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The Shareholder Wealth Implications of Google's Dutch Auction IPO

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In this paper I implement the event study methodology to analyse the short-term and long-term effects on shareholders' wealth resulting from Google's Dutch auction IPO. In the short-term, I find Google's IPO was materially underpriced, despite the owners' objective of creating aftermarket share price stability. Evidence suggests this could be due to the auction design and the desire to avoid the winner's curse phenomenon. In the long-term, Google significantly outperformed the benchmark, which is atypical of the average IPO firm. Google's 'over-performance' can be explained by the series of highly profitable acquisitions and successful product launches introduced following its IPO.

Keywords: Event study, IPO anomalies, overpricing, underperformance, Dutch auction

1. Introduction

The aim of this study is to analyse both the short-term and long-term effects on shareholders' wealth resulting from Google's Dutch auction style initial public offering (IPO) on the NASDAQ stock exchange on 19/08/2004. Specifically, I implement the event study methodology to investigate to what extent the 'IPO anomalies' of short-run underpricing and long-run underperformance affected Google's share price and hence the wealth of Google's equity investors. The motivation for this study stems from the fact there is a lack of empirical research in the IPO literature focusing on single firm event studies. This paper contributes to the existing IPO literature by conducting an in-depth investigation of one of the most debated technology IPOs of the 21st Century. A secondary objective is to shed some light on the usefulness of the Dutch auction method for pricing IPOs given the current mixed evidence.

In April 2004, the global technology company Google announced its intention to go public. As part of the offering, it sold 19.6m shares at an offer price of $85 per share, raising a total of nearly $1.67bn in equity capital. Of this $1.67bn amount, approximately 28% ($464m) went to existing shareholders selling their stake in the company, whilst the remaining $1.21bn was used for maintaining working capital allowances and financing acquisitions (Google, 2004). The purpose of the IPO was threefold: to raise additional capital, create a market for Google stock and facilitate future access to the public equity markets.

The Google IPO was unconventional in the sense that a Dutch auction method was used to determine the offer price, opposed to the traditional underwriter-led book building process. In a Dutch auction offering, prospective investors submit their bids stating the number and price of shares demanded. The offer price is then determined by starting with the highest price, which is subsequently lowered until investor demand equals the total amount of shares in issue (Oh, 2006). Dutch auctions are said to be non-discriminatory (uniform price), since all investors pay the equilibrium offer price regardless of their bid. Google's motivation for wanting to undertake an auction IPO was primarily to avoid underpricing and the associated initial price jump, creating share price stability in the publicly traded aftermarket. According to the Google's prospectus filing with the SEC: "our goal is to have a share price that reflects an efficient market valuation of Google and that moves rationally based on changes in our business and the stock market" (Google, 2004, p. 31).

The main events surrounding the IPO are listed in Table 1 on the next page. The initial prospectus was filed with the Securities and Exchange Commission (SEC) on 29/04/2004, with the auction opening several months later in mid-August. Interestingly, Google's shares closed at $100.33 on the first day, significantly higher than the $85 offer price. This price jump occurred even after the offer price was set far below the estimated preliminary price range of $108 to $135 per share.

Table 1: Timeline of Events

Date	Event
29/04/2004	Google files IPO registration statement with the SEC
26/07/2004	Estimated price range of $108 to $135 per share is set
13/08/2004	Bidding opens to investors
18/08/2004	Auction closes, offer price of $85 per share is set
19/08/2004	Shares begin trading at $85, closing at $100.33

The findings of this paper indicate that in the short-run, Google's IPO was materially underpriced. The highly significant first trading day abnormal return of 18.89% provides meaningful evidence that Google's stock was issued at a price far below what the market perceived as fair. Further to this, the second day abnormal return was also significantly positive at 6.81%. Abnormal returns were generally stable in the following one-week period in line with what is expected in an informationally efficient market. I propose two potential explanations for the observed underpricing, which rely on impurities in the auction design and the presence of a winner's curse phenomenon. In the long-run, I find that Google did not underperform the benchmark, and actually generated highly positive risk-adjusted returns in the 3 and 5 year periods following its IPO. I suggest that Google's superior share price performance can be explained by its major acquisitions of complementary companies that allowed it to expand its product portfolio and increase its future revenue generating capacity.

2. Literature Review

The IPO anomalies of short-run underpricing and long-run underperformance are well documented in the corporate finance literature both within the domestic and international public equity markets. In this section I discuss the most relevant empirical evidence relating to these IPO anomalies, and discuss the evidence in support and against Dutch auctions as a method of avoiding IPO underpricing.

2.1. Short-Run Underpricing

In the short-run, IPO underpricing is the tendency for underwriters to price an IPO below the fair market value of the stock, leading to a significant positive initial return in the market post-IPO. Underpricing is a widespread phenomenon: approximately 70% of IPOs experience a positive first day price adjustment (Ritter and Welch, 2002). In a seminal study, Ibbotson (1975) finds significant one-day abnormal returns of around 11.4% for a sample of 112 US common stock IPOs between 1960-1969. This evidence is corroborated by a larger sample study of 4,534 US IPOs by Ibbotson, Sindelar and Ritter (1988), who find an average initial return of 16.4%.

Loughran, Ritter and Rydqvist (1994) reviewed the international evidence on short-run underpricing and found that the average initial return varies enormously in the cross-section of international markets. The highest degree of underpricing was found within developing economies such as Malaysia (80.3%), Brazil (78.5%), Korea (78.1%), and Thailand (58.1%). The lowest degree of underpricing is found in the developed markets of the Netherlands (7.2%), Canada (5.4%) and France (4.2%). Their study does not include the Chinese market, where initial returns for A-share IPOs have been found to be as high as 948.6% (Su and Fleisher, 1999).

There is some evidence that technology and Internet company stocks exhibit a greater degree of underpricing than non-technology stocks. Loughran and Ritter (Table II, 2004) find the average first-day returns on tech and Internet stocks from 1990 to 1998 is 22.2% compared to that of 11.3% for non-technology stocks. At the peak of the dotcom bubble in 1999-2000, this discrepancy was as high as 80.6% for tech stocks and 23.1% for non-tech stocks. Moreover, they find younger firms on average have similar initial returns to tech stocks regardless of industry.

There have been a number of proposed explanations for this underpricing phenomenon (for a review, see Agrawal, 2009). The risk-averse underwriter hypothesis assumes investment banks intentionally underprice IPOs to mitigate the risk of an unsuccessful offering. However, this theory doesn't explain why underwriting spreads are not adjusted to compensate for the risk of the IPO, and it lacks empirical backing from the literature. The monopsony power hypothesis introduced by Ritter (1984) suggests underwriters exploit the limited competition in the underwriting market and use their market power to underprice and ration IPO shares to their 'preferred' customers who purchase other financial services from them. Brennan and Franks (1997) extend this theory and suggest the rationing process can be used to allocate shares to many small investors to discourage blockholdings by large shareholders. Managers in the IPO firm can then benefit from this dispersed ownership in the form of entrenchment.

Rock (1986) develops an alternative model based on asymmetric information. Informed investors only participate in offerings they believe to be underpriced, whilst uninformed investors cannot discriminate between offerings and participate in all. Therefore when an IPO is overpriced, uninformed investors receive 100% of the shares: there is no rationing between informed and uninformed investors. Anticipating this issue, underwriters intentionally discount the price of IPO shares in order to keep the uninformed investors in the market. Other asymmetric information explanations include Benveniste and Spindt's (1989) information-gathering model, in which underpricing is a form of compensation. In this model, informed investors are rewarded for providing valuable demand and pricing information to underwriters. Hanley and Wilhelm (1995) test these competing explanations by examining the outcomes for informed investors of participating in IPOs. Their findings are that informed investors receive approximately the same proportion of shares in both over and underpriced issues. They interpret this as evidence against Rock's explanation, and in support of Benveniste and Spindt.

2.2. Dutch Auction IPOs

The above findings, although robust, relate to book built IPOs where the underwriter plays a dominant role in determining the offer price. The evidence surrounding auction IPO underpricing is somewhat mixed. Firstly, the Dutch auction has been cited as an efficient mechanism to reduce the degree of underpricing by allowing the offer price to be a direct result of competitive bidding, rather than being determined through the book-building process (Degeorge, Derrien and Womack, 2007). It has been shown that auctions are able to incorporate more information into the pricing process to accurately determine a fair offer price (Sherman, 2000). Kaneko and Pettway (2003) confirm the hypothesis that auction IPOs exhibit statistically significant lower underpricing than the traditional book-building method by examining the Japanese market. In the period 1993 to 2001, the average degree of auction underpricing was 11.4% compared to the 48% for underwritten issues. However, an initial return of 11.4% for auction IPOs is still high by most developed market's standards. Derrien and Womack (2003) adopt a similar approach to examine the French market for auction IPOs. They find auctions lead to less underpricing and lower variance of underpricing on average. This result is driven by the auction's ability to incorporate more information into the IPO price, in line with Sherman's (2000) conclusion. Degeorge, Derrien and Womack (2009) comprehensively study the 19 US auction IPOs from 1999 to 2007, and report a mean one-day return of 13.8%. But when making an adjustment for the market movement, this return falls to -2.0%, indicating no underpricing.

On the other hand, a number of papers argue against the use of Dutch auctions. Anand (2005) cites the examples of the auction IPOs of Andover.net, Genitope and MorningStar, which had initial first day returns of 337.85%, 38.89% and 8.38% respectively, as evidence of Dutch auction underpricing. Kandel, Sarig and Wohl (1999) examine a unique set of IPO auctions in Israel, and find a significant risk-adjusted abnormal return on the first trading day of 4.5%. Similarly, Pettway (2003) finds within Japan during the period 1989 to 1996 when all Japanese IPOs were auctioned, the mean initial return of 11.95% was not significantly lower than underwriter priced IPOs in the US. Biais and Faugeron-Crouzet (2002) examine the various methods of IPO pricing, and conclude that Dutch auctions can lead to inefficiencies in the price discovery mechanism, driven by tacit collusion between bidders. Similarly, Jagannathan and Sherman (2005) argue in their paper that auction offer prices are highly inefficient, and can lead to not only large positive returns, but also large negative returns.

2.3. Long-Run Underperformance

In the long-run, it is widely accepted that IPO firms perform relatively poorly against a benchmark sample of non-IPO firms or the market index in the 3 to 5 year period subsequent to the IPO. Aggarwal and Rivoli (1990) find strong support for the presence of 3 year underperformance to the extent of 14%. Ritter (1991) verifies a sample of 1,526 common stock IPOs underperformed against a control sample of similar size and industry non-IPO firms by around 27%. Moreover, Gompers and Lerner (2003) analyse the aftermarket performance of over 3,600 IPOs between 1935 and 1972, and find buy-and-hold returns are 29% less than the CRSP value-weighted index over a 5 year period after the IPO.

Loughran, Ritter and Rydqvist (1994) summarise the international evidence, and find some markets are particularly susceptible to underperformance. The 3 year long-run adjusted returns for a wide cross-section of international markets are presented, including Brazil (-47%), Finland (-21.1%), the US (-20%), Germany (-12.8%) and the UK (-8.1%). In some countries, the 3 year adjusted long-run performance is actually marginally positive, including Japan (9%), Korea (2%) and Sweden (1.2%), although the sample size for these studies is generally too small to draw definitive conclusions. There is some evidence to suggest underperformance varies by industry. Ritter (1991, Table VII) finds the 3 year holding period return (HPR) for computer service IPOs is 13% versus a HPR of 50% for the control sample, suggesting technology stocks are more susceptible to underperformance. Moreover, Santos (2010) reports a direct link between IPO underpricing and underperformance: firms that go public in periods of low underpricing do not tend to underperform in the long-run, and vice-versa.

The theoretical explanations for long-run underperformance can be divided into at least 2 major groups. Jain and Kini (1994) provide an agency cost based explanation, whereby underperformance is caused by conflicts of interest between the original owners and new shareholders. These conflicts are perceived to destroy value in the newly publicly traded firm. They later extend this theory and conclude venture capital backed IPOs have superior long-run stock price performance due to the strong monitoring incentives of the venture capitalists, reducing the loss due to agency costs (Jain and Kini, 1995). However, Mikkelson, Partch and Shah (1997) found no notable relationship between long-run operating performance and ownership structure. Alternatively, Ritter (1991) provides a behavioural explanation that investors are systematically overoptimistic about an IPO firm’s future earning potential, and this initial optimism is corrected through downward price adjustments in subsequent years, as more value relevant information becomes publicly available.

3. Testable Hypotheses

Based on the aforementioned empirical evidence in the literature review, I postulate two hypotheses. Hypothesis 1 relates to the short-term effects on shareholders' wealth. Since there is no consensus on whether auction IPOs exhibit significant underpricing, formulation of a hypothesis that is consistent with the literature is difficult. However, many of the papers that favour Dutch auctions do not test the hypothesis that abnormal return is significantly greater than zero; instead they examine whether it is lower than book-built IPOs. In many cases, the returns are still highly positive. Therefore, I formulate the hypothesis that there is underpricing in the short-run since the case for this is the most convincing. If Google's IPO was underpriced, there should be a significantly positive abnormal return (AR) in the first day of trading, as demand by investors pushes the stock price upwards to its fair value. The null (H_0) and alternative (H_a) hypotheses that are the subject of the empirical tests are provided alongside each hypothesis.

Hypothesis 1: The Dutch auction pricing mechanism underpriced the market value of Google's stock, so the first day abnormal return should be significantly positive.

$$H_0: AR \leq 0 \qquad\qquad H_a: AR > 0 \tag{1}$$

Hypothesis 2 considers the long-run effects on shareholders' wealth. Based on the substantial evidence discussed in the literature review, there is a compelling reason to believe that Google should conform to similar underperformance. The extent of underperformance is given by the intercept term (Jensen's alpha) in a time-series regression of the Fama and French (1993) three-factor model. This term is a risk-adjusted measure of abnormal return, and it should be significantly lower than zero if Google underperformed the market.

Hypothesis 2: Google experienced significantly negative abnormal returns for the 3 to 5 year period subsequent to the IPO, measured by Jensen's alpha.

$$H_0: \alpha \geq 0 \qquad\qquad H_a: \alpha < 0 \tag{2}$$

4. Data

To measure equity returns, I use the Total Return Index (RI) metric from Datastream as this variable is adjusted for stock splits and dividends, and provides a consistent definition of return. Following MacKinley (1997), the well-diversified S&P 500 equity index is used to proxy for the unobservable market portfolio. The daily and monthly RI for Google and the S&P 500 are obtained for the period 31/08/2004 to 31/08/2009. This period starts at the month end of the IPO and ends 5 years after, providing enough data to conduct the tests discussed in the next section. Furthermore, in order to compute the first day return against the $85 offer price, I download Google's first day Unadjusted Price Index (UPI). From this data, I compute the daily and monthly discrete returns for Google and the S&P 500. Discrete returns are preferred over continuously compounded ('logarithmic') returns so as to not introduce negative compounding bias over large time periods, as documented by Barber and Lyon (1997). Discrete returns are defined as the percentage change in the Total Return Index (RI) over a time period $\mathbf{t-1}$ to $\boldsymbol{t}$, as in equation (3):

$$\mathbf{r_{it}} = \frac{RI_{\mathbf{it}} - RI_{\mathbf{it}-1}}{RI_{\mathbf{it}-1}} \tag{3}$$

Or the percentage change in the UPI (dividends are observed to be zero within the one-day post-IPO time period) as in equation (4):

$$\mathbf{r_{it}} = \frac{UPI_{\mathbf{it}} - UPI_{\mathbf{it}-1}}{UPI_{\mathbf{it}-1}} \tag{4}$$

Where:

$\mathbf{r_{it}}$	Discrete return for security $\mathbf{i}$ at time $\mathbf{t}$
$RI_{\mathbf{it}}$	Total Return Index for security $\mathbf{i}$ at time $\mathbf{t}$
$UPI_{\mathbf{it}}$	Unadjusted Price Index for security $\mathbf{i}$ at time $\boldsymbol{t}$

For the long-term study, the monthly return data for the Fama-French factor portfolios is obtained from Kenneth French's website.[1] The returns on the high-minus-low (HML) and small-minus-big (SMB) portfolios are computed as the value-weighted return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ that have a CRSP share code of 10 or 11 at the beginning of month *t*, good shares and price data at the beginning of *t*, and good return data for *t* (French, 2013). The return on the S&P 500 is used again as a proxy for the market portfolio return. Finally, as a proxy for the risk-free rate in the model, I use the yield on short-dated (3-month) US Treasury bills, which are perceived to be as close to risk-free as possible. The monthly return on 3-month US Treasury bills is obtained from Datastream within the period 31/09/2004 to 30/08/2009.

Additional firm-specific information is gathered from Google's IPO prospectus filing and subsequent amendments with the Securities and Exchange Commission (SEC). Long-term accounting data about profitability and performance is taken from Google's published annual reports. All news events are from articles taken from the Factiva database.

5. Methodology

The purpose of an event study is to examine the behaviour of a firm's stock price around the time of a corporate event (Khotari and Warner, 2004). The event study methodology is frequently applied to study the performance of IPO firms in both the short-term and long-term (for example, see Bommel and Vermaelen, 2003; Jiang and Leger, 2010). An implicit assumption crucial to the success of the event study methodology is the presence of semi-strong form efficient markets, in which asset prices reflect all publicly available information and immediately adjust to new information (Fama, 1970). However, this assumption can be relaxed in the short-term by accumulating abnormal returns over a longer time period, as discussed in section 5.1. Furthermore, throughout this paper asset returns are assumed to be joint normal and temporally independent and identically distributed (IID). This section is split into two subsections, short-term and long-term, to reflect the differences in the methodology applied for each time period.

[1] From: mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

5.1. Short-Term

Short-term event study analysis is used to examine the extent to which Google's IPO was underpriced. Campbell, Lo and MacKinlay (1997) identify 7 steps involved in conducting a large sample short-term event study. Adapting this framework for a single firm leads to 6 major steps:

1. *Event definition*. The first task is to identify the event of interest and the period over which stock returns will be measured.
2. *Abnormal and expected returns*. These two terms should be explicitly defined. To appraise the event's impact, it is necessary to select an appropriate asset pricing model to quantify expected return.
3. *Estimation procedure*. Once an asset pricing model has been chosen, the parameters must be estimated using a subset of the data population known as the estimation period.
4. *Testing procedure*. This step involves using the determined model parameters to estimate and test the significance of abnormal returns within the test period.
5. *Empirical results*. The penultimate step is to present results. The presentation of diagnostic and robustness tests can also be advantageous.
6. *Interpretation and conclusions*. The final step is to analyse results and draw conclusions. Ideally the results will lead to insights about the event and its effect on security prices.

The event being examined in the short-term study is Google's IPO. The impact of the event is examined on the event day: 19/08/2004 (this day is known as day 0). Additionally, I compute the impact of the event in a one-week period to capture the full extent of underpricing in case Google's stock takes longer than one-day to adjust to its fair value.

The principle of all event studies is the concept of abnormal return. Abnormal return for security $\mathbf{i}$ at time $\mathbf{t}$ ($AR_{\mathbf{it}}$) is defined as the security's period $\mathbf{t}$ realised return, $\mathbf{r}_{\mathbf{it}}$, minus its period $\mathbf{t}$ expected return, $E(\mathbf{r}_{\mathbf{it}})$. It is a direct measure of the unexpected change in stock returns associated with the event (Khotari and Warner, 2004). The formula for calculating abnormal return is given by equation (5):

$$AR_{\mathbf{it}} = \mathbf{r}_{\mathbf{it}} - E(\mathbf{r}_{\mathbf{it}}) \qquad (5)$$

Expected return is defined as the would-be return on the stock if there was no event. Consequently, AR should be insignificantly different from zero if the event had no notable impact on company returns. This is because realised return would roughly be equal to expected return. Several alternative methods have been proposed to estimate expected return, including: the constant mean return model, the market model, multifactor risk models, and economic models such as the capital asset pricing model (CAPM) and arbitrage pricing theory (APT) (MacKinlay, 1997). I apply the market model (Fama, 1976) to measure expected return. The market model is intuitive, practical to implement, and has the main advantage over simpler methods that it removes the portion of return that is related to variation in the market's return. By doing this, the variance of AR can be reduced, increasing the power of the test to pick up hypothesised effects.

However, the conclusions in Brown and Warner (1980, 1985) are that the choice of model does not qualitatively affect the result drawn from the test in terms of accepting or rejecting the hypothesis; it only affects the quantitative result. But choosing an appropriate model is fundamental to estimate an accurate AR and assign a value to the amount of wealth shareholders gained or lost from participating in the IPO. In this sense, I use AR to measure the extent of underpricing in a given time period.

The market model states the return on firm $\mathbf{i}$ is a linear function of the return on the market portfolio, plus a constant 'intercept' term and a zero-mean random error term. The model's linear specification follows from the assumed joint normality of asset returns (Campbell, Lo and MacKinlay, 1997). The specification of the market model is:

$$\mathbf{r_{it}} = \alpha_{\mathbf{i}} + \beta_{\mathbf{i}}\, \mathbf{r_{mt}} + \varepsilon_{\mathbf{it}} \tag{6}$$

Where:

$\mathbf{r_{it}}$	Return for security $\mathbf{i}$ at time $\boldsymbol{t}$
$\alpha_{\mathbf{i}}$	Intercept term
$\beta_{\mathbf{i}}$	Sensitivity of security $\mathbf{i}$'s return to the market return
$\mathbf{r_{mt}}$	Return on the market at time $\boldsymbol{t}$
$\varepsilon_{\mathbf{it}}$	Zero-mean random error term at time $\mathbf{t}$

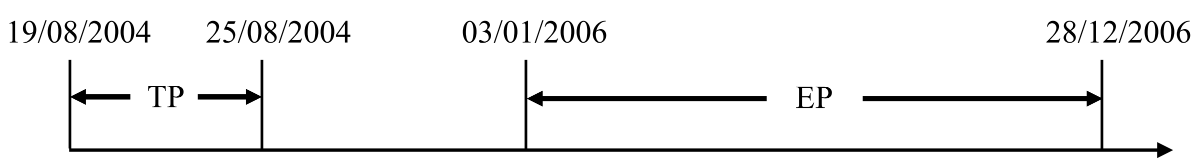
The parameters of the market model are estimated using ordinary least squares (OLS) regression with 250 daily returns within the estimation period. The justification for the use of daily return data comes from Morse (1984) who examined the econometric trade-off between the choice of daily and monthly return data, and found if there is certainty over the precise announcement date of the information, the use of daily data is generally preferred. Since with an IPO event study we do not have the luxury of pre-event data, the estimation period (EP) of the model is defined as the post-IPO period from 03/01/2006 to 28/12/2006. Using 250 daily returns provides enough observations to make the estimates statistically robust, whilst concurrently minimising the chance of time-variation in the coefficients. Given the regression point estimates of $\hat{\alpha}_{\mathbf{i}}$ and $\hat{\beta}_{\mathbf{i}}$, expected return is given by equation (7):

$$\mathrm{E}(\mathbf{r_{it}}) = \hat{\alpha}_{\mathbf{i}} + \hat{\beta}_{\mathbf{i}}\, \mathbf{r_{mt}} \tag{7}$$

Substituting (7) into (5) yields a convenient formula for calculating AR:

$$\mathrm{AR}_{\mathbf{it}} = \mathbf{r_{it}} - \mathrm{E}(\mathbf{r_{it}}) = \mathbf{r_{it}} - (\hat{\alpha}_{\mathbf{i}} + \hat{\beta}_{\mathbf{i}}\, \mathbf{r_{mt}}) \tag{8}$$

After estimating the market model within the EP, I use the estimated parameters to compute abnormal return in the test period (TP). For the primary empirical test, the TP is a single day event window consisting exclusively of the event date 19/08/2004 (day 0). To capture the extent of underpricing over the one-week time period, I extend the event window and compute the one-week cumulative abnormal return (CAR) from day 0 to the end of day 4 on 25/08/2004 (weekends are not trading days and hence are excluded). Any period longer than one-week is likely to be distorted by returns of unrelated events and introduce a confounding event bias. To summarise, a diagrammatical representation of the EP and one-week extended TP is featured in the timeline below.



The significance of AR is examined using Patell's (1976) standardised residual test. AR can be viewed as the error term predicted on an out of sample basis (outside of the EP). Therefore an adjusted t-statistic ($\upsilon_{\mathbf{it}}$) is used to control for this out-of-sample prediction problem by introducing a correction factor ($C_{\mathbf{it}}$). This factor reflects the increase in variance due to prediction outside of the EP, and reduces the probability of making a type I error. The adjusted t-statistic is then given as follows:

$$\upsilon_{\mathbf{it}} = \frac{AR_{\mathbf{it}}}{\mathbf{s.e}\sqrt{C_{\mathbf{it}}}} \sim t\,(T_{EP} - 2) \tag{9}$$

The standard error ($\mathbf{s.e}$) of the estimate is defined as the square root of the sum of the squared residuals (SSR) divided by the number of days in the EP (T_{EP}) minus 2:

$$\mathbf{s.e} = \sqrt{\frac{1}{T_{EP} - 2} \sum_{\tau=1}^{T} \varepsilon_{\mathbf{i}\tau}^{2}} \tag{10}$$

The correction factor ($C_{\mathbf{it}}$) is calculated for each day in the TP. It is a function of the number of days in the EP (T_{EP}), the market return at time $\boldsymbol{t}$ ($\mathbf{r_{mt}}$) and the arithmetic average market return during the EP ($\bar{\mathbf{r}}_{\mathbf{m}}^{\mathbf{EP}}$):

$$C_{\mathbf{it}} = 1 + \frac{1}{T_{EP}} + \frac{(\mathbf{r_{mt}} - \bar{\mathbf{r}}_{\mathbf{m}}^{\mathbf{EP}})^2}{\sum_{\tau=1}^{T_{EP}} (\mathbf{r_{mt}} - \bar{\mathbf{r}}_{\mathbf{m}}^{\mathbf{EP}})^2} \tag{11}$$

Where:

τ	Subscript denoting an element belonging to the EP
$\mathbf{t}$	Subscript denoting an element belonging to the TP

The adjusted t-statistic ($\upsilon_{\mathbf{it}}$) is t-distributed with ($T_{EP} - 2$) degrees of freedom. This t-statistic is compared with the critical value of the t-distribution for a given level of significance to determine whether AR is statistically significant. Hypothesis 1 predicts the AR should be significantly greater than zero to indicate the presence of underpricing. To test the hypothesis explicitly, if the adjusted t-statistic is greater than the critical value, one can reject the null hypothesis in hypothesis 1 and conclude the IPO was underpriced.

To calculate the extent of underpricing over a one-week period, I calculate the cumulative abnormal return (CAR) from day 0 (t_1) to day 4 (t_2). CAR can be found by summing the ARs on each individual day:

$$\mathrm{CAR}_{\mathbf{it}=t_1:t_2} = \sum_{t=t_1}^{t_2} \mathrm{AR}_{\mathbf{it}} \tag{12}$$

If the market is informationally efficient, Google's stock price should instantly reflect all public information and the price adjustment should happen on the event date only. If not, then I expect large positive AR values in subsequent days. The degree to which underpricing is concentrated on the first trading day can be seen by examining the difference between the values of AR and CAR. If these values are similar, then the majority of the upward price adjustment happened in the first trading day.

By summing the individual day adjusted t-statistics and dividing by the square root of the number of days in the TP (T_{TP}), one can compute the relevant t-statistic for CAR to conduct the significance test. This value (denoted $\kappa_{\mathbf{i}}$) follows a t-distribution with ($T_{EP} - 2$) degrees of freedom:

$$\kappa_{\mathbf{i}} = \frac{\sum_{t=t_1}^{t_2} \upsilon_{\mathbf{it}}}{\sqrt{T_{TP}}} \sim t\,(T_{EP} - 2) \tag{13}$$

The adjusted t-statistic of CAR is compared with the critical value of the t-distribution and in an identical fashion to the one-day test, one can conclude the one-week CAR is significantly greater than zero if $\kappa_{\mathbf{i}}$ is greater than this critical value.

5.2. Long-Term

In the long-term event study, I use the Fama-French (1993) three-factor model to test for underperformance. This model is appropriate as it captures many of the risk factors that might explain Google's long-run stock returns. The model incorporates not only systematic market risk, but also the risk associated with value and large cap stocks by introducing the HML and SMB factors. Research has shown that inclusion of these factors can explain significantly more of the variation in equity portfolio returns than the standard CAPM (Fama and French, 1996). The estimated model is given by equation (14):

$$\mathbf{r_{it}} - \mathbf{r_{ft}} = \alpha_i + \beta_m (\mathbf{r_{mt}} - \mathbf{r_{ft}}) + \beta_H \mathbf{HML_{it}} + \beta_S \mathbf{SMB_{it}} + \varepsilon_{\mathbf{it}} \tag{14}$$

Where:

$\mathbf{r_{it}} - \mathbf{r_{ft}}$	Excess return above the risk-free rate for firm $\mathbf{i}$ at time $\boldsymbol{t}$
$\alpha_{\mathbf{i}}$	Jensen's alpha
β_j	Factor sensitivity for the jth independent variable
$\mathbf{r_{mt}} - \mathbf{r_{ft}}$	Excess return on the market over the risk-free rate at time $\boldsymbol{t}$
$\mathbf{HML_t}$	Return on the high-minus-low book-to-market value portfolio
$\mathbf{SMB_t}$	Return on the small-minus-big market capitalisation portfolio
$\varepsilon_{\mathbf{it}}$	Zero-mean random error term at time $\mathbf{t}$

I estimate the model over two test periods: 30/09/2004 to 31/08/2007 (3 years) and 30/09/2004 to 31/08/2009 (5 years), using 36 and 60 monthly observations respectively. The justification for the choice of TP is based on the empirical findings of previous studies, which state underperformance is present for 3 to 5 years post-IPO. Consistent with Brav and Gompers (1997), the extent of underperformance will be given by Jensen's (1968) alpha coefficient in the time-series regression. Alpha can be seen as an 'abnormal performance' constant that is not explained by the risk factors in the model. A significantly negative alpha symbolises long-run underperformance during the time the model is estimated. To determine the statistical significance of alpha, the relevant t-statistic is obtained from the regression output.

6. Results

6.1. Short-Term

The results of the market model OLS regression are presented in Table 2. The values of α_i, β_i and the adjusted R^2 are presented along with the number of observations (n). The adjusted R^2 value determines the proportion of the variability in Google's stock return explained by the model. The t-statistics are given in brackets. The significance tests for $\alpha_{\mathbf{i}}$ and $\beta_{\mathbf{i}}$ are two-sided tests that the coefficients are non-zero.

Table 2: Market Model OLS Output

$$\mathbf{r_{it}} = \alpha_{\mathbf{i}} + \beta_{\mathbf{i}}\, \mathbf{r_{mt}} + \varepsilon_{\mathbf{it}}$$

Coefficient	Value (t-statistic)
α_i	0.0002 (0.16)
β_i	1.1213** (8.33)
Adj. R^2	0.215
n	250

*Significant at the 5% level
**Significant at the 1% level

The results show alpha is insignificant with a near zero value of 0.0002. The estimate of beta is 1.12 and is highly significant at the 1% level, indicating a positive relation between return and systematic risk, as expected. The (unreported) value of the F-statistic in the regression is 69.38, which is highly significant with a *p*-value approaching zero. Therefore the value of alpha is still used to compute expected return because the F-test shows the coefficients are jointly significant. The adjusted R^2 of 0.215 (21.5%) suggests the model has a good level of explanatory power given the potentially high presence of firm-specific idiosyncratic risk.

These estimates are used to calculate the expected and abnormal returns within the test periods specified in section 5.1. Firstly, Table 3 presents the results and adjusted t-statistic of the one-day test period. AR is decomposed into its constituent components of realised return and expected return.

Table 3: AR Decomposition in the TP of 19/08/2004

$$\mathbf{r_{it}} - \mathrm{E}(\mathbf{r_{it}}) = \mathrm{AR}_{\mathbf{it}}$$

Date (day)	r_{it}	$E(r_{it})$	AR_{it} (adjusted t-statistic)
19/08/2004 (0)	18.05%	−0.84%	18.89%** (9.90)

*Significant at the 5% level
**Significant at the 1% level

The results in Table 3 provide strong evidence that the AR of 18.89% on the first trading day was significantly greater than zero. In fact, Google's realised stock return was significantly positive despite the S&P 500 declining on that day. With an adjusted t-statistic of 9.90, AR is highly significant at the 1% level, so this conclusion is statistically robust and unlikely to be down to chance. From this, it is clear the Dutch auction pricing mechanism underpriced Google's stock as hypothesised, leading to a rejection of the null hypothesis in hypothesis 1.

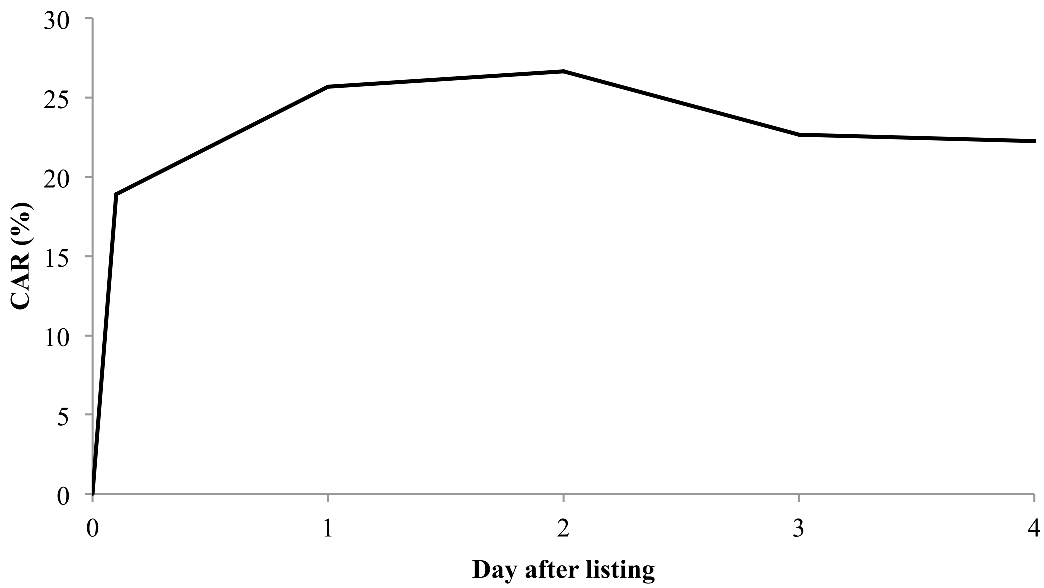
Table 4 extends this analysis and presents the results for the extended one-week test period. Column 2 presents the AR on each day, whilst column 3 presents the cumulative AR (a running total of the daily AR) along with the cumulative t-statistic. The t-statistic of the final CAR value is presented in the final row by dividing the cumulative t-statistic by the square root of the number of days.

Table 4: CAR in the TP of 19/08/2004 to 25/08/2004

Date (day)	AR (adjusted t-statistic)	CAR (cumulative t-statistic)
19/08/2004 (0)	18.89%** (9.90)	18.89% (9.90)
20/08/2004 (1)	6.81%** (3.56)	25.70% (13.46)
23/08/2004 (2)	0.95% (0.50)	26.65% (13.96)
24/08/2004 (3)	−4.0%* (−2.13)	22.65% (11.83)
25/08/2004 (4)	−0.40% (−0.21)	22.25% (11.62)
CAR = 22.25%** (adjusted t-statistic, $\kappa_i = 11.62/\sqrt{5} = 5.20$)		

*Significant at the 5% level
**Significant at the 1% level

Figure 1: One-Week CAR



The results of both tests confirm Google's IPO was materially underpriced. During the one-week TP, AR on the second trading day (day 1) of 6.81% was also significantly positive at the 1% level, introducing the possibility that the market took 2 days to fully react to the underpricing. On subsequent days, Table 4 and Figure 1 both show the CAR does not fluctuate greatly, which is in line with what is expected in an informationally efficient market. In the one-week period, CAR approximately lies within the range 19% to 26%, indicating that the full extent of underpricing is likely to be within this range. However, as a primary measure of the wealth gain Google's shareholders received, I use the first-day AR of 18.89%.

6.2. Long-Term

The results of the 3 year (36 month) and 5 year (60 month) Fama-French regressions are presented in Table 5. The significance tests for the variables are a one tailed test of α_i being significantly less than zero and a two-tailed test of β_m, β_H and β_S being significantly different from zero.

Table 5: Fama-French Model Regressions		
$r_{it} - r_{ft} = \alpha_i + \beta_m (r_{mt} - r_{ft}) + \beta_H HML_{it} + \beta_S SMB_{it} + \varepsilon_{it}$		
Coefficient	**3 year (t-statistic)**	**5 year (t-statistic)**
α_i	0.0279 (1.61)	0.0263 (2.23)
β_m	1.8676** (2.80)	1.6427** (6.50)
β_H	−2.3265** (−2.37)	−1.8083** (−2.99)
β_S	−1.4347* (−1.78)	−1.1383** (−2.81)
Adj. R^2	0.258	0.422
F-statistic	5.05**	15.34**
n	36	60

*Significant at the 5% level
**Significant at the 1% level

The variable of interest is Jensen's (1968) alpha coefficient (α_i). For the 3 year regression, the positive value of alpha of 0.0279 (2.79%) is clearly not significantly less than zero. This suggests Google did not materially underperform, which is inconsistent with the theoretical predictions of a negative alpha in hypothesis 2. Similarly, the alpha given by the 5 year regression is only marginally lower at 0.0263 (2.63%), suggesting Google outperformed the market to a similar extent regardless of the measurement period. Moreover, the factor betas are all significant at the 1% level with the exception of the 3 year SMB beta. The adjusted R^2 values of 0.258 (25.8%) and 0.422 (42.2%) suggest the model is an appropriate fit, given the potential presence of firm-specific noise distorting explanatory power over long time periods. The F-statistics for the 3 year and 5 year regressions are 5.05 (p = 0.0056) and 15.34 ($p \approx 0$) respectively, indicating that both models are jointly statistically significant overall.

The results from the regressions are puzzling. The long-run underperformance of IPO companies is well documented in the literature, but the analysis suggests Google generated positive risk-adjusted long-run returns. The next section will provide a discussion of the results and propose explanations for failing to accept hypothesis 2.

7. Discussion

7.1. Short-Term

The evidence suggests strong support in favour of hypothesis 1 that Google's IPO was underpriced. Why was this the case when the owners explicitly stated they wanted to avoid underpricing? In this section, I present two potential explanations.

7.1.1. Auction Design

Hurt (2005) argues the Google IPO was not a 'pure' Dutch auction, and this could have contributed to the significant price jump observed after listing. In a true Dutch auction, anyone would be able to bid and the clearing price would determine the offer price. However, there were a number of restrictive factors that discouraged wide participation from investors. The investment banks Morgan Stanley and Credit Suisse First Boston (CSFB) that acted as the lead underwriters in the IPO insisted investors must hold retail accounts with them, and they required extremely high minimum balances on their accounts, limiting participation from smaller investors. However, this restriction received much criticism from retail investors about its discriminatory nature and was subsequently relaxed, but not abolished. Additionally, the auction featured a complicated double registration process that may have discouraged full market participation.

Behavioural factors may have exacerbated problems with the auction design. Auction IPOs are extremely rare within the US: since 1999 until the date of Google's IPO, only 15 firms used an auction process to sell their shares. A combination of unfamiliarity with the general procedures of an auction IPO, and the fact it is not commonly used within the US, may have discouraged risk-averse investors from participating in Google's initial public offering.

Consequently, these factors may have caused investors to boycott the auction in favour of buying the shares in the more accessible publicly traded market. This creates two demand curves for Google shares: an auction demand curve that is below the true post-auction market demand curve. As the true market demand is encapsulated into stock prices after listing, the price of Google stock is pushed upwards, leading to the observed initial AR.

7.1.2. The Winner's Curse

Another feasible explanation is intentional underpricing by Google to avoid the winner's curse phenomenon. In an auction IPO context, the winner's curse refers to the possibility that investors are allocated shares at a price above their fair value. The logic behind this argument is as follows. Uninformed investors have an incentive to bid at a high price for the shares and free ride on the information of informed investors. This is because regardless of how high their bid price is, they will still receive the shares at the (lower) market clearing equilibrium price. If too many investors submit these kinds of price-distorting bids, the stock price will artificially be driven higher than its fair value, resulting in a downwards price adjustment in the aftermarket and a negative initial return. Investors that receive Google shares will have overpaid relative to the company's fair value, and are subject to a 'winner's curse'.

If an initial price decline did occur, investors may conclude Google's stock was not a sound investment. This could ultimately damage Google's corporate reputation and ability to raise further equity finance in the future. In an attempt to combat this concern, Google and the IPO underwriters retained the right to set the IPO offer price different from the auction clearing price. According to their IPO prospectus filing: "we [Google] and our underwriters have discretion to set the initial public offering price below the auction clearing price" (Google, 2004, p. 38). It could be the case that the offering was purposely underpriced as an attempt to create aftermarket share price stability and avoid this winner's curse problem.

Information regarding submitted bids was never made public, but Hurt (2005, p.24) states that most critics believe investors received only a 75% share allocation. This provides evidence that the IPO was oversubscribed at the price of $85 per share, otherwise investors would receive nearly a 100% allocation. From this, one can infer the actual auction clearing price was above the $85 offer price, and the concerns regarding the winner's curse problem were unjust or over exaggerated. The findings in Berg, Neumann and Rietz (2005) support this explanation. They estimate the demand curve for Google IPO stock using publicly available information to be approximately $Q^D = 72.5m – 0.5P$ (p. 20). This leads to a fair offer price of nearly $106 to ensure the 19.6m shares being issued were subscribed. If these findings are true, then it is possible the Dutch auction was an accurate price discovery mechanism, and that intervention by Google and the underwriters caused the observed underpricing.

7.2. Long-Term

When the long-term is considered, the regression results in Table 5 provide strong evidence that Google did not experience long-run underperformance following its IPO. This is inconsistent with the well-documented findings in the literature, and presents the puzzle: why did Google not underperform?

A crucial point to make at this stage is that the empirical results report what holds on average for large samples. It might be the case that small samples or individual firms do not strictly adhere to the general trend. In this section, I propose two complementary explanations for why Google did not conform to the anomaly of long-run underperformance.

7.2.1. Acquisitions

Google made a series of highly profitable acquisitions throughout the period 2004 to 2009 that had a dramatic impact on its share price and operating performance. In August 2005, Google acquired the mobile operating system company Android for $50m, to expand its operations into the high-growth, highly lucrative smartphone operating system market. 14 months later, Google acquired the highly popular video sharing website YouTube in October 2006 in a $1.65bn all-stock transaction. The rationale for this acquisition was that Google's core advertising business could be integrated into the YouTube video streaming platform, increasing the cash inflows from advertising. At the time of acquisition, advertising accounted for 99% of Google's total revenue. Furthermore, through the $3.1bn acquisition of DoubleClick, a privately held online advertising service provider in April 2007, Google was able to substantially increase the scale of its advertising business. By integrating these businesses into its core operations and exploiting positive synergies, Google was able to consolidate its position as the market leader.

Following these acquisitions, Google's financial performance improved exponentially. From 2004 to 2009, the compound annual growth rate (CAGR) of revenue was 49.29% per annum. Similarly, the net income CAGR was even higher at 74.84% (Google, 2005; 2009). Both of these figures were far higher than the companies in Google's peer group. Furthermore, the company experienced consistent revenue and earnings growth throughout the 5 year period following its IPO. This ultimately contributed to equity returns that beat the market as a whole.

7.2.2. Product Range Expansion

In the years following the IPO, Google expanded its business into various other ventures to expand revenue streams, drive traffic to their core website and maximise advertising revenues. Many of these ventures were formed through the aforementioned acquisitions. A prime example of a successful product launch is the Android mobile operating system. Android is open source so external developers can freely use the code and system to run on their handsets. The open source nature of the product has lead to wide adaption by the major smartphone manufacturers HTC, LG, Nokia, Samsung and Sony, amongst others. Google makes its revenue through advertising in built-in Google branded applications such as Google Maps, Google Shopper and Google Play, which show targeted advertisements to users and directs all searches to the main Google website. Furthermore, through the successful introduction of Google Mail, Google Docs and other proprietary applications, the company was able to develop an 'ecosystem' of services that helped generate the strong observed financial and operating performance.

8. Conclusion

In conclusion, I implement the event study methodology to examine the short-term and long-term effects on shareholders' wealth resulting from the Dutch auction IPO of Google in 2004. After reviewing the extensive literature on IPO performance and Dutch auction IPO pricing, I formulate the hypotheses that Google's IPO was underpriced in the short-run, and in the long-run Google experienced underperformance. I proceed to comprehensively review the event study methodology in both the short-term and the long-term, using best practice from previous event studies.

The results of the short-run underpricing tests strongly support the hypothesis that Google's IPO was underpriced. The first day abnormal return was 18.89%, growing to 22.25% when the one-week cumulative abnormal return measure is used. Both of these results were highly significant. I provide several possible explanations for why the IPO was underpriced, including: the issues caused by the auction design not being a 'pure' Dutch auction, and the possibility of intentional underpricing to avoid the winner's curse phenomenon. Of these two explanations, the available evidence best supports the winner's curse scenario.

In the long-term, using the Jensen's alpha approach to measure risk-adjusted abnormal returns, the results provide strong evidence against the proposition that Google underperformed the benchmark. The tests suggest Google generated substantial value for its long-run equity holders in both the 3 year and 5 year periods following its IPO. These findings are unexpected and atypical of the average IPO firm. This superior performance can be explained to some extent by the aggressive expansion strategy Google followed after its IPO, using the equity capital it raised to acquire several major complementary companies to expand its operations and increase its future earning potential. Additionally, by using these acquisitions to launch new products and services, Google was able to sustain strong financial performance.

From this analysis there are several points that are relevant for academics and practitioners in the future. Firstly, despite their theoretical attractiveness, Dutch auction IPOs may still lead to significant underpricing, and this may be the result of firm-specific factors rather than flaws in the auction process itself. Secondly, the evidence on long-run underpricing should not discourage investors from holding recent IPO stocks; they are still capable of generating substantial long-run returns.

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