Innovative Firms and IPO Underpricing

Student Name	BSc Paulien Vissers
Study Program	MSc Finance
ANR	352670
Supervisor	Dr. M. Da Rin
Second Reader	Dr. A.H.F. Verboven
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Tilburg University - Tilburg School of Economics and Management (TiSEM)

Preface

This thesis about the underpricing phenomenon of an initial public offering (IPO) and the connection to innovative firms, forms partly the completion of my master in Finance. This topic caught my attention because of my curiosity about shares and research-intense firms. The curiosity about shares and the initial public offering was greatly fueled by the program of the master in Finance. Courses like Investment Analysis provided me some useful insights into the investment world. The curiosity about research-intense firms is caused by some well-known innovative firms, like Tesla Motors, which are regularly in the news. Tesla Motors uses advanced technologies in its electric powered vehicles, which is a new generation of vehicles that has emerged over the past several years. The immense first-day return of Tesla Motors in 2010 on the National Association of Securities Dealers Automated Quotation (NASDAQ) was 40.53%.

This graduation will partly finish my life as a Finance student at Tilburg University (TiU). During the academic years that I have studied at the TiU, I have acquired a lot of knowledge and skills. During the last year, I have mostly worked on my master thesis Finance. This was not only a challenging, but also an educational task for me. I want to thank my supervisor dr. M. Da Rin in special for his critical advice and for guiding me through this thesis process. Without his sharp comments, I would not have been where I am today with my master thesis Finance. I also want to thank all those who were part of my student life here at Tilburg University, like my fellow students and all the professors. They gave me a valuable and rewarding time as a student of the master in Finance.

Abstract: We analyze the underpricing phenomenon by looking at the connection with research-intense firms. Previous research generally attributes the underpricing phenomenon after an IPO to information asymmetry between various parties in the IPO process. In this research, we look specifically at underpricing and the innovativeness of firms. Innovation capital is normally expensed on the Income Statement or unrecognized as assets on the Balance Sheet in the generally accepted accounting principles (GAAP). Therefore, there is accounting-related information asymmetry related to innovation. The dependent variable initial return ratio, is explained by the independent variables patents and a research & development (R&D) ratio. We argue that the extent of underpricing is related to the innovation level of a firm. Evidence from 218 IPOs from the NASDAQ in 2014 and 2015, show an average initial return ratio of 16.85%. Although the model has explanatory power, it does not significantly confirm the empirical predictions that innovative firms face more underpricing.

Keywords: Initial Public Offering, Underpricing, Innovation, Patents, R&D

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I. Introduction

Much research has been done on IPO underpricing, it is one of the best-documented empirical findings in finance (Nielsson & Wójcik, 2016). On average, the first-day return of an IPO in the United States (US) from 1993 up to 2008 was 24% (Liu & Ritter, 2011). In case of underpricing, companies leave money on the table (Loughran and Ritter, 2002). The shares are sold for a price below the true market value. This topic has enjoyed a boost of activity mainly due to the astonishingly high initial returns on IPOs in the recent Dotcom Bubble at the end of the twentieth century (Ljungqvist & Wilhelm, 2003). Internet related IPOs even reached a first-day return of 89% during 1999 and 2000. To explain underpricing, asymmetric information models are popular among academics. These models are about information asymmetry between various parties of the IPO process.

In this research, the underpricing phenomenon is linked to innovation because of the accounting-related information asymmetry regarding innovation capital. Innovation capital is normally expensed on the Income Statement or unrecognized as assets on the Balance Sheet by using the currently GAAP (Chin, Lee, & Kleinman, 2006). Hereby, the informativeness of innovative firms' financial statements is reduced. This results in accounting-related information asymmetry which intersects with asymmetric information models about underpricing.

Innovation is nowadays up-and-running. Since 2005, the Boston Consulting Group publishes a global annual ranking of the 50 most innovative companies (Ringel, Taylor, & Zablit, 2015). Last year, 2015, 79% of the respondents ranked innovation as the top or top-three priority at their company. This is the highest percentage since the beginning of the global rank in 2005. Back then, only 66% said innovation was at the top or top-three priority. The top-three of the innovation global rank 2015 is: 1. Apple, 2. Google, and 3. Tesla Motors. One of the most popular global research-intense firms of the past decade, is Apple Incorporated. Apple is leading in consumer electronics and personal computers. The first-day return of the IPO of this research-intense firm in 1980 on the NASDAQ was 32%.

Competition levels are increasing and the product life cycle is decreasing (Artz, Norman, Hatfield, & Cardinal, 2010). Therefore, more than ever, the ability of a firm to generate a stream of innovation is very important. By generating a continuous stream of innovation, the firm can maintain its competitive advantage. R&D expenditures are innovation input, whereas patents are innovation output (Lanjouw, Pakes, & Putnam, 1998). Although it is very costly, underpricing is

a way to signal firm quality which is often used by innovative firms because of the existing accounting-related information asymmetry (Allen & Faulhaber, 1989). In this research, the initial return of 218 IPOs on the NASDAQ during 2014 and 2015 are examined by looking at R&D activities and patents.

The remainder of the paper is organized as follows. Section II describes the literature review, the theoretical background. Section III is about the variables description, sample selection, and the data collection. Section IV discusses the empirical results. Finally, section V provides a summary, conclusion, and a discussion.

II. Literature Review

We start by examining the IPO process itself. Thereafter, we describe the underpricing phenomenon regarding an IPO. Next, we discuss asymmetric information models about underpricing. Finally, we focus on innovation and the accounting-related information asymmetry.

A. Initial Public Offering

An initial public offering is also known as going public, the first time a firm enters the public capital market (Chemmanur, He, & Nandy, 2010). In this way, a private company turns into a public traded company. Two main reasons why a firm goes public are obtaining new funds and refinancing the firm (Rock, 1986). Obtaining new funds, which is often the primary reason, is simply taking advantage of positive net present value investments. This means that the firm raises money for expansion. Refinancing the firm takes care of the risk aversion of the owners of the firm. Not only do investors want to add some liquidity to their investment, but they also want to diversify their portfolios. All reasons for going public include a trade-off between the benefits and the costs of being publicly traded (Benninga, Helmantel, & Sarig, 2005). The owner gives up the private benefits of control for the advantages of being publicly traded.

To go public, a detailed prospectus is required. The prospectus includes: a history of the firm's business, information of past financial performance, ownership details, information about the offering, and the risk associated with the issuance (Bhabra & Pettway, 2003). The prospectus must be approved by the Securities and Exchange Commission (SEC) for material accuracy. The SEC is an agency of the US federal government. The prospectus is a legal document that protects both the issuer and the underwriter because this is a proof that the investors are aware of all the

material facts related to the issuance. Mostly, the issuer appoints an investment bank to act as the underwriter in the IPO. Underwriter quality is very impactful. Top-tier banks have broader access to a network of investors (Wang & Yung, 2011). Therefore, they can more easily target the right investors to obtain information about the issue.

There are three well-known IPO selling methods. These are the fixed-price method, the auction method and the bookbuilding mechanism. With the fixed-price method, the market demand is only known after the firm has gone public (Benveniste & Busaba, 1997). The fixed-price method does not consider investors interest. With the auction model, any investor can bid for the quantity and price of shares (Pukthuanthong, Varaiya, & Walker, 2007). After all bids are set, the underwriter and the issuer will determine the offer price. The quantity of shares offered will equal the quantity of shares demanded by the investors. Although any investor can participate in the auction method, the underwriter controls investor selection and share allocation in the bookbuilding method. Bookbuilding is mostly used by underwriters in the US (Derrien & Womack, 2003). Firstly, an ex-ante price range is set. (Ritter & Welch, 2002). Next, the underwriters and issuers go to a road show across many locations. On a road show, the underwriters and issuers will market the company to possible investors. Excitement and interest in the IPO is fueled by these presentations. If the underwriter notices that there is a huge demand, the offer price will be higher than in case there is little demand. In other words, during the bookbuilding period the predetermined offer price will be adapted by information from possible investors, which is gathered during the road show. When the road show is completed, the final prospectus will be made and distributed to possible investors and the SEC.

B. IPO Underpricing

The phenomenon underpricing is the systematic increase from the initial offer price to the first-day closing price (Ritter & Welch, 2002). The IPO is priced below its true market value. There is left money on the table which stands for the number of shares sold times the difference between the first-day closing price and the offer price (Loughran and Ritter, 2002). If the shares would have been sold for the first-day closing price, the proceeds of the issuance would be much greater. Therefore, underpricing leads to an immediate loss for the issuer.

The Dotcom Bubble in the late 1990s is a clear example of IPO underpricing. There was a rapid development of technological advances, in special the commercialization of the Internet. The

Internet sector grew enormously in the second half of the 1990s (Leone & Medeiros, 2015). The Internet sector even accounted for 6% of the overall market capitalization of the US public companies (Ofek & Richardson, 2003). The US stock markets experienced an overall growth in its main indices between approximately 1995 and 2000. For example, the NASDAQ, which contains many Internet-heavy firms, had a composite index of 775.20 in January 1995 which grew to 5048.62 in March 2000. Afterwards, the market dried up and the overall indices declined. The composite index of the NASDAQ fell to 1314.85 in August 2002. Because of the growth and the following drop in stock prices, this period is referred to as a bubble in the US stock market. Looking specifically at the initial return, the first-day return of IPOs averaged 17% in 1996 (Ljungqvist & Wilhelm, 2003). This number increased to 73% in 1999 and decreased to 58% in 2000. Internet related IPOs during 1999 and 2000 even averaged an initial return of 89%. That is why this time is indicated as the Dotcom Bubble.

A bubble suggests a deviation of the stock price from its intrinsic value (Leone & Medeiros, 2015). At the peak of the Dotcom Bubble, the valuation techniques for setting a price were abnormal. The entire Internet sector was priced as if the average growth rate of the earnings would exceed the growth rates of the fastest growing individual firms in the past (Brunnermeier & Nagel, 2004). Additionally, the required rate of return was expected to be 0% for the upcoming decades. Investors were overexcited and had impossible expectations, they overlooked several fundamentals. These valuation levels and expectations were so enormously extreme that this period is main part of the history of asset pricing bubbles.

C. Asymmetric Information Models

To explain the underpricing phenomenon, asymmetric information models are very popular among academics. Asymmetric information models are about information asymmetry between various parties of the transaction (Ljungqvist & Wilhelm, 2003). Although asymmetric information models are main part of research done about underpricing, there are also other theories about underpricing. There are for example also theories focused on ownership and control (Nielsson & Wójcik, 2016). Because the asymmetric information models connect to the accounting-related information asymmetry regarding innovation capital, only some asymmetric information theories about underpricing will be discussed here. All theories about underpricing which are based on information asymmetry share the expectation that underpricing is positively related to asymmetric

information (Ritter & Welch, 2002). The lower the asymmetric information, the less underpricing there will be.

The first model discussed here, is the winner's curse model from Rock. In this case, there is information asymmetry between investors, which is also referred to as the adverse selection problem. The adverse selection rationale from Rock is probably the most well-known theory about underpricing (Habib & Ljungqvist, 2001). The uninformed investors face adverse selection because there are informed investors who have superior information (Grinblatt & Hwang, 1989). The informed investors do not subscribe to issues which they think are overpriced, leaving overpriced issues for the uninformed investors. The uninformed investors suffer from the Winner's Curse because they do not know the quality of an issue. The Winner's Curse increases proportionally to the fraction of informed investors who react on good issues. Uninformed investors are likely to be allocated to a disproportionate share of bad issues because their transactions are biased towards these less profitable issues (Allen & Faulhaber, 1989). Uninformed investors are only willing to participate in new issues if the offer price is low enough to compensate for the expected losses and the issues being less attractive. To ensure that uninformed investors will take part in the issuance, the offer price should be set at a lower value than its intrinsic value.

Secondly, there is the signaling model from Allen and Faulhaber. This model is about information asymmetry between the issuer and the investor. In case the issuer is more informed than the investor, investors will fear a lemons problem (Ritter & Welch, 2002). The lemons problem is referred to the problem of information asymmetry between a buyer and a seller. The issuer of stock knows the true value and a potential investor does not have this knowledge. Only issuers with a quality lower than average are willing to sell their shares at an average price. Therefore, investors do not want to pay more than an average price because of the risk they are taking. Issuers want to signal the quality of their issue by setting prices lower than average. Hence, high-quality firms are signaling their level of quality by throwing money away, leaving money on the table. In case the investor knows more than the issuer, the issuer faces a problem in the placement of stock. There is a situation of unknown demand. The issuer is not aware of the price the market is willing to bear.

Next, there is the moral hazard model from Baron. The moral hazard problem is about information asymmetry between the issuer and the underwriter (Grinblatt & Hwang, 1989). The investment bank, also called the underwriter, acts as the agent and the firm acts as the principal

(Baron, 1982). The investment bank is better informed about the market demand than the issuer. Therefore, the investment bank has superior information. The firm cannot observe the effort expended by the investment bank. Underpricing is used to account for this moral hazard to make sure that the investment bank puts enough effort into the issue process. In this way, underpricing is caused by using the compensation mechanism for the optimal contract between the principal and the agent. This compensation depends on the IPO proceeds and the offer price.

D. Innovation

The ability of providing significant advances in productivity and creating functionalities not previously available, is called innovation (Chin et al., 2006). A pioneering firm may benefit from an innovation in the product market, but there is a risk that they will be forced out by other firms that come up with a better technology (Maksimovic & Pichler, 2001). Nowadays, technological innovation plays a major role in economic growth (Guo & Zhou, 2016). An increasing number of firms engage in innovative activities to search for a winning technology to increase firm value.

Innovation can be measured by focusing on the creation of knowledge and intellectual property (IP). This can be further elaborated in objective measures. Knowledge assets regarding innovation are for example R&D investments and patents. Knowledge assets are key drivers of firm value (Sandner & Block, 2011). R&D activities and patents are often and extensively researched regarding the level of innovation. A patent provides information on the characteristics of the specific innovation and its inventor (Lanjouw et al., 1998). Patent data is available for all firms over a relatively long period. R&D activity is the most-used alternative to measure the level of innovation. The advantage of R&D activity is that there can be assigned a money value to the extent of innovation. R&D activity is innovation input, whereas patents are innovation output (Lanjouw et al., 1998).

D.1. Accounting-Related Information Asymmetry

Regarding several researches, underpricing is a frequent phenomenon at innovative firms. As discussed before, innovation capital is normally expensed on the Income Statement or unrecognized as assets on the Balance Sheet using the currently GAAP (Chin et al., 2006). Due to this lack of disclosure, the informativeness of the financial statements for innovative companies is reduced, which results in accounting-related information asymmetry. The presence of this

information asymmetry hinders investors to evaluate the level of innovation of firms. This asymmetric information problem is tackled by issuers by offering shares at a discount to show the true value of the firm. In special for innovative firms, an issuer is assumed to have better information about the market valuation of the firm and the expected performance than its investors (Grinblatt & Hwang, 1989). Firm value of innovative firms is often derived from intangibles and perceived growth opportunities instead of tangible assets and a business model (Ragozzino & Reuer, 2007). If there is already innovative information available within the firm that is not yet publicly available, firms are reluctant to provide extra information in the financial statements (Francis, Hasan, Huang, & Sharma, 2012). Confidentiality is important in the research process. That is why the value of innovative firms is hard to detect from financial statements. Only good firms can overcome a direct loss from underpricing. In this case, underpricing is used as a signaling device by invisible high-quality firms to signal their true firm value (Welch, 1989). This is also done to 'leave a good taste in the investors' mouths', possibly followed by subsequent underwritings at higher prices (Allen & Faulhaber, 1989).

III. Research Method

Starting this chapter, we describe the variables using theoretical background knowledge. The variables consist of the dependent variable, the two independent variables, and the eight control variables. Afterwards, we explain the sample selection procedure about the IPOs used in this research. Lastly, we clarify the data collection for all the variables.

A. Variables Description

We use underpricing as the dependent variable in this research. Setting the price for an IPO is extremely important. In case of setting a price that is too low, there is underpricing and money is left on the table (Loughran & Ritter, 2002). The price is set below the true market value. Focusing on the short-term performance of an IPO, the empirically identified underpricing pulls the attention (Benveniste, Fu, Seguin, & Yu, 2008). The predictable phenomenon of this first-day return should not exist according to the standard financial theory of the Efficient Market Hypothesis.

For the first independent variable concerning the innovativeness of a firm, we use patents. Literature suggests that patenting activity reflects the quality and extent of the level of innovativeness of a firm (Bernstein, 2015). The definition of a patent is a document, issued by an

authorized governmental agency which grants the right to exclude anyone else from the production or use of the specific new process or device for a stated number of years (Griliches, 1990). When the expected value of receiving the patent exceeds the cost of applying for the patent, an application for a patent is filed (Griliches, Nordhaus, & Scherer, 1989). A patent is granted when it passes several standards of novelty and potential utility. Patent statistics are used by researchers to directly measure R&D effectiveness (Chin et al., 2006). Although patents are seen as the R&D effectiveness, not all inventions are patentable and not all patentable inventions are patented. Patents are an indicator of innovation output. They serve the firm by protecting the technological knowledge (Sandner & Block, 2011). Patents can be seen as evidence that a company is well managed, the firm is at a certain stage of development and has found their market niche (Lemley, 2001). Therefore, innovation protected by patents is an important attribute of a business strategy (Blazsek & Escribano, 2016). Focusing on the accounting-related information asymmetry, the value of patents is often omitted or even completely ignored on the Balance Sheet (Chin et al., 2006). This understates the value of total assets, which in turn leads to a lower offer price of the IPO. Therefore, we expect that patents have a positive relationship with underpricing.

R&D activities account for the second independent variable about the level of innovation of a firm. R&D activities are intangible investments extensively researched in finance (Guo, Lev, & Shi, 2006). R&D activities are often used in research for innovativeness because these intangible investments must be disclosed in corporate financial reports and are not aggregated with other expense items (Guo et al., 2006). Where patents are more related to innovation output, R&D activities are more related to innovation input (Lanjouw et al., 1998). Firm competitiveness is increasing by innovation investments in R&D activities (Chin et al., 2006). Therefore, R&D activities play a major role in overall economic growth. It is proven that R&D activities can create intangibles such as patents (Guo & Zhou, 2016). Although R&D expenditures lead to an increase in knowledge and innovation, not all R&D activities lead to patenting. Literature suggests that R&D activities contribute to the phenomenon of information asymmetry (Guo et al., 2006). Although R&D activities should be disclosed in corporate financial reports, no systematic information or progress must be reported. Due to the absence of this current information and the associated uncertainty regarding R&D activities, asymmetric information increases. This causes a problem for innovative firms to translate the technological knowledge into accounting numbers of revenues and earnings. Besides, according to the R&D activities being expensed, operating income

is reduced (Chin et al., 2006). This understates the accounting earnings in the Income Statement, which in turn leads to a lower offer price for the IPO. Therefore, we expect that R&D activities have a positive relationship with underpricing.

There are also some IPO-specific and firm-specific control variables in this research. These control variables cannot be left behind because they have already a proven impact on the dependent variable. However, these variables are not the point of interest in this research. As IPO-specific control variables are chosen: issue proceeds, filing amount, shares offered and venture capital (VC) backed. Looking at issue proceeds, prior literature suggests that less gross issue proceeds are related to more underpricing (Aggarwal, Krigman, & Womack, 2001). So, in case of underpricing, issue proceeds are forgone. Therefore, we expect that issue proceeds have a negative relationship with underpricing. Focusing on filing amount and shares offered, both about the IPO size, prior literature suggests that the size of an issue stands for the overall risk and uncertainty (Guo et al., 2006). More senior firms often make larger issues and such firms are often less risky. Besides, the issuer's incentives to control underpricing increases with the number of shares sold (Chen, Fok, & Kang, 2010). Therefore, we expect that filing amount and shares offered have a negative relationship with underpricing. Looking at VC-backed, prior literature suggests that the presence of VC in an IPO causes more underpricing (Bradley, Kim, & Krigman, 2015). Venture capitalists are allocated to shares after the lockup expiration. That is why venture capitalists are not in the first place concerned about the offer price at the IPO, but about the price at lockup expiration. Underpricing creates information momentum by attracting attention to the stock (Aggarwal et al., 2001). At lockup expiration, shares can be sold at higher prices than would have been obtained otherwise. The large future flows of capital into VC funds is also called the Grandstanding Hypothesis (Lee & Wahal, 2004). Therefore, we expect that VC-backed has a positive relationship with underpricing.

As firm-specific control variables are chosen: firm age, total assets, fixed assets, and leverage. Focusing on firm age, prior literature suggests that there is less information available from younger firms which results in underwriters having more difficulty in valuing such issues (Cogliati, Paleari, & Vismara, 2011). Therefore, we expect that firm age has a negative relationship with underpricing. Looking at total assets, prior literature suggests that information asymmetry is less likely to be present at larger firms (Chin et al., 2006). Regarding the ex-ante uncertainty about firm value, larger firms face less risk than smaller firms (Ellul & Pagano, 2006). Because of less

risk for larger firms, there will be more certainty about firm value. Therefore, we expect that total assets have a negative relationship with underpricing. Looking at fixed assets, prior literature suggests that this is an important company characteristic (Ellul & Pagano, 2006). It is a proxy for certainty about the value of the firm's assets. When the proportion of fixed assets to total assets is relatively high, there is less uncertainty about the value of the firm's assets. Therefore, we expect that fixed assets have a negative relationship with underpricing. Focusing on leverage, the presence and extent of a prior credit relationship reduces the ex-ante uncertainty about valuing the firm's equity (James & Wier, 1990). Therefore, we expect that leverage has a negative relationship with underpricing.

B. Sample Selection

For this research, IPOs from the NASDAQ during 2014 and 2015 are used. These IPOs are obtained from the website of the NASDAQ. 19 IPOs are dropped because of non-NASDAQ OTC market and IPO dates before or after 2014 and 2015. 32 IPOs are dropped because of changing firm symbols and therewith problems in obtaining all needed data for each IPO. 56 IPOs are dropped because the R&D expenditures were not available for the year prior to the IPO. The initial sample contained 325 IPOs on the NASDAQ during 2014 and 2015. After dropping some observations, 218 IPOs were left for this research.

C. Data Collection

We collect our data from Thomson Reuters Datastream, Bureau van Dijk Orbis, Wharton Research Data Services (WRDS) Compustat North America, Thomson Reuters SDC Platinum, and the website of the NASDAQ. Firstly, Thomson Reuters Datastream is a global financial and macroeconomic data platform. Thereafter, Bureau van Dijk Orbis is a database for company information across the globe. Next, WRDS is the interface to several datasets regarding financial, economic, and marketing aspects. WRDS Compustat North America is especially about listed firms of the US and Canada. Subsequently, Thomson Reuters SDC Platinum provides information on new issues, mergers and acquisitions, syndicated loans, private equity, and more for global financing. Finally, the website of the NASDAQ contains analysis, company news, financials, market information, stock quotes and even investing guidelines and tools.

We measure the dependent variable underpricing by using the initial return ratio, which stands for the first-day return of an IPO (Ellul & Pagano, 2006). The initial return ratio is calculated as the first-day closing price minus the offer price divided by the offer price times 100% (Schenone, 2004). We obtain the offer price of the IPOs from the website of the NASDAQ and the closing price from Datastream. The closing price from Datastream is the closing price which has not been historically adjusted for bonuses and rights issues. The numbers are actual or raw prices as recorded on the day.

For the first independent variable patents, we use the basic measure of total number of granted patents up until September 2016 (Bernstein, 2015). We collect data for this independent variable from Orbis. For the second independent variable R&D activities, we use an R&D ratio which is calculated as the R&D expenditures normalized by total assets from the fiscal year prior to the IPO (Bernstein, 2015). We obtain R&D expenditures from Orbis. On WRDS, we obtain some missing values of the R&D expenditures. The R&D expenditures represent all costs incurred during the year that relates to the development of new services or products. This amount is only the company's contribution. We obtain total assets from Orbis.

Concerning the IPO-specific control variables, we measure issue proceeds by multiplying the offer price by the number of shares sold (Aggarwal et al., 2001). We obtain the offer price from the website of the NASDAQ and the number of shares sold from Datastream. The number of shares sold indicate the unadjusted turnover by volume and is not historically adjusted for corporate actions. These numbers are actual or raw values as recorded on the day. Secondly, we measure filing amount using the original filing amount of the IPO (Hanley & Hoberg, 2010). The filing amount is obtained from the website of the NASDAQ. Thirdly, we measure shares offered by simply using the total number of shares offered (Ellul & Pagano, 2006). We retrieve the total number of shares offered from the website of the NASDAQ. Lastly, we measure VC-backed using the dummy variable of VC-backed IPOs (Bernstein, 2015). We obtain data from SDC Platinum. The variable of VC-backed is a binary dummy variable which takes the value of one if the IPO is VC-backed and zero if not.

Regarding the firm-specific control variables, we measure firm age using the number of years between the firm's incorporation and the year of the IPO (Ellul & Pagano, 2006). We obtain the year of incorporation from Orbis. Secondly, we measure total assets using the total assets from the fiscal year prior to the IPO (Bernstein, 2015). We obtain total assets from Orbis. Thirdly, we

measure fixed assets using the ratio of the total number of fixed assets to total assets, both from the fiscal year prior to the IPO. We use the fixed assets ratio instead of only the value of total fixed assets to make it a more comparable number (Ellul & Pagano, 2006). We obtain fixed assets and total assets from Orbis. Lastly, we measure leverage using the percentage of total leverage which is measured by dividing total liabilities by total liabilities plus total stockholders' equity from the fiscal year prior to the IPO (Habib & Ljungqvist, 2001). We obtain total liabilities and total stockholders' equity from the website of the NASDAQ.

IV. Results

This chapter will start with some descriptive statistics about each variable. Thereafter, univariate analysis about the dependent and independent variables will be discussed using the independent two-sample t-test. Next, correlations are made with the complete set of variables. Afterwards, the multivariate regression will be made with all variables. Lastly, there is the robustness check, which also includes the complete set of variables. An overview of all variables and their description can be found in table I from appendix A. Other tables concerning this chapter can also be found in appendix A, graphs can be found in appendix B.

A. Descriptive Statistics

Table II presents key descriptive statistics regarding 218 IPOs on the NASDAQ during 2014 and 2015. Issue proceeds, filing amount, and total assets are shown in millions of US Dollars and shares offered is shown in millions. Only the raw data is used for the descriptive statistics.

The mean of the initial return ratio is 16.85% with a median of 6.20%. This shows us that higher initial return ratios are clustered into only a small group of IPOs. There are more IPOs with a lower initial return ratio than the mean value. The mean of patents is 16.68 with a median of 6.00. The mean is higher than the median, which means that the biggest part of the IPOs has a below-average value of patents regarding this sample. The higher values of patents are clustered into a group of only a few IPOs. The mean of the R&D ratio is 0.75% with a median of 0.29%. This indicates that the higher R&D ratios are clustered into a smaller group of IPOs. There are more IPOs with a smaller R&D ratio than the mean value. Figures 1, 2, 3 and 4 show the normal curves for these variables. Regarding the independent variable patents in figure 2, there can be seen that the logarithmic version should be used to account for large skewness. The distribution

with the logarithmic version is shown in figure 3. After accounting for skewness, the curves of the dependent variable initial return ratio and the independent variables patents and R&D ratio, show all a normal distribution.

Next, the IPO-specific control variables are examined. Issue proceeds has a mean of $86.64 million with a median of $31.61 million, filing amount has a mean of $113.69 million with a median of $69.00 million, shares offered has a mean of 7.89 million with a median of 5.78 million, and VC-backed has a mean of 0.70 with a median of 1.00. Three out of four IPO-specific control variables have higher means than the median, which tells us that the largest part of the IPOs have a lower value than the mean of these variables. The larger values are clustered into a small group of IPOs. However, the IPO-specific control variable VC-backed has a greater median than its mean. This indicates that the value of zero for this binary variable VC-backed is clustered into a small group of IPOs. Therefore, most of the IPOs in this sample are VC-backed.

Regarding the firm-specific control variables, firm age has a mean of 8.26 with a median of 7.00, total assets has a mean of $204.28 million with a median of $33.53 million, the fixed assets ratio has a mean of 0.24% with a median of 0.13%, and the leverage ratio has a mean of 1.84% with a median of 0.73%. This shows that large numbers for firm age, total assets, the fixed assets ratio, and the leverage ratio are clustered into a few IPOs. There are more IPOs with a lower value than the mean of these variables.

For the variables patents, issue proceeds, filing amount, shares offered, firm age, and total assets, there is accounted for skewness by using the logarithm version of these observations. In this way, some observations are dropped to account for outliers and ensure a normal distribution. These logarithmic variables will be used in this further research.

B. Univariate Analysis

To analyze an above- and below-average group regarding this sample of total number of granted patents and the R&D ratio with the initial return ratio, the independent two-sample t-test is used, as shown in tables III and IV. The independent two-sample t-test of patents and the initial return ratio shows a lack of statistically significance, with a P-value of 0.7667. Therefore, we cannot conclude that the means of the initial return ratio of the above- and below-average group of patents are not the same. The independent two-sample t-test of the R&D ratio with the initial return ratio shows statistically significance at a 90% confidence level, with a P-value of 0.0706. Therefore, we

can conclude that the means of the above- and below-average R&D ratio groups are not the same. There is a statistically significant difference for the initial return ratio between these two groups.

Looking at the initial return ratio and patents in table III, the above-average group of total number of granted patents is larger with 145 IPOs than the below-average group with 73 IPOs. The above-average group has a mean of the initial return ratio of 17.36% compared to the mean of the below-average group of 15.83% which results in an absolute difference in the mean of 1.53%. Therefore, in our sample there are more IPOs with an above-average total number of granted patents and these IPOs have a higher initial return ratio than the below-average group. A higher value of the total number of granted patents is connected to a higher initial return ratio and thus more underpricing. This positive relationship between patents and the initial return ratio is exactly what we expected. The higher the level of innovation of a firm, regarding the number of granted patents, the more underpricing there is.

When looking at the initial return ratio and the R&D ratio in table IV, the above-average group of the R&D ratio is smaller with 47 IPOs than the below-average group with 171 IPOs. The above-average group has a mean regarding the initial return of 8.46% and the below average group a mean of 19.16% resulting in an absolute difference in the mean of 10.70%. In our sample, the biggest part of the IPOs has an R&D ratio below the mean and these IPOs have a higher initial return ratio than the above-average group of the R&D ratio. A lower value of the R&D ratio is connected to a higher initial return ratio and thus more underpricing. This negative relationship between the R&D ratio and the initial return is not what we expected.

C. Correlations

Next, correlations are analyzed about the complete set of variables, as shown in table IV. The correlations of the initial return ratio with issue proceeds, filing amount, total assets, the fixed assets ratio, and the leverage ratio are statistically significant. The correlation of the initial return ratio with issue proceeds is statistically significant at a 99% confidence level (P-value of 0.0005), with filing amount at a 90% confidence level (P-value of 0.0819), with total assets at a 95% confidence level (P-value of 0.0295), with the fixed assets ratio at a 95% confidence level (P-value of 0.0201), and with the leverage ratio at a 90% confidence level (P-value of 0.0887). Therefore,

for these variables, we can conclude that there is a correlation between the predictor or control variable itself and the dependent variable.

The initial return ratio has a positive correlation with patents of 0.0674 and a negative correlation with the R&D ratio of -0.0533. These results are not completely consistent with our expectation that more innovative firms face more underpricing. The expectation of the positive relationship between patents and the initial return ratio is met. The higher the total number of granted patents, the higher is the initial return ratio and thus more underpricing. This implies that firms with a higher level of innovation, regarding patents, experience more underpricing. However, the expectation of the positive relationship between the R&D ratio and the initial return ratio is not met. The higher the R&D ratio, the lower is the initial return ratio and thus less underpricing.

Looking at the IPO-specific control variables, the initial return ratio has a positive correlation with issue proceeds of 0.2324, with filing amount of 0.1181, with shares offered of 0.0317, and with VC-backed of 0.0780. This means that an increase in one of these four control variables leads to an increase in the dependent variable and otherwise. These results are, except for VC-backed, against our expectation that the control variables have a negative relationship with the dependent variable. A VC-backed IPO was expected to have more underpricing. So, the positive correlation between VC-backed and the initial return ratio is exactly what we expected.
Regarding the firm-specific control variables, the initial return ratio has a negative correlation with firm age of -0.0631, with the fixed assets ratio of -0.1574, and with the leverage ratio of -0.1156. Meaning that an increase in one of these three control variables leads to a decrease in the dependent variable and otherwise. These results are consistent with our hypotheses. The initial return ratio has a positive correlation with total assets of 0.1474. This means that an increase in total assets leads to an increase in the initial return ratio and otherwise. This positive correlation is against our hypothesis.

D. Multivariate Regressions

To learn more about the relationship between the predictor variables and the dependent variable, the robust multivariate regression is used, as shown in table V. Rarely all the assumptions concerning ordinary least squares (OLS) regressions are met by using the normal multivariate regression for estimating the unknown parameters of a regression model. There are too many

assumptions. Failure to meet these assumptions can lead to biased estimates of coefficients of the variables. Robust regressions are going beyond the normal OLS regressions and adjust the estimates that consider some of the flaws in the OLS regression. The robust regression is used to account for influence which consists of outliers and leverage. Outliers are observations with a large residual. An observation with an extreme value is a point with high leverage. So, leverage is about how far a predictor variable deviates from its mean. If removing an observation substantially changes the coefficient estimate, the observation is said to be influential. Influence is some sort of product of outliers and leverage. The robust regression is a form of weighted and reweighted OLS regression. The most influential points are dropped and large absolute residuals are down-weighted.

The R-squared of this robust multivariate regression model is 0.2167 or also 21,67%. This indicates that 21,67% of the variation in the initial return ratio is explained by this model. The model shows statistical significance at the 99% confidence level, with a P-value of 0.0002. Therefore, we can conclude that the model has explanatory power. Only the control variable issue proceeds is separately statistically significant at the 99% confidence level, with a P-value of 0.000. Therefore, we can only conclude that the coefficient of issue proceeds is not equal to zero. The robust multivariate regression formula is as follows:

$$\begin{aligned}\text{Initial Return Ratio} = {} & -97.3418 - 0.0589(\text{Patents}) + 0.9331(\text{R\&D Ratio}) \\ & +8.7844(\text{Issue Proceeds}) - 4.2679(\text{Filing Amount}) \\ & +1.1482(\text{Shares Offered}) + 3.6714(\text{VC} - \text{backed}) \\ & +0.1163(\text{Firm Age}) + 0.6133(\text{Total Assets}) \\ & -3.0401(\text{Fixed Assets Ratio}) - 0.6017(\text{Leverage Ratio}) \qquad (1)\end{aligned}$$

The predictor variable patents with a coefficient of -0.0589 is negatively related to the dependent variable initial return ratio. This is against our hypothesis that innovative firms experience more underpricing. The higher the coefficient of total number of granted patents, the lower is the initial return and thus less underpricing. The R&D ratio with a coefficient of 0.9331 is positively related to dependent variable initial return. This is consistent our hypothesis that more innovative firms face more underpricing. Our results show that an increase in the R&D ratio causes

an increase in the initial return ratio. More innovative firms, regarding R&D, experience more underpricing.

Looking at the IPO-specific control variables, issue proceeds, shares offered, and VC-backed are positively related to the initial return ratio. This is against our expectation that an increase in issue proceeds and shares offered leads to a decrease in the initial return ratio and therefore less underpricing. VC-backed is exactly what we expected. A VC-backed IPO has a higher initial return ratio and thus more underpricing. Filing amount is negatively related to the initial return ratio. This is consistent with our expectation that a higher filing amount would cause a lower initial return ratio and thus less underpricing.

Regarding the firm-specific control variables, firm age and total assets are positively related to the initial return ratio. This is against our expectations that an older firm or a higher value of total assets leads to a lower initial return ratio and thus less underpricing. The fixed assets ratio and the leverage ratio are negatively related to the initial return ratio. This negative relationship is consistent with our hypothesis that an increase in the coefficients of these variables leads to a decrease in the initial return ratio and therefore less underpricing.

E. Robustness Check

Like said before, rarely all the assumptions concerning multiple regressions are met by using the OLS regression for estimating the unknown parameters of a regression model. With our robust multivariate regression, we account for influence, which consists of outliers and leverage. This robust multivariate regression did not test for homoscedasticity, the homogeneity of variances. To test for homoscedasticity, we will use the regression with the robust standard errors. The regression with the robust standard errors does not only test for homoscedasticity, it can deal with a collection of minor aspects regarding the failure to meet the OLS assumptions.

The normal and robust standard errors are estimated using the normal multivariate regression and the multivariate regression with the robust standard errors, as shown in table 6. The robust standard errors are estimated using the Huber-White sandwich estimators. These standard errors deal with homoscedasticity and a lack of normality. As shown in table VI, the point estimates of the coefficients of the variables stayed the same as in the normal multivariate regression by adding robust standard errors. The standard errors itself did change. However, the conclusions of the normal multivariate regression and the regression with the robust standard errors are the same.

The model is statistically significant at a 99% confidence level, with a P-value of 0.0004 for the normal multivariate regression and 0.0008 for the multivariate regression with robust standard errors. Therefore, the model has explanatory power. The R-squared is 0.2044, so 20.44% of this model is explained by the independent and control variables. Only the control variable issue proceeds is statistically significant at a 99% confidence level, with a P-value of 0.000 for the normal multivariate regression and 0.001 for the multivariate regression with the robust standard errors. Therefore, the model is robust regarding homoscedasticity. Because the model is robust for homoscedasticity, we can use our robust multivariate regression for interpreting the results.

V. Conclusion

This chapter starts with an overall summary of innovative firms and IPO underpricing. Thereafter, the conclusions are drawn from the empirical research. Lastly, there is the discussion with the main limitations of this research.

A. Summary

We examine 218 IPOs on the NASDAQ in 2014 and 2015 to investigate whether more innovative firms face more underpricing by looking at the initial return ratio. Innovation is connected to underpricing because of the accounting-related innovation asymmetry of innovation capital and the asymmetric information theories about underpricing. Underpricing, although it is very costly, is a way to signal firm value of innovative firms because of the asymmetric information. With decreasing product life cycles and increasing competition levels, innovation is more important than ever. With a continuous stream of innovation, a firm can maintain its competitive advantage. To measure the level of innovation, an R&D ratio and the total number of granted patents are used. The R&D ratio is used as the innovation input, whereas the total number of granted patents is used as the innovation output. In order to measure underpricing, the initial return ratio is used.

B. Conclusion

The normal OLS regression in table VII, is quite different from the robust multivariate regression in table VI. This indicates that further research should be done to find out what the real problem is. When these two models are different, the robust multivariate regression should be used to draw conclusions.

The statistically significant conclusion we can make regarding the robust multivariate regression, is that the model has explanatory power. The complete model of the robust multivariate regression is statistically significant at a 99% confidence level, with a P-value of 0.0002. The model has an R-squared of 0.2167. So, 21.67% of the dependent variable initial return ratio is explained by the predictor variables patents and R&D ratio and the control variables issue proceeds, filing amount, shares offered, VC-backed, firm age, total assets, fixed assets ratio, and leverage ratio. The negative coefficient of patents and the positive coefficient of the R&D ratio are not statistically significant. So, we cannot conclude that these predictor variables have an influence on the dependent variable.

Although the individual predictor variables are not statistically significant, it is useful to look at these variables in the independent two-sample t-test, correlation matrix, normal multivariate regression, and the regression with the robust standard errors. Except for the robust multivariate regression, the predictor variable patents has a positive relation with the initial return ratio and the R&D ratio has a negative relation with the initial return ratio. Even for the regression with the robust standard errors. However, accounting for outliers with the robust multivariate regression, these signs change. The predictor variable patents changed into a negative relation with the initial return ratio and the R&D ratio changed into a positive relation with the initial return ratio. Therefore, we can conclude that outliers have a huge impact on the results here.

C. Discussion

Main limitations of this research are the sample size and the time span. Looking at other research articles, even sample sizes of a few thousand IPOs and time spans of over 10 years are used. A sample size of 218 IPOs and a time span of 2 years is quite low in comparison to these standards. For future research, I would recommend to use more IPOs and a longer time span than I did in this research. Results will, overall, become better and more significant.

Not only the limited number of IPOs and the short time span are limitations of this research, also the NASDAQ itself is a limitation. Only one exchange is used in this research, which is the NASDAQ. Mainly technology firms are part of this exchange. In special, the pharmaceutical industry is well represented. The pharmaceutical industry has one of the highest sector rates of R&D expenditures and patenting (Mazzucato & Tancioni, 2012). By only focusing on the NASDAQ, averages about innovation factors will be relatively higher compared to other

exchanges which are not focused on technology firms. When you include another exchange, which is not only focused on technology firms, the differences will be larger between more and less innovative firms. I expect these outcomes to be more helpful for this research topic.

Regarding the limited time span available for this master thesis, the simple patent count is used in this research as an independent variable. The simple count of the total number of granted patents is an imperfect measure of innovation output (Lanjouw et al., 1998). There is noise in this simple method of patent count. This is because not all inventions are patentable and not all patentable inventions are patented. Therefore, the simple measure of patent counts does not cover all the innovation output.

Appendix

A. Tables

Table I

Overview Variables

This table contains description of the variables used in this research. These include the dependent variable, independent variables and control variables which are separated into IPO-specific and firm-specific control variables.

Dependent Variable:	**Definition:**
Initial Return Ratio (%)	[(First Day Closing Price – Offer Price) / Offer Price] * 100%
Independent Variables:	
Patents (No.)	LOG [Number of Granted Patents]
R&D Ratio (%)	[R&D Expenditures / Total Assets]
Control variables:	
IPO-specific:	
Issue Proceeds ($ millions)	LOG[Offer Price * Number of Shares Sold at IPO]
Filing Amount ($ millions)	LOG[Offer Price * Number of Shares Offered at IPO]
Shares Offered (No. millions)	LOG[Number of Shares Offered at IPO]
VC-backed (Dummy)	Dummy Variable Equal to one if VC-backed
Firm-specific:	
Firm Age (Years)	LOG[2016 – Year of Incorporation]
Total Assets ($ millions)	LOG[Total Assets]
Fixed Assets (%)	[Fixed Assets / Total Assets]
Leverage Ratio (%)	[Debt / (Debt + Stockholders' Equity)]

Table II

Descriptive Statistics

The data about 218 IPOs in 2014 and 2015 on the NASDAQ is collected from several databases. The variables initial return ratio, issue proceeds, filing amount, shares offered, and VC-backed are measured on the day of the IPO. Patents is measured in September, 2016. The R&D ratio, total assets, the fixed assets ratio, and the leverage ratio are measured regarding the fiscal year prior to the IPO. Firm age is measured by looking at the year of the IPO minus the year of incorporation.

	N	Mean	SD	Minimum	Median	Maximum
Initial Return Ratio	218	16.85	35.94	-40.31	6.20	206.67
Patents	218	16.68	31.06	0.00	6.00	214.00
R&D Ratio	218	0.75	3.01	0.00	0.29	43.39
Issue Proceeds	218	86.64	164.82	0.09	31.61	1604.54
Filing Amount	218	113.69	193.03	3.08	69.00	1780.03
Shares Offered	218	7.89	10.14	0.65	5.78	93.69
VC-backed	218	0.70	0.46	0.00	1.00	1.00
Firm Age	218	8.26	6.94	0.00	7.00	55.00
Total Assets	218	204.28	807.18	0.17	33.53	7299.09
Fixed Assets Ratio	218	0.24	0.26	0.00	0.13	1.40
Leverage Ratio	218	1.84	4.25	-23.75	0.73	24.86

Table III

Independent Two-Sample T-Test Patents

This table contains the independent two-sample t-test of the dependent variable initial return ratio with the independent variable patents.

	Mean 0	Mean 1	Difference	t-value	P-value
Initial Return Ratio	15.8280	17.3633	-1.5353	-.2971	.7667
Observations	73	145			

Table IV

Independent Two-Sample T-Test R&D Ratio

This table contains the independent two-sample t-test of the dependent variable initial return ratio with the independent variable R&D ratio.

	Mean 0	Mean 1	Difference	t-value	P-value
Initial Return Ratio	19.1558	8.45712	10.6987	1.8172	.0706
N	171	47			

Table V

Correlation Matrix

This table contains the correlation matrix of the dependent variable initial return ratio with the independent variables patents and R&D ratio and the control variables issue proceeds, filing amount, shares offered, VC-backed, firm age, total assets, the fixed assets ratio, and the leverage ratio.

	Initial Return Ratio	Patents	R&D Ratio	Issue Proceeds	Filing Amount	Shares Offered	VC-backed	Firm Age	Total Assets	Fixed Assets Ratio	Leverage Ratio
Initial Return Ratio	1.0000										
Patents	0.0674	1.0000									
	(0.4065)										
R&D Ratio	-0.0533	0.0031	1.0000								
	(0.4336)	(0.9694)									
Issue Proceeds	0.2324***	0.0095	-0.0465	1.0000							
	(0.0005)	(0.9066)	(0.4943)								
Filing Amount	0.1181*	0.0489	-0.0712	0.8462***	1.0000						
	(0.0819)	(0.5474)	(0.2953)	(0.0000)							
Shares Offered	0.0317	0.1018	-0.0940	0.6501***	0.8909***	1.0000					
	(0.6420)	(0.2088)	(0.1666)	(0.0000)	(0.0000)						
VC-backed	0.0780	-0.0277	-0.0720	0.1418**	0.1095	0.0695	1.0000				
	(0.2514)	(0.7329)	(0.2896)	(0.0364)	(0.1068)	(0.3067)					
Firm Age	-0.0631	0.3817***	-0.1677**	-0.0701	-0.0632	0.0110	0.0459	1.0000			
	(0.3661)	(0.0000)	(0.0157)	(0.3158)	(0.3655)	(0.8755)	(0.5113)				
Total Assets	0.1474**	0.1319	-0.3441***	0.5016***	0.5977***	0.5812***	-0.1596**	0.1296*	1.0000		
	(0.0295)	(0.1031)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0183)	(0.0627)			
Fixed Assets	-0.1574**	-0.0688	-0.0628	0.0441	0.1218*	0.2112***	-0.3921***	0.1454**	0.3398***	1.0000	
Ratio	(0.0201)	(0.3966)	(0.3560)	(0.5173)	(0.0727)	(0.0017)	(0.0000)	(0.0366)	(0.0000)		
Leverage Ratio	-0.1156*	0.0519	0.2676***	-0.0920	-0.1421**	-0.1174*	-0.0038	0.0545	-0.3119***	-0.0351	1.0000
	(0.0887)	(0.5231)	(0.0001)	(0.1760)	(0.0360)	(0.0836)	(0.9552)	(0.4354)	(0.0000)	(0.6061)	

***p<0.01, **p<0.05, *p<0.1

Table VI

Multivariate Regression

This table contains the robust multivariate regression regarding the dependent variable initial return ratio with the predictor variables patents and R&D ratio and the control variables issue proceeds, filing amount, shares offered, VC-backed, firm age, total assets, the fixed assets ratio, and the leverage ratio.

	Robust Regression
Patents	-0.0589
	(1.445)
R&D Ratio	0.9331
	(3.194)
Issue Proceeds	8.7844***
	(2.392)
Filing Amount	-4.2679
	(6.410)
Shares Offered	1.1482
	(6.229)
VC-backed	3.6714
	(4.675)
Firm Age	0.1163
	(2.529)
Total Assets	0.6133
	(1.865)
Fixed Assets Ratio	-3.0401
	(8.192)
Leverage Ratio	-0.6017
	(0.420)
Constant	-97.3418**
	(44.792)
Observations	148
R-squared	0.2167

Standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

Table VII

Robustness Check

This table includes the robustness check for the model used in this research with the dependent variable initial return ratio, the predictor variables patents and R&D ratio and the control variables issue proceeds, filing amount, shares offered, VC-backed, firm age, total assets, the fixed assets ratio, and the leverage ratio. The first regression is the normal OLS regression and the second regression is the regression with the robust standard errors.

	(1) Regression	(2) Robust Regression
Patents	2.7414	2.7414
	(2.476)	(2.571)
R&D Ratio	-1.8567	-1.8567
	(5.474)	(3.342)
Issue Proceeds	15.6051***	15.6051***
	(4.100)	(4.389)
Filing Amount	-10.9086	-10.9086
	(10.984)	(10.528)
Shares Offered	-2.6681	-2.6681
	(10.675)	(10.830)
VC-backed	3.7804	3.7804
	(8.012)	(7.465)
Firm Age	-3.2026	-3.2026
	(4.334)	(3.759)
Total Assets	1.5735	1.5735
	(3.196)	(2.856)
Fixed Assets Ratio	-19.0208	-19.0208
	(14.039)	(12.590)
Leverage Ratio	-.5905	-.5905
	(.720)	(.475)
Constant	-38.9719	-38.9719
	(76.760)	(67.405)
Observations	148	148
R-squared	0.2044	0.2044

Standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

B. Figures

Figure 1

Histogram Initial Return Ratio

This figures contains the normal curve of the dependent variable initial return ratio.

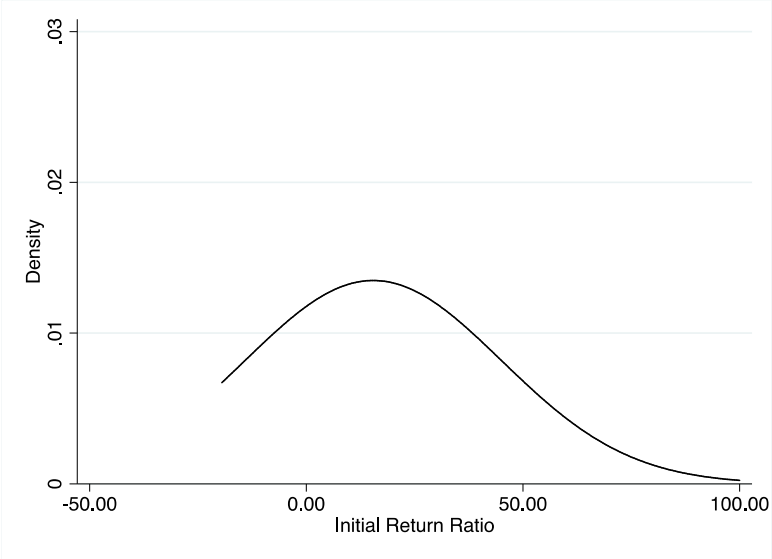


Figure 2

Histogram Patents

This figures contains the normal curve of the independent variable patents.

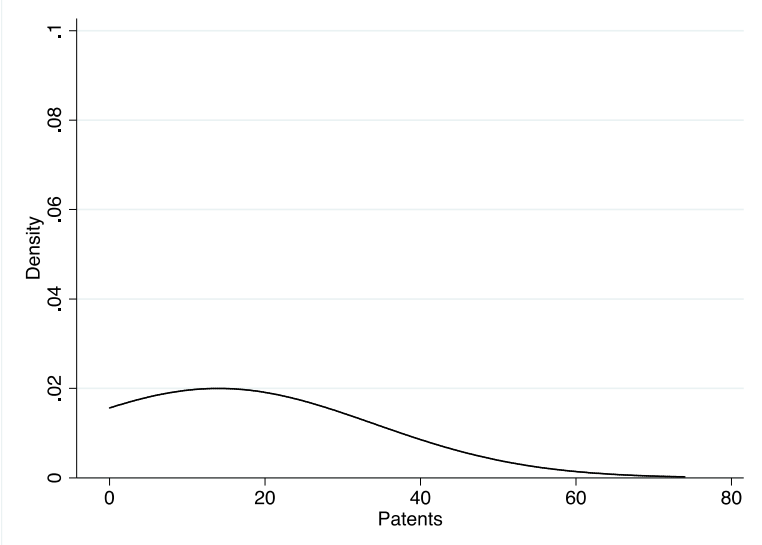


Figure 3

Histogram LOG Patents

This figures contains the normal curve of the logarithmic version of the independent variable patents.

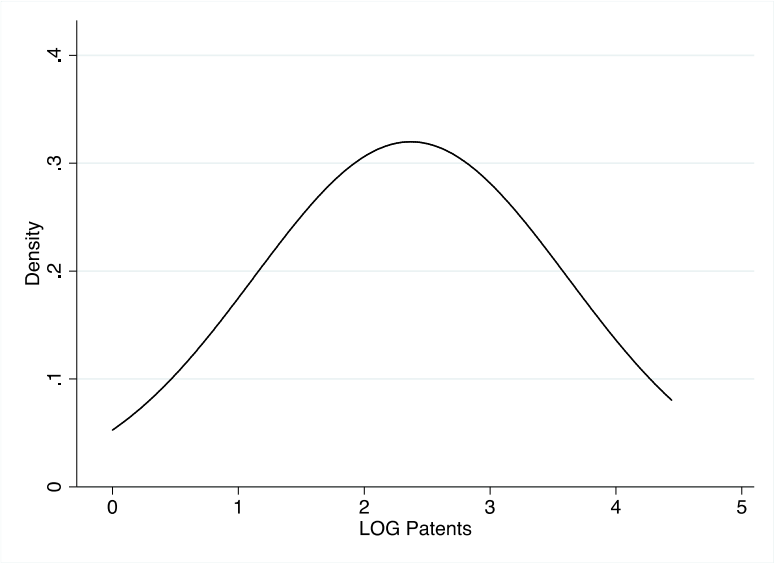
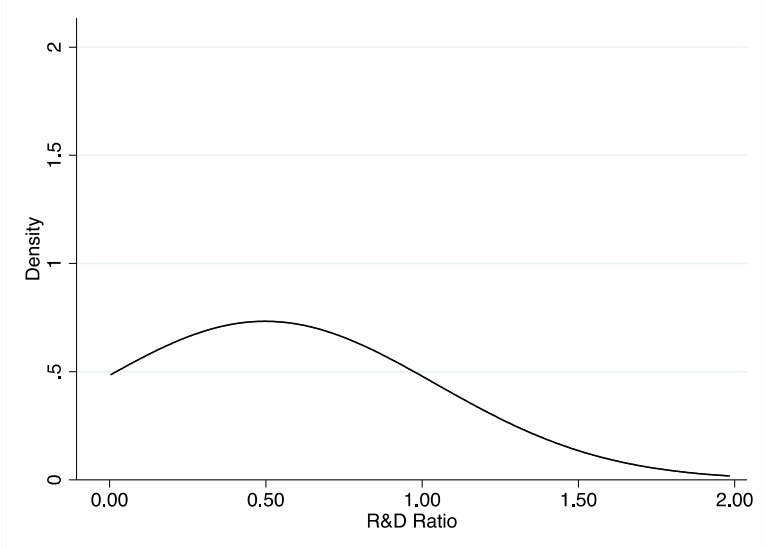


Figure 4

Histogram R&D Ratio

This figures contains the normal curve of the independent variable R&D ratio.



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