

A Work Project presented as part of the requirements for the Award of a Master's degree in  
Finance from the Nova School of Business and Economics.

**THE IMPACT OF VENTURE CAPITAL ON THE LONG-RUN PERFORMANCE OF  
IPOs**

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17-12-2021

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## **Abstract**

This paper examines the impact of venture capital on the long-run performance of U.S. initial public offerings (IPOs) on the stock exchanges NASDAQ and NYSE from 2011 to 2018. The main findings of this paper indicate a strong positive impact of venture capital on the market-based criteria of stock returns and market-to-book value, but a small negative impact on abnormal return on assets and the survival rate of the backed companies. The strongly growing size of the U.S. venture capital market was not reflected in an increase in the performance of venture capital-backed IPO.

## **Keywords**

Venture Capital, Financial Markets, IPO, Performance Analysis, Startups, Abnormal Return

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

## **1. Introduction**

The United States (U.S.) economy has been in a steady upward trend that was strongly accompanied by an ever-growing initial public offering (IPO-) market since the financial crisis of 2007/08. An IPO is a public event by companies to offer their shares for purchase on the equity market for the first time. The IPO is one of the most important procedures for companies to raise capital (Ritter and Welch 2002) and the most prestigious way to be integrated into the public market. In particular, the IPO of Alibaba Group Holding Limited in 2014, with a valuation of USD 21 billion was a significant moment, which is still the largest IPO in U.S. history (Statista 2021). Not by coincidence, the IPO of Alibaba was venture capital (VC)-backed. VC is one of the most important industries when it comes to startup development and IPO success. In fact, the VC industry is highly ramified with the startup and IPO industry. The seven largest U.S. companies by market capitalization (for 11/10/2021) - Microsoft, Apple, Alphabet, Amazon, Tesla, Meta (Facebook) and NVIDIA – were all VC-backed in their early years (Bloomberg L.P. 2021). The initial idea behind VC is to be an alternative in financial funding for companies that face difficulties accessing traditional financing sources like banks. VC is a pool of capital that is professionally managed and invested into shares of equity of private ventures (Gifford 1997). Providing funding and know-how for innovative companies with high growth potential is a crucial role of VC firms (Pommet 2011). The principal objective is to positively influence the company's economic prospects and actively contribute to the success of the company being managed by the VC firm (Manigart, Baeyens, and Van Hyfte 2002). VC firms follow a high-risk high-return concept in building a portfolio out of young ventures that require financial support to launch their business idea or enlarge their company (Raj Kumar and Manu Sharma 2020). Since such innovative companies are associated with substantial risk and failure rates (Storey and Tether 1998), VC firms seek to reduce the degree of failure by contributing capital as well as network effects, strategic and monitoring advice in

the effective management of the company and monitoring. VC is a private investment where funds are invested into a young company in exchange for equity or ownership (Caffrey 2020). Utilizing a strategy that combines careful due diligence, intensive monitoring, and direct support, VC firms seek to establish companies that eventually go public (Gompers and Lerner 1999). The typical exit types for VC firms are trade sale, secondary sale, liquidation, or through an IPO (Giot and Schwienbacher 2007). The latter can generate the highest profits for VC firms (Gompers and Lerner 2001), although they do not generally dispose of all their ownership. Following Barry et al. (1990), 89% of VCs in their sample group have retained most of their shares in the startup for one year or more after the IPO date. This is attributable to contractual reasons based on lock-up agreements, liquidations plans and performance incentives. Moreover, even after the VC firm has sold all its ownership, the practices of the VC firm still have a subsequent impact on the company's performance. Cumming and Johan (2010) state that the average holding investment period of VC firms between 1980 and 2003 was approximately 3.34 years until their backed companies went for an IPO. During this time, under the supervision of VC, various financial practices such as a strong focus on research & development (R&D), patent generation and the establishment of management structures are introduced, which will remain in place for a certain period of time after the VC firm's complete exit and will help the IPO company perform better in the long run (Gornall and Strebulaev 2021). Furthermore, VCs remain on the board of directors long after the IPO and may continue establishing access to capital that those companies might not receive otherwise. The VC support thus can influence the type of shareholders of the company after the IPO. For this reason, the objective of this paper is to analyze the long-term performance of VC-backed IPOs compared with non-VC-backed IPO companies for the first three years after the IPO date, which is the typical period taken from prior research regarding this topic (Krishnan et al. 2011; Chen and Liang 2016; Bessler and Seim 2012).

This study is organized as follows: Section 2 gives a literature overview of past research on topics related to the objective of this study and the development of the hypothesis. Section 3 describes the data collection of the sample used, specifies the estimation on the long-run performance of IPO companies, and defines the relevant variables of the econometric model. Section 4 provides the empirical results on the regression model and suggestions for future research. Finally, the conclusion is drawn in Section 5.

## **2. Literature Review & Hypothesis Development**

In past studies, the question often arose as to what extent VC financing is associated with advantages for the supported companies in their IPO and, in particular, in the company's post-IPO performance. For this purpose, the general theoretical concepts in this context are first outlined. Subsequently, the advantages and disadvantages of VC influence on long-term IPO performance are assessed, with reference to conclusions drawn from previous studies. Finally, the hypothesis of this study is derived.

### **2.1. Theoretical Framework**

#### **Agency Theory:**

So-called agency problems can arise between VC firms and entrepreneurs. These are conflicts of interest between two parties that occur when the goals of both are not aligned, and the risk tolerance is different (Eisenhardt 1989). The theory concept describes that the principal (VC firm) and agent (entrepreneurs) represent their own interests and pursue maximizing their profit as their individual purpose (Eisenhardt 1989). The extent of effort to align objectives is positively correlated with the VC's equity stake in the firm, and if successful, VCs can eliminate moral hazard and adverse selection (Brav and Gompers 1997, Megginson and Weiss 1991, Doukas and Gonenc 2005).

#### **Information Asymmetry:**

Typical companies backed by VCs are young innovative companies without an extensive

reference of their financial history. Therefore, an information asymmetry between the management of the company and potential investors exists. This impedes potential investors' assessment of the company's future performance (Brav and Gompers 2003; Mason and Stark 2004). The firm's managers may have the incentive to announce overoptimistic future earnings estimates to maximize returns through the IPO. In this case, adverse selection in the equity market may occur.

### **Resource Dependence Theory:**

Resource dependence theory (RDT) addresses the effect of resource acquisition on the actions of organizations. The core idea is that an organization must interact with other organizations and individuals in its environment to acquire resources. This can be applied to interactions between startups and VC firms, which can generate benefits but can also hinder the organization. Within the framework of RDT, control over resources conveys power. Organizations need to develop plans to prevent being affected by an unequal balance of power that could interfere with resource acquisition (Campbell 2021). Likewise, the duration of VC investments can be interpreted in the context of the resource-based view. RBT suggests that VCs invest in their backed company until its value as a strategic resource falls below the value provided by a new owner or partner of the company (Hillman, Withers and Collins 2009).

## **2.2. The positive impact of VC firms on the IPO performance**

VC firms possess lots of resources and make their investment decisions based on various parameters, which results in selecting the most promising startups to support financially (Gompers and Lerner 2004). Only a few ventures out of thousands are funded by VC firms (Gifford 1997), for which the VC firm believes the startup to have a high chance of becoming the next major company for its respective industry. Because of the selectivity of the VC's investment process (Sahlman 1990), the first impact is the strong signal effect of an investment by a VC firm disseminating positive information about the company's credibility and by thus,

reducing the information asymmetry between the company and the market. The VC's investment in the company signals to the market that the VC believes in the potential value of the company (Brav and Gompers 2003; Field and Hanka 2001). Furthermore, the VCs' effective auditing and monitoring of the backed company discloses valuable information, which also mitigates information asymmetry (Megginson and Weiss 1991). Megginson and Weiss (1991) concluded that the presence of VC as one of the earliest investors at the time of the company's IPO plays a decisive certification role for the IPO's quality and, according to Manigart, Baeyens, and Van Hyfte (2002), provides better chances for cheaper sources of financing. Consequently, VC-backed IPOs raise higher amounts of funds and are connected to more prestigious underwriters (investment banks) than non-VC-backed IPO companies (Jain and Kini 2000). This positively affects the impact on the post-IPO-survival rate of VC-backed companies. Another factor in this regard is the reputational concern of VC firms. In order to be successful as a VC firm, an association with failures when bringing companies into the public market must be averted by the VC firm (Gompers 1996). For this reason, VCs are less likely to overstate the IPO or build unsustainable hype around it (Brav and Gompers 1997). Moreover, VCs are in a better position to choose the ideal time for going public (Lerner 1994).

The second advantage in the context of agency theory is the reduction of agency conflicts and business risks by using control mechanisms like specific control rights such as convertible securities (Schmidt 2003). Compared to traditional investors such as banks, VC firms are better suited to solve agency problems because the VC firm besides providing capital is also involved with the strategic composition of the company, helping it with its expertise, strong network effects and frequently monitors for potential defects (Admati and Pfleiderer 1994). Since, for the most part, VCs acquire a significant equity stake in the company, agency theory as a whole argues that VCs, through their certification and export monitoring, positively affect the long-run performance of the IPOs they support and perform better than non-VC-backed IPO.

Third, VCs can provide their portfolio companies access to essential resources due to their extensive network (Boissin and Sentis 2012). Previous research has shown that, in addition to financial capital, the most critical resource categories for firms can be strategic and market information, human resources such as competent managers, potential customers, connections to key suppliers, and other vital stakeholders (Baysinger and Zardkoohi 1986; Frooman 1999). The fact that VC owns a significant equity stake in the company combines the payoff structures of both parties. In the context of the RDT, it is therefore in the interest of the VC firm to make use of all of its resources that positively impact the success of the supported company. VC firms can generate added value by providing the company with their strong professional network and by giving them more favorable access to capital, for example, due to close connections with institutional investors like portfolio companies or investment banks as underwriters for the IPO (Jain and Kini 2000; Manigart, Sapienza and Vermeir 1996). This accreditation granted by VC firms signifies less need for revenue management by the backed companies, leading to higher growth prospects and more positive long-term post-IPO performance.

Last, the VC firm adds direct value to the company. VC firms help building a qualified management team, recruit top managers, and develop the operating business strategy through their strong expertise (Hellmann and Puri 2002). VC firms also contribute to improved corporate governance quality of the publicly traded company by monitoring it or serving on the board of directors (Hellmann and Puri 2000; Kaplan, Strömberg, and Sensoy 2002). In this way, the experience and expertise of the VC firm can result in better operational and financial performance. Likewise, greater emphasis can be placed on research and development, which generates more patents filed and improves the company's chances of survival (Bessler and Bittelmeyer 2008).

Prior empirical studies show that these general advantages of VC are also positively reflected in the post IPO performances. Megginson and Weiss (1991) observed less underpricing in VC-

backed IPOs, which they attributed to the certification role of VC firms. One of the most relevant studies on the effect of VC on the long-term performance of IPOs in the U.S. market by Brav and Gompers (1997) showed the superior performance of VC-backed IPOs over five years after the IPO date using equal-weighted returns. Doukas and Gonenc (2005) concluded that VC-backed U.S. IPOs have a higher buy and hold return after two and three years. Krishnan et al. (2011), also taking into account the reputation of the VC firm, observed a positive impact of VC on abnormal stock returns, market to book ratio (M/B ratio), return on assets (ROA) and probability of survival of the backed companies over a three-year period. Jain and Kini (2000) showed the positive impact of VC on the survival rate of U.S. companies.

### **2.3. The negative impact of VC on the IPO performance**

VCs generally invest in small, young, more innovative, but thus also higher than average risk companies. As a result, VC-supported companies have lower survival probabilities and higher failure rates than non-VC-supported IPOs (Dimov and De Clercq 2006). Dimov and De Clercq (2006) suggest that the likelihood of failure for startups is about 40% in the first year and 90% over a ten-year period.

Through the VC's active participation in the management, a conflict of interest can arise between the VC and the entrepreneurs, which can restrict the entrepreneur's scope of action. There is a considerable additional expenditure of time due to constant coordination with the VC firm about company-defining decisions. Those conflicts of interest can potentially impede the development and growth possibilities of the company (Ritter 1998; Hellmann and Puri 2000). In an extreme case, the conflict of interests could extend to the point that the VC firm, to optimize its return, might bring forward the timing for the IPO when the investors' optimism and expectations about the company perspective are at their peak. Thus, VCs can increase their initial return, this contemplative overvaluation will impair, however long-term performance as it is unprobable that the company will keep up with such high investor expectations (Ritter

1998). IPOs of companies included in the VC's investment portfolio are essential to build a reputation of success. In particular, younger VC firms who quickly want to demonstrate success with their first fund may push entrepreneurs to go public ahead of schedule (Gompers 1996; Lee and Wahal 2004). However, a premature IPO can disrupt the company's organic growth and, at times, lead to significant undervaluation.

Moreover, there is an adverse selection problem associated with information asymmetry for a VC firm to fund companies. Manigart, Baeyens, and Van Hyfte (2002) argue that selling equity during an early stage is very costly for the company and that the most promising ventures will be able to seek funding from less expensive sources of capital.

Finally, VC firms face a trade-off between being fully involved in the post-investment management of their portfolio companies and optimizing fund returns (Elango, Fried, and Polonchek 1995). Optimizing the fund's return can come at the cost of some companies in their portfolio (Dimov and De Clercq 2006). Ruhnka, Feldman, and Dean (1992) argue that backed companies that do not promise a superior performance will not get much involvement of the VC firm due to their efficient allocation of time. In such cases, VC firms may try to liquidate their shares or the company and place the entire focus on the star performers in their portfolio (Manigart, Baeyens, and Van Hyfte 2002).

There are also empirical studies concluding a worse performance for VC-backed IPOs. Chen and Liang (2016) investigate the three year long-run performance of IPO companies by measuring abnormal ROA as an operating performance metric. Their study concludes that VC-backed IPOs perform worse than non-VC-backed IPOs, particularly when companies hold high levels of redundant cash. The reason is that excessive cash from VC firms leads to unwarranted investment (Chen and Liang 2016). Dimov and De Clercq (2006) showed that the specialized expertise of VC firms in the development stage negatively affects the survival rate of the invested companies. Other studies reported no significant difference on the impact of VCs on

long-term returns. Manigart, Baeyens, and Van Hyfte (2002) stated no considerable difference between the survival rate of VC-backed and non-VC-backed IPO companies. Lee and Masulis (2011), who examined the influence of VC on the earnings of the supported companies, could not identify any significant difference.

## **2.4. Hypothesis Development**

There are certain contradictions in the conclusions of previous research studies that focused on the issue of the impact of VC on long-term post-IPO performance. In general, the research findings to date for the U.S. tend to support a positive impact of VC on long-term IPO performance. This is mainly due to the fact that the VC industry in the U.S. is one of the strongest worldwide and the advantages of VC support through the additional expertise, the valuable network and the invested capital outweigh the negative aspects mentioned. From this finding, the following primary hypothesis of this paper is derived:

*"Venture Capital positively impacts the long-run performance of IPO companies in the U.S. market."*

As the effectiveness and size of the VC industry are the highest in the U.S. (Bottazzi et al. 2004), all U.S. IPOs from NASDAQ and NYSE between January 1, 2011 and October 31, 2018 will be examined in this study. The last research papers are several years in the past and there has been no analysis for the period after the financial crisis 2007/08 in the U.S., which is characterized by a steady upward trend of the economy and significant growth of the VC industry. The objective of this paper is to investigate the difference between the long-run performance of VC-backed IPOs and their counterparts for the U.S. market using an econometric model. To date, there have been scarce studies examining the impact of VC market size on the performance of VC-funded firms. Including the variable of U.S. VC market size into the analysis should provide valuable insights into the impact of the increasing importance of the VC market on the performance of VC-backed companies. The result of this study may

be of fundamental importance, especially for investors, as it shows them the extent to which excess returns can be achieved by investing in VC-backed IPOs in the U.S. market.

### **3. Methodology**

This section elaborates the methodology used in this study and the data collected to estimate the proposed models. First, the underlying data and their collection are described. Subsequently, the analysis procedure used is outlined. Finally, the quantitative methods are detailed and the development of the econometric model with its variables is explained.

#### **3.1. Selection and description of data**

The sample for this study's analysis consists of 1,403 IPOs with 474 VC-backed and 929 non-VC-backed companies listed on NASDAQ and NYSE that had offerings between January 1, 2011 and October 31, 2018. The year 2011 was chosen as the starting year to minimize the effects of the contemplative upswing phase after the financial crisis 2007/08. The data was extracted from EIKON Reuters and FactSet and matched together using the IPO company tickers or CUSIP number.

There are two types of data: On the one hand, data that is available at the time of the IPO such as IPO date, market capitalization, offer price, gross proceeds, year founded, total assets and several other accounting ratios. On the other hand, time-series data such as daily stock prices of all IPO companies and the S&P500 as a benchmark index and various quarterly accounting measures like total assets, earnings-before-interest-tax (EBIT) and shareholders' equity for the period 2011 to 2021. The daily price data were collected starting with the "offer date" and ending 1,100 days later (~3 years). A reference portfolio of non-IPO companies was assembled by matching all two-digit Standard Industrial Codes (SIC) included in the list of IPO companies with a random sample of large market capitalization stocks of non-IPO companies. Daily stock prices and the same quarterly accounting measures for 2011 to 2021 are also provided for the

reference portfolio. In addition, the annual VC investment amount in the U.S. for all underlying years was extracted from Statista and added to the database.

### **3.2. Model Specification**

This study applies various methodologies to empirically test the hypothesis of whether VC-backed U.S. IPOs outperform non-VC-backed U.S. IPOs in the long-run for the period 2011 to 2018. The dependent variable long-run performance is measured in four different metrics similar to Krishnan et al. (2011) to represent the different kinds of performance measurement. Therefore, we will use the buy-and-hold abnormal return (BHAR) as a stock market-related measure, the market-to-book value (MTBV) as a proxy for growth prospects, the abnormal return on assets (Abnormal ROA) as an accounting-based profitability measure and the binary variable of survival (Survivor) of the company in the three years under review. Since both metric and binary performance indicators are included, in line with previous research, a pooled panel Ordinary Least Squares (OLS)-regression will be employed for the first three continuous variables and a logit regression for the binary variable of survival in line with prior research by Jain and Kini (2000) and Pommet (2017).

#### **Regression Model:**

$$Performance_i = \beta_0 + \beta_1 VC\ Backed_i + \beta_2 VC\ Size_i + Control_i + u_i \quad (1)$$

#### **3.2.1. Dependent Variables**

##### **Buy and Hold Abnormal Return (BHAR):**

The main proxy for post IPO long-run performance is the variable "buy and hold abnormal return" (BHAR). Following the majority of previous research on the long-run IPO performance (e.g. Lyon, Barber, and Tsai 1999; Krishnan et al. 2011; Brav and Gompers 1997; Ritter 1991; Loughran and Ritter 1995; Bessler and Seim 2012), this variable is computed as follows:

$$BHAR = \prod_{t=1}^T (1 + R_{i,t}) - \prod_{t=1}^T (1 + R_{b,t}) \quad (2)$$

Hereby,  $R_{i,t}$  is the return of the IPO company  $i$  at time  $t$  and  $R_{b,t}$  is the return of the benchmark index at the same day  $t$  for which the S&P500 was taken. BHAR is calculated on a daily basis, from the 1<sup>st</sup> trading day to the 758<sup>th</sup> trading day. This corresponds to a period of three years which should minimize the momentum effect of the IPO on the stock price. Buy and hold means hereby that the investor buys the stock at IPO date and holds it over the period of all 758 trading days. The advantage of BHAR is that it can compare directly real investment strategies in investing in an IPO or investing in a benchmark like the S&P 500 over the defined period of three years. Also, the abnormal figure already implies the containment of the beta, the market risk, of the stock. The underlying cumulative returns for the BHAR calculation were winsorized at 1% and 99% levels to mitigate the highly distorting effect of outliers on the regression (Krishnan et al. 2011).

#### **Market to Book Value (MTBV):**

The MTBV represents the growth prospects and the real option value of the company and serves as a ratio for assessing the long-term financial position of the listed company. The MBTV can be used as an approximation for Tobin's Q (Krishnan et al. 2011) and is defined as the market capitalization of the IPO company divided by shareholder's equity as of the 36<sup>th</sup> month after the IPO date. Shareholder's equity is used as a proxy for the book value. Also, the MTBV is winsorized at the 1% and 99% levels to minimize the impact of outliers in the data set.

#### **Abnormal Return on Assets (Abnormal ROA):**

As ROA is a popular operating performance measure in extant literature (Lyon, Barber, and Tsai 1999; Krishnan et al. 2011; Chen and Liang 2016), it is used as the third dependent variable. Similar to Chen and Liang (2016), ROA is defined as EBIT divided by the total assets at the 36<sup>th</sup> month after the IPO date. In order to not integrate potential influencing factors due

to the capital structure with interest expenses into the model, instead of net profit EBIT is used for the ROA calculation (Chen and Liang 2016). Barber and Lyon (1996) point out that ROA is usually mean-reverting and strongly dependent on the firm's industry. This can lead to biased statistical conclusions if the unadjusted ROA is estimated without controlling for the performance and industry effect. To avoid the bias, the industry-adjusted ROA is calculated by matching each firm in the IPO sample to one non-IPO company using the two-digit SIC. The comparison company is the one whose MBTV is most similar to that of the IPO company. The industry-adjusted Abnormal ROA is calculated as the ROA of the IPO company minus the ROA of the matching non-IPO peer company with the same two-digit SIC. Abnormal ROA is winsorized at the 1% and 99% levels to minimize the bias effects of outliers in the sample.

#### **Survival Rate (Survivor):**

The last measure for performance is the binary variable of survival that takes a value of 1 for companies that remain listed on NYSE and NASDAQ for the analyzed period of three years and 0 otherwise (firms that go bankrupt or private, that are liquidated or defunct). Survivor is critical to exclude from the effect of survivorship bias (Krishnan et al. 2011).

#### **3.2.2. Independent Variables**

The first independent variable **VC-Backed** is a binary dummy variable with the values 0 if the IPO is not VC-backed and 1 if the IPO is VC-backed. Also, the variable **VC Size** was included to infer the impact of VC market size on performance. Size is defined as the annual value of all VC investments in the U.S. for the years 2011 to 2018.

#### **3.2.3. Explanatory control Variables**

Based on previous literature, a set of control variables is implemented in the regression analysis to isolate the effect of VC on the IPO performance and reduce the potential bias. These control variables provide general information about IPO deals and can have specific impacts on the long-run performance besides the VC dummy variable and VC Size. Brav and Gompers (1997)

found out that VC-backed IPOs do not underperform non-VC-backed IPOs and that the factors size of the company and the M/B ratio show an important impact on the significance of the regression. They concluded that underperformance is a characteristic of small, low book-to-market firms regardless of the fact of IPO event or not. To account for this, control variables on firm size, M/B ratio and other key determinants of long-run performance were embedded in the econometric model. The control variables are listed below:

**LN Offer Size:**

Prior research done by Carter, Dark, and Singh (1998), Doukas and Gonenc (2005) and Su and Bangassa (2011) argue that larger issuance offers are typically made by financially strong and established IPO issuers that publish more information to the investors. Beatty and Ritter (1986) introduced the idea that small size IPO companies yield a higher initial return due to their higher risk and uncertainty but underperform larger IPO companies in the long-run. Also, Brav and Gompers (1997) found out that underperformance by non-VC-backed IPOs is primarily explained by the small market capitalization of their issuers. Therefore, LN Offer Size, defined as the natural logarithm of IPO gross proceeds, is added to the model to control for any systematic influence on the IPO long-run performance.

**LN Issuer Age:**

LN Issuer Age describes the company's age at the time of IPO issuance since its founding year. It can be seen as an approximation of the company's stage of development and growth potential, the level of tangible assets, the breadth of the customer base and the experience of the management team (Krishnan et al. 2011). If all these characteristics are widely manifested, a lower growth profile of the underlying company is implied. Being a young company bears more risk due to the higher uncertainty, which requires a higher average initial return. As this variable is skewed, the natural logarithm of 1 + issuer age (LN Issuer Age) following prior research is taken (Ritter 1991). Muscarella and Vetsuypens (1989) also exhibit a statistically significant

negative relation between initial returns and the age of the IPO company.

**Underpricing:**

Underpricing is defined as the first day return of the public listed company and calculated as the percentage change from the first trading day closing price  $P_{i,CP}$  of firm  $i$  to the IPO offer price  $P_{i,OP}$  of the same firm  $i$  (Lee and Wahal 2004; Loughran and Ritter 2004).

$$UP_i = \frac{P_{i,CP} - P_{i,OP}}{P_{i,OP}} \quad (3)$$

Therefore, Underpricing is the return to an investor buying shares in the primary market and selling them at the end of the first trading day in the secondary market. Incorporating this variable into the regression is essential since Yi (2001) found a positive correlation between underpricing and long-term performance. Jain and Kini (1994) stated a signaling effect by underpricing for better post-IPO operating performance. The underpricing of the stock before the IPO results in an upward adjustment of the stock price to market demand due to a high first day return. This can cause a bias in the analysis of long-term performance, which would produce weaker regression results. However, Krigman, Shaw, and Womack (1999) elaborated an inverse relationship between underpricing and the long-term performance of IPO companies based on a behavioral perspective. IPOs with high initial returns are likely to be influenced by overoptimistic investor sentiment, leading to poorer post-issue operating performance. Similarly, Ritter (1998) found that IPOs with a higher degree of underpricing tend to perform worse in the U.S. To minimize the effect of outliers, underpricing was winsorized at the 2% and 98% levels.

**Issuer M/B:**

Issuer M/B indicates the M/B ratio of the IPO company at the IPO date and is a good metric to measure the growth prospects of a company. Krigman, Shaw, and Womack (1999) describe that companies decide to go public when investors have peak optimism about the company's

growth prospects and are accordingly willing to pay high ratios for the company. However, this is the reason that leads to underperformance in the post-IPO period. To include the effects of the market's perceived growth prospects of the firm at the IPO time in the regression, we control for the growth potential (Lyon, Barber, and Tsai 1999; Brav and Gompers 1997; Doukas and Gonenc 2005). Due to the strong outliers, this figure was winsorized at the 5% and 95% levels.

### **VC Industry:**

The investment of VC firms is majorly agglomerated in industries related to technology and management expertise. According to Bessler and Bittelmeyer (2008) companies related to the high-tech sector usually face higher risk due to uncertainty, but also provide a higher potential to generate excess returns in combination with high quality patents compared to other industries. To adjust for this effect, a VC industry dummy variable similar to Ritter (1991) is included in the regression model. Derived from the seven high-tech industries used by Brown (2005) in his research, four two-digit SIC are utilized to label the VC industries. These are: 28 Chemicals and Allied Products, 34 Fabricated Metal Products, Except Machinery and Transportation Equipment, 35 Industrial And Commercial Machinery And Computer Equipment and 36 Electronic And Other Electrical Equipment And Components, Except Computer Equipment. This inclusion is consistent with other significant studies in this field by Krishnan et al. (2011) and Gompers, Kovner, and Lerner (2009).

### **3.3. Robustness Test**

Robustness tests are also performed in this study to check the consistency of the regression results. A better overall conclusion can be reached by including four different performance parameters in the model. The inclusion of the various control variables serves to distinguish them from other factors that affect performance. Another regression was performed without the variable VC Size, which yielded almost identical results. Likewise, regressions without including the VC Industry variable or adding the number of underwriters at the IPO date as a

variable produced consistent results. When determining the survival rate, the exact last day of the three-year period was not used as the reference value for determining the company's survival, as many values in the extracted dataset ended a few days earlier, for companies that were still officially listed at these times. After several cross-checks, the 753rd trading day was set as the reference value.

## **4. Empirical results**

### **4.1. Descriptive Statistics**

In the study period of 2011 to 2018, there are a total of 1,403 IPOs on the two biggest U.S. exchanges NASDAQ and NYSE with company headquarters in the U.S. in our sample. 34.3% of all IPO companies are VC-backed. *Table 1* provides the descriptive statistics of all variables included in the model. Comparisons are drawn with the results from the study by Krishnan et al. (2011), as it is the most recent research to investigate the impact of VC on long-run IPO performance in the U.S.

Over the examined period of three years, the mean BHAR is negative with -8.40%, slightly lower than the mean BHAR of -0.19% reported by Krishnan et al. (2011) for U.S. IPOs over the 1993-2004 period. However, this is consistent with the observations of Ritter and Welch (2002) that stated underperformance of IPO companies to a comparable market index over the same three-year period. Prior studies by Ritter (1991) and Yi (2001) also reported the underperformance of IPO companies relative to a benchmark. The standard deviation of BHAR is relatively high at 125.7%, indicating the wide dispersion in the long-term return results of IPOs. Even after winsorizing the cumulative returns for the 1% and 99% levels, the maximum value for BHAR is 627.5%. It can therefore be said that most IPOs lag the U.S. market in the first three years after issuance, but a few companies achieve exceptionally high abnormal returns. Therefore, the payoff of venture capital investments is strongly skewed with time. The mean figure for the MTBV is 3.89 and thus similar to 3.55 reported by Krishnan et al. (2011).

The standard deviation is relatively high with 18.109. The Abnormal ROA has a moderate standard deviation of 10.7%. Its mean is slightly negative with -6.60% and again under the reported value of 0.40% of Krishnan et al. (2011). Looking at the last performance measure Survivor, only 79.2% of the IPO companies remained listed in the exchange over the period of three years which is about 5% less than the rate of survivors for the period 1993-2004 in the sample of Krishnan et al. (2011).

*Table 2* shows the correlation matrix of all variables included in the model with the primary purpose to check for multicollinearity between variables. A good model is characterized by Pearson correlation coefficients expected to be below 0.3. This is the case for the dependent performance variables, whose collinearity is always below 0.1. Only the collinearity between BHAR and MTBV of 0.172 and BHAR with ROA of 0.114 is slightly higher, yet still sufficiently low to underline the good informative value of the individual variables. The threshold value of 0.7, at which the explanatory value of the individual parameters is questionable, as they can easily be replaced by other variables with which they have high collinearity, is never exceeded for the whole model. Considering all variables, the overall collinearity of the model is low and exceeds the value of 0.3 only two times: for Abnormal ROA and LN Offer Size with 0.413 and for VC-Backed and VC Industry with 0.461.

## **4.2. Analysis of dataset**

To conduct a successful regression, the data set must be validated for the OLS conditions. The examination of the zero means of the error term is shown in *Table 3* and results in values close to zero for all four regressions. It can be concluded that no bias can be detected in the error terms. Since many financial market datasets have heteroskedasticity (Lyon, Barber, and Tsai 1999), the dataset was also tested for heteroskedasticity using the Breusch Pagan Test; the output is shown in *Table 4*. The p-value for the BHAR, ROA, and Survivor regression reflected a value close to zero, respectively, showing a heteroskedastic dataset for these three regressions.

Only MTBV with a p-value of 0.07913 tested negative for heteroskedasticity. Given that the presence of heteroskedasticity violates the Gauss-Markov assumptions, the robust standard errors are applied to obtain unbiased standard errors of the OLS coefficients. The regression results are plotted with the robust standard errors in the next chapter. Further, the explanatory independent variables for a correlation with the error term were examined to check for a violation. The correlations of all seven independent variables with the error term returned close to zero, ruling out a violation of the exogeneity assumption of the Gauss-Markov theorem. To integrate no survival bias, the last available day ( $t < 758$ ) or quarter ( $t < 12$ ) from the companies not surviving to the end of the three-year horizon is taken as the reference point for the calculation of all variables. Thus, the regression is not just drawn over the winners.

### **4.3. Regression Results**

Regression results are reported for all four different performance measures (BHAR, MTBV, ROA, and Survivor) and are shown in the *Table 5* of the appendix. Like discussed in section 3.2, one regression was performed for each of the four performance measures. The variable VC-Backed is statistically significant for all four performance criteria, with statistical significance at 1% significance level for BHAR, MTBV, and Abnormal ROA and at a 5% level for Survival. Furthermore, several control variables have a statistically significant impact on long-term performance. The second independent variable VC Size is only statistically significant for the Abnormal ROA regression, however with a very small negative impact of -0.03%. Deriving from this, the first conclusion drawn is the absence of a relevant effect stemming from the growing size of the VC market on the performance impact of VC on IPO company.

The BHAR regression shows that VC exerts a strong positive effect of 0.339, meaning that the BHAR of VC-funded companies was 33.9% higher than that of non-VC-funded companies. Thus, the hypothesis of this paper for BHAR as a performance variable is confirmed. This is

consistent with previous research findings such as Brav and Gompers (1997), Krishnan et al. (2011) and Doukas and Gonenc (2005). Of the control variables, LN Issuer Age is significant at the 5% significance level and Underpricing is significant at the 1% significance level. Contrary to the theory discussed in Section 3.2.3, the age of the company at market entry has a positive effect on long-term performance. A 1% change in firm age has a positive impact of 9.3% on long-term BHAR. Underpricing negatively affects long-run abnormal returns and is consistent with the statement of Krigman, Shaw, and Womack (1999). A 1% change in returns on the first trading day has a negative impact of -6.4% on long-term returns in the data set.

The second performance indicator to be analyzed, MTBV, is also strongly positively influenced by the VC-Backed dummy variable. VC support has a statistically significant positive impact of 430.3% on the MTBV of the listed company. Thus, the null hypothesis of this paper is also confirmed for MTBV as the performance variable. This substantial positive impact of VC can be explained by the fact that VCs invest in companies from which they expect enormous future growth. The MTBV is an approximation of the market's expectation of the company's future growth. Other previous studies such as Krishnan et al. (2011) also observed a strong positive impact of VC on MTBV. Only the control variable for the defined VC industries is statistically relevant at the 5% significance level and has a strong negative effect on the MTBV of -2.884. Thus, the majority of companies with high MTBV were not found in the two-digit SIC of the four defined VC industries at the end of the three-year period.

The VC-Backed dummy variable has a coefficient of -0.045 on the Abnormal ROA, implying that the Abnormal ROA for the VC-backed group is with -4.5% slightly more negative than that of the non-VC-backed group. This is in line with the observation of Chen and Liang (2016) who also found a poorer operating performance of VC-backed IPO companies compared to non-VC-backed companies. Chen and Liang (2016) point out that inappropriate investment may occur when optimal investment opportunities are limited and VC firms have a large stock

of cash. This can be related to Manigart, Baeyens and Van Hyfte's (2002) statement describing an adverse selection problem in which the most promising companies exercise a more affordable financing option than VC. To conclude, the null hypothesis for Abnormal ROA as a performance criterion is rejected. A number of control variables are also statistically significant for the Abnormal ROA. The variable LN Offer Size is statistically significant at the 1% significance level with a positive value of 2.4%. Thus, the size of market capitalization at the time of the IPO affects the long-run ROA profitability measure positively. This finding is consistent with the observations of Beatty and Ritter (1986) and Brav and Gompers (1997), who argued that larger issuance offerings outperform small offerings in the long-run. Similar to the observation for BHAR, the variable LN Issuer Age, which is statistically significant at the 5% level, imparts a slightly positive effect of 0.6% on the long-term Abnormal ROA. This result contradicts the general theory describing a convex relationship with decreasing profitability with increasing age. Only at old age do companies have increasing profitability again (Loderer and Waelchli 2010; Akben-Selcuk 2016). The underpricing variable is statistically significant at the 1% level and has a negative impact on Abnormal ROA of 0.4% for each unit of change in Underpricing, aligning with the study by Krigman, Shaw, and Womack (1999). Finally, the VC Industry variable is statistically significant at the 1% level and affects Abnormal ROA at -0.065.

Examining the final regression by firm survival rate for the three-year period, this study reaches similar conclusions to Pommet (2011) and shows a negative association between firm survival and VC support. 5.4% more companies of the VC-backed sample went bankrupt in the studied three-year period. Thus, for the performance variable Survivor, the null hypothesis of the paper is dismissed. The negative relation between VC and Survivor is attributable to the riskier investment strategy of the VC companies and thus confirms the theory of Dimov and De Clercq (2006) and Storey and Tether (1998) discussed in chapter 2.3. LN Issuer Age and Underpricing

are observed as control variables being statistically significant at the 5% level. For every additional year of the IPO company age, the chances of survival rise by 2.1%. As older companies have a more established position in the market with better-defined product offerings and a more extensive customer base, they tend to have more assets as financial backing and vouch for less future uncertainty. Underpricing affects survival rate positively by 0.6%.

The central hypothesis of this paper is the positive impact of VC on the long-term performance of IPO companies. In this study, however, we obtain counter-intuitive empirical results. When performance is equated with BHAR and MTBV, a strong positive effect of VC is evident, and the hypothesis of this paper is confirmed. However, if Abnormal ROA and Survivor are used as performance metrics, there is a negative interaction between the performance metrics and the VC-Backed variable, the hypothesis is negated. An explanation for these contradictory results can be found in the investment strategy of VC firms. These invest in young innovative companies with the aim of maximizing their future performance growth. Hereby, the most important selection factors for VC are not accounting metrics that provide information about the current performance of the company, but future indicators such as market penetration, growth of the market in which the company operates, innovativeness including intellectual property, the management team, market competition, and corporate strategy (Carragher, Lane, and Sullivan 2008; Muzyka, Birley, and Leleux 1996). Canh et al. (2019) found that investing in innovative processes initially has a negative impact on profitability but can improve the ROA sustainably over time. As a result, many VC-funded companies are not profitable at the time of the IPO or even several years afterward. A good example is Tesla, which was VC-backed and did not have its first profitable year until 2020, 10 years after its IPO. However, towards the end of 2020, Tesla was already valued significantly higher than other car manufacturers such as Daimler or BMW, which had a much higher ROA. Tesla's large market valuation is primarily a result of high expectations for future growth in the electric mobility sector, rather than Tesla's

current accounting measures. It can be concluded that optimizing ROA is not a primary goal for VC firms in the first years after IPO, but rather maximizing the future performance potential and thus also the current market valuation of the company. The return of VCs is linked to their equity stake in the backed company, whose value grows proportionally with the company's market valuation. BHAR and MTBV are both metrics that reflect the market's expectations of the company's future. The more optimistic the company's future is perceived to be, the higher the increase in the stock price, the multiple of the market valuation above the book value of the company and the return on investment for the VC firms. The slightly negative impact of VC funding on Survivor can be attributed, as described earlier, to the riskier VCs' investment strategy. Another reason for a negative effect on the survival rate is the support of the IPO company by a VC firm unsuitable in terms of unmatching expertise (Manigart, Baeyens, and Van Hyfte 2002; Demov and De Clercq 2006).

#### **4.4. Limitation and Future Research**

This study has some limitations that need to be considered when interpreting the results. First, not all data over the three-year period was found for all companies, leading to a smaller sample size. IPOs on the two largest U.S. exchanges, NASDAQ and NYSE, are included in the sample and cover the majority of U.S. IPOs. IPOs on smaller U.S. exchanges could be added to the dataset in future research. Furthermore, studies such as Krishnan et al. (2011) indicate that the reputation of the VC firm has a significant impact on the firm's long-run performance. A weighted average of various VC characteristics such as IPO market share, VC age, total investment value and equity share, internal rate of return, average years to exit and management level can be taken as a reputation indicator into the model. The addition of the VC reputation can help to strengthen the validity of future models. However, it depends heavily on the availability of the relevant data. Moreover, to investigate the impact of VC support on company survival over the period studied, more advanced models such as the Cox proportional hazard

model should be considered to obtain better results (Lamberto and Rath 2010). Since four different performance metrics are used in this thesis and survival rate is not the focus of the thesis, a logit regression was performed for simplification, which also reflects reliable data.

## **5. Conclusion**

This paper analyses the long-run performance of a unique sample of 474 VC-backed IPO companies and 929 non-VC-backed IPO companies on the U.S. stock exchanges NASDAQ and NYSE over the period 2011 to 2018. The central hypothesis of the study examines whether VC has a positive impact on the long-run performance of U.S. IPOs. Four different performance criteria were determined for this purpose: Buy-and-hold-abnormal-return (BHAR), market-to-book-value (MTBV), abnormal return on assets (Abnormal ROA) and the survival rate of IPO companies (Survivor). Combining the existing literature with the results of this study, the inference can be drawn that VC-backed IPOs in the U.S. outperform non-VC-backed companies for the market-based performance metrics BHAR and MTBV but fail to improve the Abnormal ROA and survival rate. This can be explained by the investment strategy of VCs, which is strongly driven by optimizing the future potential and by thus the current market valuation of the backed companies. Accounting performance metrics like ROA are of secondary importance, as they indicate the economic status of the company in the present and provide lesser information about the company's future potential. Furthermore, the size of the VC industry for the period under investigation was included in the regression dataset. No significant correlation was identified between the strongly increasing value of total annual VC investments and an increased positive influence of VC on long-term IPO performance. The study concludes that investors in the equity market were able to achieve significant long-term excess returns by investing in VC-backed U.S. IPOs over the period 2011 to 2018. However, the strong growth of the VC market in the U.S. does not positively impact the performance of VC-backed IPO companies.

## 6. Appendix

**Table 1: Descriptive statistics of variables for the IPO company sample**

Table 1 reports the descriptive statistics of all variables included in the model. The data sample consists of U.S. initial public offerings between 2011 and 2018, sourced from EIKON Reuters and FactSet's database. Buy-and-hold abnormal returns (BHAR) are calculated over a three-year period from the date of the IPO. The S&P500 is chosen as the benchmark for calculating the abnormal return. Abnormal Return on Asset (ROA) and Market-to-Book value are calculated in the 36th month after the IPO date or the latest available date. BHAR, MTBV, Abnormal ROA and Survivor are included as the dependent variables for performance measurement. Except for survivor, they were all winsorized at the 1% and 99% levels to mitigate biasing outlier impacts. The VC-Backed variable is a dummy variable that takes the value of 1 if the firm is backed by venture capital and 0 if not. Control variables include the level of underpricing, the natural logarithm of the firm's size at the IPO date, the market-to-book ratio at the IPO date, the logarithm of the company age at the IPO date and the VC Industry variable derived from the 2-digit SIC: Chemical, Metal, Computer and Electric Industry

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
BHAR	1,223	-0.084	1.257	-1.694	-0.822	0.221	6.275
MTBV	1,133	3.890	18.109	-111.642	1.064	5.898	86.570
ROA	949	-0.066	0.107	-0.512	-0.110	0.000	0.135
Survivor	1,377	0.792	0.406	0	1	1	1
VC-Backed	1,377	0.343	0.475	0	0	1	1
VC Size	1,377	63.840	27.981	33.000	36.600	79.200	122.000
LN Offer Size	1,375	4.897	1.109	0.519	4.287	5.570	9.681
LN Issuer Age	1,339	1.913	1.226	0.000	0.693	2.708	5.231
Underpricing	1,366	1.450	4.768	-0.213	0.000	0.300	25.173
Issuer MB	978	9.531	35.062	-55.862	0.521	11.572	127.506
VC Industry	1,377	0.256	0.436	0	0	1	1

**Table 2: Correlation matrix between variables for the IPO company sample**

Table 2 reports the correlations between the individual variables. The data sample consists of U.S. initial public offerings that occurred between 2011 and 2018 which is collected from EIKON Reuters and FactSet. BHAR, MTBV, Abnormal ROA and Survivor are included as the dependent variables for performance measurement. Buy-and-hold abnormal returns (BHAR) are calculated over a three-year period from the date of the IPO. The S&P500 is chosen as the benchmark for calculating the abnormal return. Abnormal Return on Asset (ROA) and Market-to-Book ratio are calculated in the 36th month after IPO date or the latest available date. Except for survivor, they were all winsorized at the 1% and 99% levels to mitigate biasing outlier impacts. The dummy variable VC-Backed and the variable VC Size are the independent variables of the underlying model. LN Issuer Age, Underpricing, Issuer M/B, LN Offer Size and a VC Industry dummy variable were added to isolate other factors influencing the long-term performance of the companies from the independent variables.

	BHAR	MTBV	ROA	Survivor	VC-Backed	VC Size	Ln Offer Size	LN Issuer Age	Underpricing	Issuer MB	VC Industry
BHAR	1	0.172	0.114	-0.060	0.134	0.069	-0.005	0.109	-0.194	-0.030	0.056
MTBV	0.172	1	0.003	-0.010	0.091	0.037	0.013	0.042	-0.039	-0.037	-0.001
ROA	0.114	0.003	1	0.029	-0.379	-0.149	0.413	0.037	-0.250	0.032	-0.487
Survivor	-0.060	-0.010	0.029	1	0.016	-0.089	0.007	0.163	-0.083	-0.054	0.026
VC-Backed	0.134	0.091	-0.379	0.016	1	0.049	-0.181	0.185	0.115	0.001	0.461
VC Size	0.069	0.037	-0.149	-0.089	0.049	1	-0.064	0.006	-0.018	0.0001	0.115
Ln Offer Size	-0.005	0.013	0.413	0.007	-0.181	-0.064	1	-0.064	-0.219	0.070	-0.285
LN Issuer Age	0.109	0.042	0.037	0.163	0.185	0.006	-0.064	1	0.060	-0.172	0.113
Underpricing	-0.194	-0.039	-0.250	-0.083	0.115	-0.018	-0.219	0.060	1	-0.038	0.166
Issuer MB	-0.030	-0.037	0.032	-0.054	0.001	0.0001	0.070	-0.172	-0.038	1	-0.059
VC Industry	0.056	-0.001	-0.487	0.026	0.461	0.115	-0.285	0.113	0.166	-0.059	1

**Table 3: Zero Mean Residuals for each performance metric**

Table 3 reports the analysis of the mean residuals of each of the four regressions made. The data sample consists of U.S. initial public offerings that occurred between 2011 and 2018 which is collected from EIKON Reuters and FactSet. BHAR, MTBV, Abnormal ROA and Survivor are included as the dependent variables for performance measurement. Except for survivor, they were all winsorized at the 1% and 99% levels to mitigate biasing outlier impacts.

Regression type	BHAR	MTBV	ROA	Survivor
Zero Mean Residual	2.124809e-17	-1.388354e-15	-3.387646e-18	4.212533e-16

**Table 4: Breusch-Pagan Test for each performance metric**

Table 4 reports the results of the Breusch-Pagan Test for heteroskedasticity. The data sample consists of U.S. initial public offerings that occurred between 2011 and 2018 which is collected from EIKON Reuters and FactSet. BHAR, MTBV, Abnormal ROA and Survivor are included as the dependent variables for performance measurement. Except for survivor, they were all winsorized at the 1% and 99% levels to mitigate biasing outlier impacts.

Regression type	BHAR	MTBV	ROA	Survivor
BP	48.684	12.724	84.885	25.352
df	7	7	7	7
p-Value	2.617e-08	0.07913	1.384e-15	0.0006572

**Table 5: Long-run performance of U.S. VC-backed IPO companies**

Table 5 represents pooled panel cross-sectional regression estimates and the associated t-statistics in case of OLS for BHAR, MTBV and ROA and z-statistics in case of logit regression for Survivor in parentheses, based on robust standard errors for heteroskedasticity. Significance at the 10, 5, and 1 percent levels is indicated by 1, 2, and 3 asterisks, respectively. BHAR, MTBV, Abnormal ROA and Survivor are included as the dependent variables for performance measurement. Except for survivor, they were all winsorized at the 1% and 99% levels to mitigate biasing outlier impacts. The dummy variable VC-Backed and the variable VC Size are the independent variables of the underlying model. LN Issuer Age, Underpricing, Issuer M/B, LN Offer Size and a VC Industry dummy variable were added to isolate other factors influencing the long-run performance of the companies from the independent variables. The dataset is based on 1,403 U.S. IPO companies for the stock exchanges NASDAQ and NYSE in the years 2011 to 2018.

	<i>Dependent variable:</i>			
	BHAR <i>OLS</i> (1)	MTBV <i>OLS</i> (2)	ROA <i>OLS</i> (3)	Survivor <i>Logit</i> (4)
VC-Backed	0.339*** (0.101)	4.303*** (1.350)	-0.045*** (0.007)	-0.054** (0.023)
VC Size	0.002 (0.002)	0.027 (0.025)	-0.0003*** (0.0001)	0.0002 (0.0004)
Ln Offer Size	0.011 (0.035)	0.508 (0.555)	0.024*** (0.004)	-0.005 (0.008)
Ln Issuer Age	0.093** (0.027)	0.202 (0.461)	0.006** (0.002)	0.021** (0.008)
Underpricing	-0.064*** (0.005)	-0.177 (0.194)	-0.004*** (0.001)	0.006** (0.001)
Issuer MB	-0.001 (0.001)	-0.023 (0.024)	0.00001 (0.0001)	-0.0003 (0.0003)
VC Industry	0.029 (0.118)	-2.884** (1.466)	-0.065*** (0.008)	0.038 (0.024)
Constant	-0.462* (0.220)	-1.326 (4.048)	-0.128*** (0.023)	0.857*** (0.053)
Observations	953	954	851	957
R <sup>2</sup>	0.067	0.019	0.387	
Adjusted R <sup>2</sup>	0.060	0.011	0.382	
Log Likelihood				-251.006
Akaike Inf. Crit.				518.012
Residual Std. Error	1.312 (df = 945)	18.005 (df = 946)	0.083 (df = 843)	
F Statistic	9.673*** (df = 7; 945)	2.570** (df = 7; 946)	75.986*** (df = 7; 843)	

*Note:*

\* \*\* \*\*\* p < 0.01

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