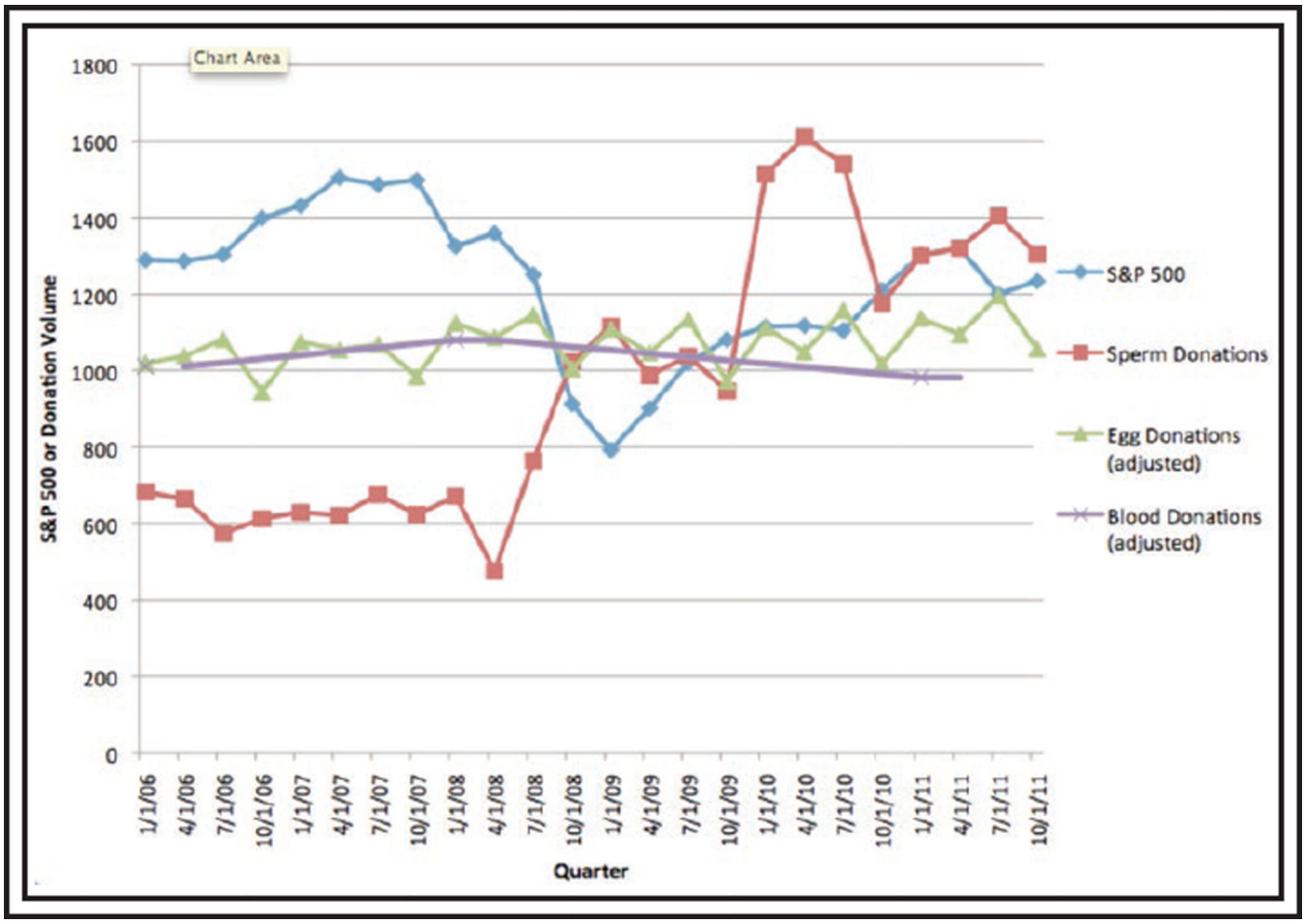

Figure 2.
Quarterly United States Gamete and Blood Donation Rates and S&P 500 from 2006–2011. Egg and blood donation volume has been scaled to fit.

TABLE 1

Cross-correlations between economic indicators and sperm, egg, and blood donation Google search volume

	Sperm donation	Egg donation	Blood donation
S&P 500	r = −0.6; p < 0.01	r = −0.4; p = 0.02	r = −0.6; p < 0.01
GDP	r = −0.2; p = 0.2	r = −0.6; p < 0.01	r = −0.07; p = 0.7
US Leading Index	r = −0.5; p < 0.01	r = −0.4; p = 0.01	r = −0.4, p = 0.02
Gross Savings Rate	r = −0.3; p = 0.08	r = −0.2; p = 0.3	r = −0.6; p < 0.01
Mortgage Interest Rate	r = −0.1; p = 0.5	r = 0.4; p = 0.02	r = −0.4; p = 0.01
Unemployment Rate	r = −0.03; p = 0.9	r = −0.6; p < 0.01	r = 0.4; p = 0.03
Consumer Price Index	r = 0.07; p = 0.7	r = −0.5; p < 0.01	r = 0.4; p = 0.04