Investment Banks and Underpricing: The Influence of Profit Sharing Agreements in a Two-Stage IPO Signalling Model

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Contents

List of Symbols for Allen and Faulhaber (1989)

α	Fraction of a firm sold to primary market investors
α', α''	Signalling fraction of the firm sold in the initial public offering
$\hat{\alpha}$	Pooling fraction of the firm sold in the initial public offering
B	Bad firm
C	Investment cost
δ	One period discount factor
e_2	Dividend payment at $t = 2$
G	Good firm
H, L	High and low dividend payment respectively
λ	Probability that a good firm successfully implements an innovation
p_0	The initial public offering price
p_0', p_0''	Signalling initial public offering price
π_G	Probability that a good firm pays a high dividend H
π_B	Probability that a bad firm pays a high dividend H
R_G	Expected good firm value after implementation from the owner's perspective
R_B	Expected bad firm value after implementation from the owner's perspective
R_G^0	The owner's expected return of an initially good firm at $t = 0$
R_B^0	The owner's expected return of an initially bad firm at $t = 0$
r_0	Prior investor belief that a firm is good
r_H	Probability that a firm is good, after observing high dividend H
r_L	Probability that a firm is good, after observing low dividend L
θ	Probability that a firm is of good type
V_H	Expected firm value if high dividend was observed
V_L	Expected firm value if low dividend was observed
V_0	Expected firm value at $t = 0$

List of Symbols for the new model in section 3

α	Fraction of a firm sold to primary market investors
α_s	Fraction of a firm sold if signal is sent (separating equilibrium)
α_p	Fraction of a firm sold if no firm sends a signal (pooling equilibrium)
B	Indicating a bad quality firm, is used as subscript, too
b	Discounted proportional underwriting fee for the seasoned equity offering when signalling (separating equilibrium)
C	Investment cost
Δ	Difference in profit for a good firm owner selling or retaining shares at $t = 4$
f	Investment bank information acquisition cost
f_s	Expected price stabilisation cost
G	Subscript indicating a good quality firm
γ_i	Probability that a firm of type i is subject to a positive release of information
H	High dividend payment, is used as subscript, too
h	Release of information indicating positive information
i	Subscript placeholder for good and bad firms G and B
k	Proportional profit sharing parameter
k_s	Proportional profit sharing parameter when signalling (separating equilibrium)
L	Low dividend payment, is used as subscript, too
l	Release of information indicating negative information
λ	Probability that an initially good firm remains good after implementation
p_0	Initial public offering price

p_1	First trading price
p_s	IPO share price if a firm sends a signal (separating equilibrium)
p_p	IPO share price if no firm sends a signal (pooling equilibrium)
p_2	Seasoned equity offering price
Π	Expected profit of the investment bank
q	Proportional initial public offering or seasoned equity offering underwriting fee
R_i	Expected value of a firm after implementation
r_0	Investors' belief – probability that a firm is good at $t = 0$
r_y	Investors' Bayesian probability that a firm is good conditional of the quality of information y released
S	Expected market value of a good firm in the separating equilibrium
t	Time
θ	General probability that a firm is of good type
U	Expected market value of a good firm in the separating equilibrium
V_y	Firm value from investors' perspective after and conditional on the quality of the released information y
V_0	Firm value from investors' perspective at the initial public offering
W_i	Expected market valuation of a firm of type i from the owner's perspective after the implementation and before the release of information
W_i^0	Expected return of a firm owner of type i at $t = 0$
w_i	Probability that a firm pays a high dividend H
y	Placeholder parameter for quality of the released information

Abbreviations

CAR	Cumulative Abnormal Return
FINRA	Financial Industry Regulatory Authority
IPO	Initial Public Offering
M&A	Mergers and Acquisitions
NASD	National Association of Securities Dealers
SEC	U.S. Securities and Exchange Commission
SEO	Seasoned Equity Offering

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Investment Banks and Underpricing: The Influence of Profit Sharing Agreements in a Two-Stage IPO Signalling Model

Abstract

After the Internet Bubble in 1999-2000, US investigators found that investment banks have manipulated initial public offerings (IPO) in differing schemes to create higher profits at the cost of investors and issuing firms. One of these schemes included profit sharing agreements in which an investment bank offered underpriced share allocations of rationed IPOs to buy-side investor clients in return for their commitment to direct trades to the same bank creating more revenue on commission business. This dissertation examines the extent to which the anticipation of these profit sharing agreements alters the economic outcomes of stakeholders at an IPO. A two-staged IPO signalling model is used to explore this setting. First, it is found that profit sharing agreements can have beneficial effects for issuing firms, when investment banks pass on some revenue from profit sharing agreements to issuers. Second, investment banks prefer underpriced IPOs, however, ultimately induce higher price efficiency on the secondary market by enabling separation between good and bad firms more frequently.

Zusammenfassung

Nach der Dotcom-Blase der Jahre 1999-2000 haben die US Aufsichtsbehörden festgestellt, dass Investmentbanken Initial Public Offerings (IPOs) in unterschiedlichen Praktiken manipulierten haben um ihren eigenen Gewinn auf Kosten von Investoren und Emittenten zu steigern. Einer dieser Praktiken beinhaltet Profit-Sharing-Abkommen in denen vereinbart wird, dass die Investmentbank ihren Buy-Side-Investoren vergünstigte Aktienzuteilungen von überzeichneten IPOs liefert, wobei dieselben Investoren im Gegenzug bei der Investmentbank erhöht Transaktionen durchführen und somit den Umsatz von Maklergebühren steigern. Diese Dissertation untersucht inwiefern die Berücksichtigung von Profit-Sharing-Abkommen die verschiedenen IPO-Akteure beeinflusst. Ein zweistufiges IPO-Signalling-Modell wird dazu verwendet. Es wurde festgestellt, dass Profit-Sharing-Abkommen positive Auswirkungen auf Emittenten haben, wenn Investmentbanken Teile der erhöhten Umsätze durch Maklergebühren an Emittenten weitergeben. Weiterhin bevorzugen Investmentbanken IPOs, die Underpricing beinhalten, womit letztlich eine höhere Preiseffizienz auf dem Sekundärmarkt herbeigeführt wird, da die Separation zwischen guten und schlechten Firmen regelmäßiger geschieht.

1. Introduction

In financial economics, the pricing of equity in initial public offerings (IPO) has been within the focus of researchers ever since empirical studies indicated that new issues are underpriced on average.[1] There have been many attempts – theoretical and empirical – to solve the puzzle and find an explanation for the ongoing phenomenon called underpricing.[2] To name a few, the underpricing of new issues has been attributed to informational asymmetries between the underwriting investment bank and investors.[3] Describing the same cause however, a fairly different approach credited the phenomenon to informational asymmetries between informed and uninformed investors.[4] Yet, another approach gives informational asymmetries between firms and investors as an explanation.[5] A rather recent strand of the literature attributed the money left on the table to incentives an investment bank has to underprice IPOs due to profit sharing agreements.[6] It shall be one focus of this dissertation to explore the latter approach and investigate to what extent the incessant underpricing of IPOs can be explained by signalling-theoretical models.

1.1 Background

The initial public offering can be an important step in a firm's lifecycle. Issuing equity for the first time is a common way to finance risky endeavours. But, it may also be an effective way for firm founders to divest their stakes and diversify their portfolio. In

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[1] See Ibbotson (1975) p. 235.

[2] E.g. (Rock, 1986; Beatty and Ritter, 1986; Benveniste and Spindt, 1989; Welch 1989). Underpricing is defined as the relative difference between the IPO share price and the price on the first day of trading. If not specified, the term underpricing without further remarks will refer to this definition. Other measures of underpricing exist.

[3] See Benveniste and Spindt (1989).

[4] See Rock (1986).

[5] See Allen and Faulhaber (1989).

[6] See Reuter (2006).

many cases, it may not be the preferred mode of raising capital. Using the "pecking-order" framework, it was theorised that founders prefer internal finance over debt and debt finance over issuing equity.[7] Later studies found that there is evidence supporting the pecking-order framework, however, they also found that issuing equity is the preferred mode of raising capital once a company's growth opportunity (intangible asset) is valued relatively higher than its assets in place.[8] This suggests that issuing equity is more attractive for companies that intend to finance their growth.

Valuing a company at an IPO therefore is a difficult task for all stakeholders, i.e. investors, firm owners and underwriters.[9] Causes that influence the pricing process may include informational asymmetries and agency problems fuelled by the presence of high uncertainty. Valuation errors cannot fully explain the ongoing underpricing. A study using data from 2000 to 2005 that included IPOs from 21 different countries, found on average underpricing of new shares in 20 of those countries ranging from 2.11 % in Argentina to 43.95 % in Japan.[10] More recent studies have shown that the underpricing of IPOs persists to this day.[11]

Now, one can imagine that the mystery surrounding the IPO underpricing phenomenon has also attracted rent-seeking investors and banks. The "Internet Bubble" is a prime example of a period with a high number of IPO manipulations, putting the principal-agent theory in the foreground of explaining IPO underpricing. It has sparked the interest of researchers to study misconduct and illegal activities surrounding IPOs. The total amount of underpricing ('money left on the table') during the Internet Bubble in the US between 1999 – 2000 accumulated to an estimated US$65 billion.[12] Later, it was revealed that investment banks have engaged in illegal practices by manipulating the

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[7] See Myers (1984).

[8] See Bayless and Diltz (1994, p. 85f.).

[9] The terms underwriter and investment bank will be used synonymously throughout this dissertation.

[10] See Engelen and Van Essen (2010, p. 1963).

[11] See Perera and Kulendran (2016), see also Nielssona and Wójcik (2016).

[12] See Ritter and Welch (2002, p. 1810).

IPO process to increase profits. There were four general schemes uncovered by investigators, journalists and researchers:

1. Investment banks artificially increased the demand on the secondary market for IPO shares, by preferentially allocating shares to investors that agree to buy multiple times the number of shares on the secondary market.[13] This practice is referred to as 'laddering'. An increased aftermarket demand intuitively leads to more underpricing and reduced price stabilisation efforts by the investment bank.[14]
2. It was alleged that investment banks provided positive analyst research coverage for IPO firms to increase their aftermarket share value and consequently induce underpricing.[15] The SEC settled with multiple investment banks on this issue, not solely related to underpricing, but for the general entanglements of the research and investment bank departments of major banks requiring the banks amongst others to pay a US$875 million in penalties and separate their research and investment bank departments.[16]
3. Investment banks were alleged to pay bribes to executives of firms that may soon go public by allocating them underpriced IPO shares (of other firms), swaying them to accept a lower offering price on their own firm's IPO, a practice known as spinning.[17]
4. Finally, investment banks and their client investors profited from underpricing by allocating shares favourably to clients that shared associated profits.[18] After the IPO, those clients generated revenue for the investment bank through

[13] The settlement information was released by the US securities and Exchange Commission, see SEC (2003b).

[14] See Hao (2007, p. 111).

[15] See Cliff and Denis (2004) for the study on analyst coverage and underpricing.

[16] See SEC (2003a).

[17] See Liu and Ritter (2010), see also Loughran and Ritter (2004).

[18] See SEC (2002), see also Reuter (2006). The investigation was originally led by the Wall Street Journal.

inflated commissions or simply by directing trades towards the bank ("quid pro quo allocations"), ultimately returning some of the profits.[19]

The focus of this dissertation is to explore the last practice mentioned: the influence of profit sharing agreements at IPOs. I will develop a theoretical model to try and gauge the effect that profit sharing agreements add in setting IPO prices. I will use the signalling model of Allen and Faulhaber (1989) as the framework for this new model. By exploring this topic, my aim is to answer two main questions to contribute to the current state of research:

1. How does the introduction of profit sharing agreements in the objective function of IPO stakeholders influence the outcome at an IPO in a asymmetric information context?
2. To what extent is the use of profit sharing agreements contributing to the underpricing of IPOs?

Because the signalling model of Allen and Faulhaber, 1989 is used as the framework for answering these questions, it is described and discussed in chapter 2 in detail. The new model exploring the introduction of profit sharing agreements is described and discussed in chapter 3.

1.2 Three IPO Pricing and Allocation Practices

To demonstrate the limits between theoretical models of an IPO and the practice of underwriting and pricing an IPO, it is briefly presented how the IPO process works. Specifically, in the advancement of this dissertation, it is quite meaningful to show how IPOs are priced and allocated. There are three methods of pricing an IPO that are relevant in today's literature: fixed price offerings, auctions and bookbuilding.

[19] The National Association of Securities Dealers (NASD) released information on a settlement due to commissions, see NASD (2003), see also Liu and Ritter (2011).

Fixed Price Offerings

First, the fixed price offering was the dominating method for pricing IPOs before the 1990s in the UK and large parts of Europe.[20] The offering price and the size of the offering are set before an offer is made to investors.[21] This way, underwriters do not formally elicit information about the quality of the issue from investors. Conducting an IPO in a fixed price offering has traditionally been cheaper than the cost associated with bookbuilt offerings. Whenever demand outstrips supply, investors can be allotted shares in a lottery or a pro-rata fashion. However, depending on the country specific regulation, the allocation of shares can be handled in a discretionary or non-discretionary manner. Usually, a pro-rata allocation is used when demand outstrips supply, meaning that shares are distributed in a non-discretionary manner.[22] Although, the fixed price method has become less frequent than bookbuilding, it is still commonly used.[23]

Auctions

Second, auction-like methods in pricing and allocating IPOs have been widespread within France, Belgium and Japan.[24] Countries that employed the auction system to sell IPOs to investors have mostly abandoned them in favour for bookbuilding.[25] The auction has the inherent disadvantage that it can lead to inefficient outcomes for the issuer and the underwriter. For example, in an auction, the underwriter and investors do not know how many investors will ultimately participate and to what degree they will be informed about the value of the firm. If too many investors with heterogeneous expectations participate in an auction, the incentives for institutional investors who

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[20] See Benveniste and Busaba (1997, p. 383).

[21] See Baur and Vincenti (2008, p. 351).

[22] See Ljungqvist, Jenkinson and Wilhelm (2003).

[23] See Jenkinson, Jones and Suntheim (2018, p. 7).

[24] See Baur and Vincenti (2008, p. 351).

[25] See Sherman (2005, p. 619).

have the potential to play an important role in the price discovery process are decreased as the probability of being rewarded a profitable allocation for their information acquisition cost decreases.[26] Support for this rationale can also be derived by the theoretical review of Miller (1977), who argued that short selling constraints and the presence of heterogeneous expectations about the value of a stock will result in higher prices for that stock.[27] An underwriter could limit access to the auction to informed investors, which in turn provides more discretion over the allocation of shares, but may intuitively lead to higher risk of undersubscription.[28]

In contrast, the IPO auction mechanism has been found by some studies to result in less underpricing compared to bookbuilding.[29] Furthermore, Degeorge, Derrien and Womack (2010) have shown that an auction design devised and currently still in use by the underwriter WR Hambrecht+Co in the United States, can yield similar outcomes as bookbuilding can, with lower underpricing and lower fees.[30] The auction design therefore plays an important role in determining how much information is elicited from investors during the process. IPO auctions have in common that they directly incorporate investor demand into the final offering price.[31] However, the allocations made to investors are hardly within the discretion of the investment bank or the issuer, although access to the auction can again be discretionary.[32] The auction as an IPO pricing method is therefore not optimal to use, considering profit sharing agreements, because an investment bank does not have the necessary discretion to distribute IPO shares to investors with whom it has an agreement, unless those

[26] See Levin and Smith (1994, pp. 594-596).

[27] See Miller (1977, p. 1156).

[28] See Sherman (2005, p. 634f.).

[29] See Kaneko and Pettway (2003), see also Kutsuna and Smith (2004).

[30] See Degeorge, Derrien and Womack (2010, p. 182).

[31] See Degeorge, Derrien and Womack (2010).

[32] See Sherman (2000, p. 697f.).

investors bid up the price which in turn makes it less profitable in terms of expected initial returns.

Bookbuilding

Third, the most prevalent method of pricing and allocating IPOs since the 90's is the bookbuilding process.[33] The underwriter first estimates the indicative price range for the firm's shares and invests efforts towards pre-marketing the offering.[34] In a roadshow, the underwriter and the executives of the issuing firm market the issue to investors. Investors then give the underwriter indications of interest that determine the reception of the firm's issue.[35] Indications of interest consist of bids that can include limits for the share price and the maximum quantity of shares to be bought, where bids with price limits, or bids with both limits on quantity and price or revised bids can be considered more informative.[36] Based on these bids, the bookrunning underwriter can gauge the demand curve of the issue and recommend an offering price to the issuing firm. Together, the underwriter and the issuer decide on the final offering price. Price revisions above the initial price range are possible and can – for example in the US – indicate oversubscription and subsequent underpricing.[37] Price revisions outside the initial price range are uncommon in the European IPO market and indicate that the investment bank and its investors are communicating more frequently before the IPO.[38]

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[33] See Sherman (2005), see also Ljungqvist, Jenkinson and Wilhelm (2003, p. 63f.).

[34] See Cornelli and Goldreich (2001, p. 2340).

[35] See Benveniste and Spindt (1989).

[36] See Jenkinson, Jones and Suntheim (2018, p. 11), see also Cornelli and Goldreich (2001, p. 2338).

[37] See Hanley (1993).

[38] See Jenkinson and Jones (2004, p. 2337), see also Jenkinson, Morrison and Wilhelm (2006).

Limits to Discretionary Share Allocation

Especially with bookbuilding, the managing underwriters and the issuing firm have the power to set prices and allocate shares. This discretion is ultimately the reason why underwriters can benefit from profit sharing agreements, spinning or laddering. For the European IPO market, regulation allows for a mostly discretionary allocation of IPO shares through the issuer and the investment bank.[39] The EU has recently introduced regulation to address potential conflicts of interest that arise between issuer and underwriting investment bank requiring the latter to non-publicly record and justify allocations to investors, especially when oversubscription occurs.[40] Although, there are countries that limit it. In Germany for instance, there are rules that stipulate that in oversubscribed IPOs, the allotment of shares to retail investors must be handled in predetermined ways, e.g. pro-rata, a lottery, or by other objective criteria, like a long-standing business relationship between the issuer and the investor that is potentially receiving an allocation.[41] However, these rules do not necessarily limit the use of profit sharing agreements, because they neither address allocation rules to institutional investors nor the proportion of the issue that is allocated to institutional and retail investors.[42]

The discretionary allocation has been limited in the United States in response to the manipulations during the Internet Bubble, with the self-regulatory body, the Financial Industry Regulatory Authority's (FINRA former NASD) introduction of rules 5130-5131 in 2003 to reduce the misconduct in underwriting IPOs.[43] For example, rule 5131(a) stipulates it is illegal to offer IPO allocations in a "quid pro quo"-manner, if it involves inflated commissions. I cannot fully answer the question if it is in turn not

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[39] See Baur and Vincenti (2008, p. 354ff.).

[40] See Articles 38 – 43 of the regulation EU 2017/565 (EU, 2017) that is supplementing the MiFiD II regulation EU 2017/65.

[41] See Deutsche Boerse AG (2000, p. 20).

[42] See Ljungqvist and Wilhelm (2002, p. 197).

[43] See FINRA (2003).

illegal to offer securities to investors more preferentially, if those investors return some of the profits through non-inflated commissions. However, the methodologies of empirical studies suggest that such arrangements may exist.[44] Moreover, the SEC does not specifically require underwriters to disclose revenue from soft dollar commissions.[45] Thus, it makes sense for an underwriter to advise an issuer to set a lower offering price.

In spite of that, it must be noted that discretionary allocation of IPO shares can be beneficial to enhance the informativeness of a stock's price. It was shown that underpricing can be understood as a means of compensation for investors, when an underwriter uses their discretion in allocating shares to incentivise truthful indications of interest and consequently gain a more accurate set of information about the expected market price of the IPO shares.[46] In addition, this rationale is valid only when there is high uncertainty about the valuation of IPO shares and the underwriter and the issuing firm do not have enough accurate information about the valuation of the issue.

Finally, the bookbuilding process is suitable for underwriters because it can be used to elicit information from investors and because it offers discretion to allocate shares. The fixed price offering may offer similar discretion, although it cannot always elicit information from investors. The literature about auctions shows there are ambiguous opinions about the auction's benefits vs. costs. Ultimately, the auction does not offer the same room for discretionary allocation of shares. From the perspective of this study, it is therefore understandable consequently that most IPOs are being offered using the bookbuilding method. Described in the next section is how underwriters have used this discretion in the past to profit at the cost of investors and firms.

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[44] See Reuter (2006). Furthermore, in a working paper of Fjesme, Michaely and Norli (2011, p. 9) it was indicated that IPO allocations are favourably given to investors that produce higher commissions for the underwriting investment bank with non-inflated commissions for the Norwegian IPO market.

[45] See Ritter (2013, p. 41).

[46] See Benveniste and Spindt (1989).

1.3 Profit Sharing Agreements

In this section, I will concentrate on recent studies focusing on the profit sharing side of IPO manipulations. Before I commence, the terms used throughout the literature are being differentiated from each other (see table 1)

Table 1: Important terms from the literature regarding profit sharing

Term	Definition and examples
Soft dollar commissions	A method of paying for services from an investment manager to a broker that are not based on the execution of trades.[47] For example, a manager of a mutual fund may pay for research provided by a broker by directing trades to that broker. The soft dollar commission is then incorporated in the overall commission for the trades.
Quid pro quo	The term in the context of IPOs is used to describe an arrangement between investment banks and their buy-side clients. An arrangement may include the investment bank to direct profitable IPO allocations to the client conditional on the client directing profitable commission business to the investment bank.[48]
Profit-sharing	Same meaning as quid pro quo allocation and often synonymously used in this context.[49]
Kickbacks	Repeat investors paid kickbacks to brokers who allocated them profitable IPO allocations.[50] Kickbacks are therefore direct cash bribes to brokers who have authority over the allocations of IPO shares.

[47] See Conrad, Johnsen and Wahal (2001 p. 397f.), see also and NASD (2004).

[48] See Loughran and Ritter (2002).

[49] See for example Ritter (2003). Profit-sharing and quid pro quo allocations are synonymously used in this dissertation.

[50] See Ljungqvist and Wilhelm (2002, p. 192). See also SEC (2017) for a current example of an investigation into a broker who is charged with receiving a cash kickback for favourable treatment.

The use of third-party commissions is a widespread business practice and often negatively perceived by those who are ultimately paying them. The use of soft dollar commissions as defined in table 1 is criticised, because it can be associated with causing issues regarding the principal-agent problem.[51] Soft-dollar commissions are payment for services that the manager received from a broker that are not based on the execution of trades. This way, the manager acting as the fiduciary agent of clients (the principals), is directing a bill they are supposed to pay out of their own pocket to their client.[52] The client pays for those non-execution services by the execution of a trade. This definition is not exclusive to the situation of an IPO. Moreover, it does not include all arrangements that an investment bank can make with its buy-side client investors to engage in profit sharing. Quid pro quo allocations for example are not exclusive to clients that act as investment managers, but rather to any investor that engages in profit sharing with an investment bank.

The principal-agent problem does not only arise in the context of an investment manager acting as an agent of their investors. To a similar extent, the investment bank is acting as the agent of an issuer that plans to place equity in an IPO. In this context, an underwriter's task is to discover and certify the price of an equity issue that has not necessarily been publicly valued before.[53]

As stated in section 1.1, the result of this pricing process is an underpricing on average to the detriment of the issuer and their original shareholders. Now, taking profit-sharing agreements into account, an underwriter could increase their revenue from an IPO transaction, if they were able to capture enough of the total amount of money left on the table. The incentive, to lower the IPO offering price to increase the brokering revenue is a relatively new explanation for underpricing that was examined by Fulghieri and Spiegel (1993) and Reuter (2006). Looking at the numbers, it is most

[51] See Horan and Johnsen (2008, p. 57f.).

[52] Ebd.

[53] Refer to section 1.2 for a brief description of the IPO pricing processes.

likely correct to assume that investment banks wish to tap underpricing as an additional source of revenue. For example, it was established that during various periods of excessive underpricing in the past, the money left on the table exceeded the IPO underwriting transaction fees by more than factor 2, with the former being US$27 billion and the latter US$13 billion between 1990-1998.[54] Furthermore, revenue sourced from buy-side client investors is typically higher than the revenue sourced from IPO underwriting fees.[55] Let us put this into perspective. A recent study using an exclusive data set including the books from a majority of bookbuilt European IPOs from 2010-2015 has found that IPO allocations are significantly, positively related to investor revenue for the same book runner.[56] Investment banks therefore have the potential to profit considerably from "quid pro quo" arrangements and they can use their discretion to allocate IPO shares to do so. When manipulations are a side effect of this discretion, aftermarket prices may be distorted as the result. Regulators around the world have consequently introduced legislation to address this issue.

1.4 Two Explanations for IPO Underpricing

It has been described so far, that practices like profit sharing agreements between investment banks and investors can potentially lead underwriters to advise an issuer to set an offering price too low, thus inducing ex ante underpricing. There are two additional, relevant hypotheses from the theoretical literature that can be introduced here to give an overview of further explanations for underpricing. Each is briefly described, and recent evidence presented.

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[54] See Loughran and Ritter (2002).

[55] See Jenkinson, Jones and Suntheim (2018, p. 2). They find yearly IPO underwriting fees to average at US$437 million and buy-side client investor revenues at US$37 billion per year for a sample of 220 IPOs from Europe, the Middle-East and Africa.

[56] See Jenkinson, Jones and Suntheim (2018).

The Information Revelation Hypothesis

The information revelation hypothesis was developed assuming that issuers and underwriters are less informed about the prospects of the issuer than investors. The most influential study on this matter uses the bookbuilding process to model an IPO.[57] In this, it is shown that informed investors will be willing to give up their positive, private information about the expected market value of an issue, if they are rewarded by receiving preferred, underpriced IPO share allocations of the firm.[58] In addition, by repeatedly allowing regular investors to participate at IPOs, an investment bank can gain leverage over its clients by granting them profits frequently. This explanation is particularly relevant because underwriters around the world have predominantly adopted the bookbuilding process in the past two decades.[59] Additionally, compared to other underpricing explanations it seems to be easier to empirically test a hypothesis within a bookbuilding framework.[60] The evidence on the information revelation hypothesis provided by the literature as formulated by Benveniste and Spindt (1989) is mixed, and some criticised that the evidence presented was subject to endogeneity and had only limited implications.[61] Hanley (1993) found supporting evidence saying that offering price revisions above the indicative price range during the bookbuilding phase of an IPO are a good predictor of underpricing, demonstrating that new information revealed in the bookbuilding process only has limited effects on increasing offering prices (partial adjustment phenomenon). Similarly, Cornelli and Goldreich (2001) found for a limited sample of 39 equity issues that investor bids that were considered more informative during the bookbuilding phase received greater allocations of shares in IPOs and SEOs, providing evidence that investors who are giving up information are being rewarded with higher initial returns. In contrast, the study of

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[57] See Benveniste and Spindt (1989).

[58] Ebd.

[59] Refer to page 17 for a description of the bookbuilding process.

[60] See Ritter and Welch (2002, p. 1805).

[61] See (Cornelli and Goldreich, 2001; Jenkinson and Jones 2004; Ljungqvist and Wilhelm, 2002, p. 170; Aussenegg, Pichler and Stomper, 2006).

Jenkinson and Jones (2004) investigated a limited sample of 27 IPOs and provided no evidence that price sensitive bids from investors were rewarded with underpriced IPO allocations. It was pointed out by the same researchers that in practice, the information production within bookbuilt IPOs takes place in the pre-marketing phase before the bids are collected, which in turn raises the question of why most empirical studies concentrate on this very stage to produce evidence on information production theories.[62] A similar result was documented earlier for German IPOs and bookbuilding.[63] Finally, Jenkinson, Jones and Suntheim (2018) found evidence consistent with information revelation models but pointed out the effect is dominated by a quid pro quo.

Furthermore, evidence was found that indicated that underwriters do no allocate IPO shares to investors as reward for information revelation, but instead because they might be in a 'quid pro quo' agreement with investors.[64]

The Signalling Hypothesis

Signalling in relation to the financial structure choice has been explored early by Leland and Pyle (1977). They asserted that entrepreneurs who believe their firms have good projects have no means of communicating this directly to lenders of capital in the presence of informational asymmetries between the better informed entrepreneurs and less informed lenders.[65] They found that in equilibrium, entrepreneurs with good projects retain a larger equity stake of their firm, since it is signalling to the market that prospects are good.[66]

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[62] See Jenkinson and Jones (2009, p. 1480).

[63] See Aussenegg, Pichler and Stomper (2006).

[64] See Fjesme, Michaely and Norli (2011). Furthermore, Jenkinson and Jones (2009) found support for "quid pro quo" allocations in their qualitative investor review.

[65] See Leland and Pyle (1977, p. 371).

[66] See Leland and Pyle (1977, p. 380f.).

The signalling hypothesis in an IPO context has been laid out amongst others by Allen and Faulhaber (1989). An important distinction between the assumptions made in the information revelation hypothesis is that the underwriter and the issuer are assumed to have superior information about the prospects of the firm. Therefore, investors cannot distinguish between good and bad firms. Adverse selection is avoided mostly by exploiting the single crossing property, i.e. good firms can profit more than bad firms from signalling or the marginal cost to signalling is higher for bad firms than for good firms, to conditionally achieve a separating equilibrium. They postulate that both the fraction of the firm sold at an IPO and the offering price can serve as a signal to the market to indicate good firm quality.[67] Signalling by underpricing can lead to a separating equilibrium because good firms can benefit by yielding higher share prices at subsequent offerings of equity.[68] Similar approaches were devised by other researchers with minor differences. For example, Welch (1989) assumed that low quality firms incur additional imitation costs when attempting to imitate the signal of a good firm.[69] Both models produce a dominant pooling equilibrium in which good firm owners are better off by pooling instead of signalling (underpricing), whenever both types of equilibrium exist.[70] Grinblatt and Hwang (1989) investigated how a two dimensional signal consisting of the fraction of a firm sold and the underpricing in conjunction with a risk averse firm owner is affecting the IPO signalling game.[71]

Like the information revelation hypothesis, the signalling hypothesis also has mixed evidence.[72] Research of Jain and Kini (1994) and Garfinkel (1993) was inconclusive towards the signalling hypothesis. A study of Michaely and Shaw (1994) found no evidence for it. The study of Alvarez and Gonzalez (2005) found supportive evidence

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[67] See Allen and Faulhaber (1989, p. 304).

[68] See Allen and Faulhaber (1989).

[69] See Welch (1989, p. 423).

[70] See Welch (1989, p. 436), see also Allen and Faulhaber (1989, p. 314).

[71] See Grinblatt and Hwang (1989, p. 395).

[72] A more complete review of evidence on synthesised predictions from IPO signalling theoretical models gathered until 2001 can be found in Jenkinson and Ljungqvist (2001, p. 82ff.).

of the signalling hypothesis for the IPO market in Spain. Likewise, Francis et al. (2010) revisited the signalling hypothesis and found strong support, especially within segmented financial markets. Based on the findings of Francis et al. (2010), Cornanic and Novak (2013) repeated the investigation for Polish IPOs which were considered to be within a less integrated financial market and also found evidence consistent with the signalling hypothesis.[73] Finally, van den Assem, van der Sar and Versijp (2017) conducted 46 interviews of CEOs and CFOs that were involved in an IPO in the Netherlands between 1990-2008 to find that 57 % believed that signalling by underpricing is a vehicle to increase the offering price on future equity offerings.

Many of the empirical studies carried out on signalling did not focus on identifying companies that are more likely to apply a signalling strategy, for example because they may issue equity more likely in subsequent offerings.[74] The signalling approach will be used as the framework for the assessment of profit sharing agreements, amongst others because it inherently considers multiple equity offerings and a long-term view of IPO stakeholders.

[73] To the best of my knowledge, there is no newer empirical evidence that investigates the IPO signaling hypothesis.

[74] See Francis et al. (2010, p. 83).

2. IPO-Signalling Model Analysis

The signalling model developed by Allen and Faulhaber from 1989 uses a two-stage pricing process to model the issuance of equity and investigate signalling as an explanation for underpricing. This chapter presents a detailed description of the model, an analysis of its economic relationships and finally a discussion of its assumptions, findings and academic reception. The now presented model and model review serve as the foundation of the model presented in chapter 3 of this dissertation.

2.1 Description

The model of Allen and Faulhaber (1989) is dedicated to the topic of signalling and underpricing. They model a setting where investors are confronted with buying shares in a two-stage initial equity offering from firms that are either good or bad. The investors do not know the quality of a firm. What they know is the probability θ of a firm being of good quality. The owners of a firm sell a fraction α of the firm to the public in an IPO at $t = 0$ to finance an investment opportunity with cost C. Debt finance is not analysed as an alternative over equity.[75] The owners know whether their firm is good or bad at $t = 0$, although they cannot transfer this knowledge to the market in a credible way avoiding the cost of signalling. Therefore, they anticipate that the initial offering price p_0 and the fraction α act as a signal to both primary and secondary market investors to condition their expectations. After the offering, the firm pays a dividend of H or L to its shareholders at $t = 1$ and $t = 2$ respectively. Depending on the value of the first dividend payment, investors will correct their valuation of the firm according to Bayes' rule. Valued at the corrected price, the original owners sell the remainder $1 - \alpha$ of their shares at $t = 1$, shortly after the first dividend was paid. They sell their shares because they are assumed to be good entrepreneurs, but not good

[75] See Allen and Faulhaber (1989, p. 307).

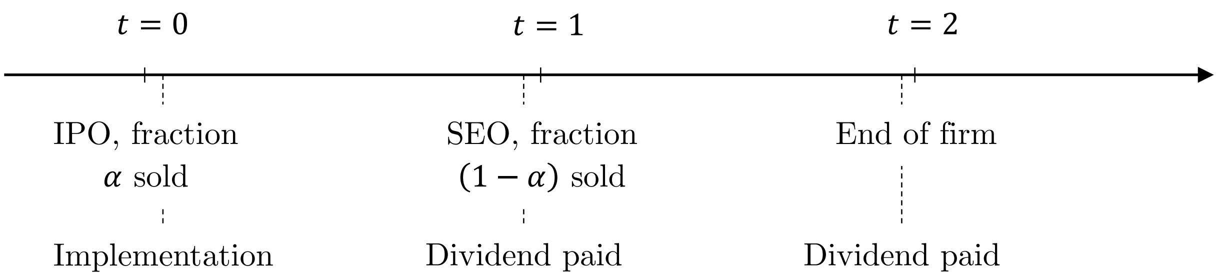

Figure 1: Timeline of the signalling model of Allen and Faulhaber (1989).[76]

at managing the firm in its more advanced stage.[77] The exact timeline of the model can be seen in figure 1.

The probability for a firm to pay the high dividend H is different for both types of firm. A good firm is paying H with probability π_G, a bad firm with π_B. L is respectively being paid with $1 - \pi_i$ with $i \in \{G, B\}$ and $\pi_G > \pi_B$. Moreover, a good firm can become bad shortly after $t = 0$, if it is unsuccessfully implementing its investment. A successful implementation has probability λ.

Now, we can look at investors' beliefs at $t = 0$ and $t = 1$. Their beliefs are determining their valuation of the firm. At the first offering, investors think that a firm will be good after implementation with probability r_0. This probability is ultimately dependent on the signalling policy of the firm. At $t = 1$, their beliefs are updated depending on the first dividend that was paid out shortly before at $t = 1$. Using Bayes' rule, it can be shown how an investor evaluates the probability of a firm being good depending on the first dividend payment.[78] If a firm pays a high dividend H, it could have come from a good or a bad firm. The probability of the firm being good from an investor's viewpoint is:[79]

$$r_H(r_0) = \frac{\pi_G r_0}{\pi_G r_0 + \pi_B(1 - r_0)}$$

[76] Ebd.

[77] See Allen and Faulhaber (1989, p. 307).

[78] See Allen and Faulhaber (1989, p. 309).

[79] See Appendix A for the detailed example using Bayes' rule.

If the firm paid a low dividend L, it has the following probability to have come from a good firm:

$$r_L(r_0) = \frac{(1-\pi_G)r_0}{(1-\pi_G)r_0 + (1-\pi_B)(1-r_0)}$$

With the conditional probabilities at hand, it is shown what investors think the firm's expected cash flow is worth $V_H(r_0)$ or $V_L(r_0)$ after receiving the first dividend payment at $t = 1$:[80]

$$V_j(r_0) = \delta\left[H\left(r_j\pi_G + \left(1-r_j\right)\pi_B\right) + L\left(1 - r_j\pi_G - \left(1-r_j\right)\pi_B\right)\right] \tag{1}$$

with $j = H$ or L indicating the revelation of a high or low dividend and δ being the one period discount factor. This valuation at $t = 1$ is determinant of their valuation of a firm $V_0(r_0)$ at $t = 0$:

$$V_0(r_0) = \delta[(H + V_H)(r_0\pi_G + (1-r_0)\pi_B) + (L + V_L)(1 - r_0\pi_G - (1-r_0)\pi_B)]$$

It consists of the first dividend payment, the investors subsequent valuation of the firm multiplied by the probability of the first dividend payment being high or low.

The perspective from a firm is a different one, since the firm and its owners know whether it is of good or bad quality. Also, they know the outcome of their implementation. The firm owners value the firm's expected return after implementation at $R_i(r_0)$, where the subscript i now takes value G or B:

$$R_i(r_0) = \delta\left[\pi_i\left(H + V_H(r_0)\right) + (1-\pi_i)\left(L + V_L(r_0)\right)\right] \tag{2}$$

The firm's valuation is directly dependent on investor beliefs. The firm owners sell their shares in a multi-stage offering. For example, a firm owner of a type B firm that is identified by investors as B will value the expected return at $R_B(r_0 = 0) = R_B(0)$. Depending on the initial public offering price at $t = 0$, we can write the expected payoff for the original owners at $t = 0$ before implementation as

[80] See Allen and Faulhaber (1989, p. 309).

$$R_G^0(p_0, r_0) = \alpha p_0 + (1-\alpha)\big(\lambda R_G(r_0) + (1-\lambda)R_B(r_0)\big) - C \tag{3}$$

$$R_B^0(p_0, r_0) = \alpha p_0 + (1-\alpha)R_B(r_0) - C. \tag{4}$$

Observe that the value of the firm to the original owners is still depending on investor beliefs r_o. A good firm's original owner considers at $t = 0$ that their firm may become bad with probability $1 - \lambda$. Looking at the structure of the original owner's payoffs, one can observe that a good firm owner has a higher expected payoff in the second round of equity offerings. That is because their firm is more likely to be paying a high dividend than a bad firm will which again triggers a positive update with higher investor expectations.[81] Furthermore, it can be observed that the valuation of a bad firm from the owner's perspective is the same as its valuation by investors that believe the firm is bad, with $R_B(0) = V_0(r_0 = 0)$.[82]

In IPO signalling models, firms need to raise enough capital to finance their investment.[83] Allen and Faulhaber (1989) embody this requirement by stating that the proceeds at the IPO must at least cover the cost of implementation:

$$\alpha p_0 \geq C \tag{5}$$

$$p_0 \leq V_0(r_0) \tag{6}$$

Condition (6) then simply states that investors purchase issues only if the issue price is less or equal to their valuation of the issue. Whenever the price of the issue p_0 is smaller than investors' expectations of its value, underpricing and rationing occurs.

The authors describe two cases that make the signalling game obsolete and consequently have to be ruled out.[84] First, if a good firm's probability of paying a high dividend is certain, i.e. $\pi_G = 1$ and bad firms certainly pay low dividends, with $\pi_B = 0$, the true quality of a firm is always revealed at $t = 1$ when a dividend payment takes

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[81] See Allen and Faulhaber (1989, p. 310).

[82] Ebd.

[83] See (Allen and Faulhaber, 1989, p. 311; Welch, 1989, p. 424; Grinblatt and Hwang, 1989, p. 395).

[84] See Allen and Faulhaber (1989, p. 311).

place. In that setting, only a pooling equilibrium survives and firms sell a minimum fraction α of their issue at $p_0 = V_0(\theta\lambda)$. Since the quality is fully revealed at $t = 1$, good firms finance the investment and benefit from a better price of their shares at $t = 1$ during the seasoned equity offering (SEO). The model therefore requires $0 < \pi_B < \pi_G < 1$.

Second, if $\lambda = 1$ and good firms remain good with certainty, the dividend payment will become obsolete when a firm manages to signal its good quality at $t = 0$. Then investors will think that it is good, with $r_0 = \lambda = 1$ and the dividend payment will not induce investors to update their beliefs about the quality of the firm ($r_H = r_L = 1$).[85] That is problematic, because a bad firm could easily imitate this signal. The signal would lose its credibility and no firm would be able to signal in the first place. The model's information structure therefore requires $0 < \lambda < 1$.

2.2 Results

This section briefly presents a description of the resulting equilibria in the model of Allen and Faulhaber (1989). There are two different types of equilibrium occurring in this signalling game. First, it will be described how a separating equilibrium can be obtained and under which conditions it exists. Next, the same is repeated for the existence of the pooling equilibrium.

The separating equilibrium

For separating to be possible, an investor must be able to observe the action of the firm. The quality of a firm must be credibly transmitted in the signal. Signalling must only be beneficial for the good firm. This is measured by the owner's payoff function $R_i^0(p_0, r_0)$. A bad firm owner decreases their expected total payoffs $R_B^0(p_0, r_0)$ by

[85] Ebd.

signalling the quality of their firm. Consequently, delivering a credible signal in this context requires that bad firms must be prevented from imitating the signals of good firms. This is achieved here by adding a cost to signalling. The firm uses the fraction α and the IPO price p_0 as a signal. Depending on whether a signal is sent or not, investors will form their beliefs r_0 about the initial quality of the firm. For example, if a firm sends a credible signal, investors will think that it remains good with probability λ, because an initially good firm may still deteriorate in quality. If no signal is sent by either type of firm (pooling), investors will believe that a firm is currently good and will remain good after implementation with probability $\theta\lambda$. In a separating equilibrium, bad firms do not send signals, resulting in investors to have beliefs $r_0 = 0$ about them.

To continue, a good firm owner must be better off or equally well off by sending a signal in a separating equilibrium.[86] Accordingly, a bad firm owner must be worse off or equal by imitating the signal of the good firm. These conditions for a separating equilibrium can be stated as:

$$R_B^0(p_0, r_0 = \lambda) \leq R_B^0(V_o(r_0 = 0), r_0 = 0) \tag{7}$$

$$R_G^0(p_0, r_0 = \lambda) \geq R_G^0(V_0(r_0 = 0), r_0 = 0) \tag{8}$$

On the left-hand side of (7), one can observe the expected gross payoff of a bad firm owner that is deviating by signalling with $r_0 = \lambda$. The right-hand side represents the usage of no signalling strategy for the bad firm owner. Condition (8) describes on the left-hand side the expected gross payoff of a good firm owner while signalling and on the right-hand side their expected gross payoff when deviating and not signalling. At this point, we do not know the exact price and proportion strategy necessary to achieve this. Although, it is known what values investors' beliefs r_0 will take according to the strategies. Using these conditions, we can state proposition 1:[87]

[86] See Allen and Faulhaber (1989, p. 311f.).

[87] See Allen and Faulhaber (1989, p. 312).

Proposition 1: Separation between firms is possible and a feasible equilibrium if

$$\frac{R_G(\lambda)}{R_B(\lambda)} \geq \frac{R_G(0)}{R_B(0)}$$

and

$$C < V_0(\mathrm{r}_0 = 0).$$

The first condition reflects the notion that the gains of signalling must be relatively higher for good firms than for bad firms. The proof will be explained now. The proceeds from the IPO must at least cover the expenses for implementation as stated in (5). Condition (7) reflects that a bad firm in a separating equilibrium cannot improve its expected payoff by signalling that it is good. Signalling for good firms in a separating equilibrium is at least as good as not signalling (8). Condition (7) holds with equality because good firm owners have no motive to underprice more than necessary.[88] Good firms can generate higher returns by selling the rest of their shares at $t = 1$, since the price at that time is likely to be higher for good firms than for bad firms, depending on the dividend payment. Expanding (7) we have:

$$\alpha p_0 + (1 - \alpha)R_B\,(\lambda) - C = \alpha V_0(0) + (1 - \alpha)R_B(0) - C$$

$$\Leftrightarrow \alpha p_0 + (1 - \alpha)R_B\,(\lambda) = V_0(0) = R_B(0)$$

$$\Leftrightarrow (1 - \alpha)R_B\,(\lambda) = R_B(0) - C$$

The price and fraction sold at the IPO in a separating equilibrium (the signal) can now be written as

$$p_0' = C/\alpha \qquad\qquad \alpha' = 1 - \frac{R_B(0) - C}{R_B\,(\lambda)}.$$

[88] See Allen and Faulhaber (1989, p. 319).

With a price and proportion strategy (p_0', α'), a good firm is just capable of sending a credible signal to investors that it is good.[89] A bad firm prices its shares at $p_0 = V_0(0)$, because signalling will not yield more returns. Remember that $\alpha p_0 = C$ is always given for a good firm owner since their expected proceeds from selling at $t = 1$ are higher, meaning they are selling only the minimum fraction of shares to stem the investment cost C. Inserting this price and proportion into condition (8), we can finish the proof of proposition 1:

$$R_G^0(p_0, \lambda) \geq R_G^0(V_0(0), 0)$$

$$\alpha' p_0' + (1 - \alpha')\big(\lambda R_G(\lambda) + (1 - \lambda) R_B(\lambda)\big) - C$$
$$\geq \alpha V_0(0) + (1 - \alpha)\big(\lambda R_G(0) + (1 - \lambda) R_B(0)\big) - C$$

$$\Leftrightarrow \tfrac{R_B(0) - C}{R_B(\lambda)}\big(\lambda R_G(\lambda) + (1 - \lambda) R_B(\lambda)\big) \geq \left(1 - \tfrac{C}{R_B(0)}\right)\big(\lambda R_G(0) + (1 - \lambda) R_B(0)\big)$$

$$\Leftrightarrow \tfrac{R_B(0) - C}{R_B(\lambda)}\big(\lambda R_G(\lambda) + (1 - \lambda) R_B(\lambda)\big) \geq \left(\tfrac{R_B(0) - C}{R_B(0)}\right)\big(\lambda R_G(0) + (1 - \lambda) R_B(0)\big)$$

Now, assuming that $C < R_B(0) = V_0(0)$, we further have

$$\tfrac{R_B(0)}{R_B(\lambda)}\big(\lambda R_G(\lambda) + (1 - \lambda) R_B(\lambda)\big) \geq \lambda R_G(0) + (1 - \lambda) R_B(0)$$

$$\Leftrightarrow \lambda R_G(\lambda) \tfrac{R_B(0)}{R_B(\lambda)} + (1 - \lambda) R_B(0) \geq \lambda R_G(0) + (1 - \lambda) R_B(0)$$

$$\Leftrightarrow \lambda R_G(\lambda) \tfrac{R_B(0)}{R_B(\lambda)} \geq \lambda R_G(0)$$

$$\frac{R_G(\lambda)}{R_B(\lambda)} \geq \frac{R_G(0)}{R_B(0)}$$

This proves proposition 1. If we assumed the opposite for a moment with $C > V_0(0)$, the inequality would reverse, since $\alpha < 1$. But this is not applicable here because the investment cost would be more expensive than the maximum price a bad firm can ask for. A separating equilibrium would not be possible in this situation. Also, it is not

[89] See Allen and Faulhaber (1989, p. 320).

possible to construct a setting where the price of the bad firm equals the price of a good firm in a separating equilibrium:

$$V_0(0) = p_0' = C/\alpha'$$

$$\Leftrightarrow V_0(0) \cdot \left(1 - \frac{(R_B(0) - C)}{R_B(\lambda)}\right) = C$$

$$\Leftrightarrow V_0(0) \cdot (R_B(\lambda) - V_0(0) + C) = C \cdot R_B(\lambda)$$

$$\Leftrightarrow \frac{V_0(0) \cdot \big(R_B(\lambda) - V_0(0)\big)}{R_B(\lambda) - V_0(0)} = C$$

$$V_0(0) = C$$

The last equation violates the initial requirement that $C < V_0(0)$. The signalling strategy requires the good firm to price its IPO below $V_0(0)$ to make it unaffordable for the bad firm. If the price of a good firm was higher than the price of a bad firm, it would not pose a cost to the bad firm to signal. Therefore, the price of a good firm is strictly lower than the price of a bad firm in a separating equilibrium. This is not explicitly stated in Allen and Faulhaber (1989) but rather intuitive, because it is implied that signalling is costly and therefore good firms underprice their issues and bad firms do not.

The pooling equilibrium

Now that the existence of a separating equilibrium was proven under specified conditions, one can determine the conditions for the existence of a pooling equilibrium. In a pooling equilibrium, good firms and bad firms both choose the same action, namely to price their shares at $p_0 = V_0(\theta\lambda)$. That is the expected value of the firm's payoffs from investor perspective at $t = 0$, if the investor has no additional information. No information is transmitted from the firm to the market. An investor then has prior beliefs of $r_0 = \theta\lambda$ that a firm will be good after implementation.[90] In this scenario, investors update their beliefs only after the first dividend was paid at $t = 1$. Bad firms must copy the actions of good firms in a pooling equilibrium, or they will reveal themselves as bad. Thus, it will be started to determine the actions of a good firm in a pooling equilibrium.

This section will investigate which condition needs to be fulfilled for a good firm to prefer the pooling strategy over not only the signalling strategy, but any other strategy. Clearly, the IPO price in the pooling equilibrium $V_0(\theta\lambda)$ is the highest price a firm can ask for if investors do not know the quality of a firm. Hence, a good firm can only achieve a better outcome if it can credibly transmit the information to the market that it is good. It has to signal its quality at $t = 0$. The existence of the pooling equilibrium can then be obtained by showing under which conditions the proceeds of a firm owner are higher using a pooling instead of a signalling strategy.

When pooling is an equilibrium, a bad firm needs to be better off by pooling than by signalling with

$$R_B^0(p_0, r_0 = \lambda) \leq R_B^0(V_o(r_0 = \theta\lambda), r_0 = \theta\lambda). \qquad (9)$$

An equivalent condition must be fulfilled for a good firm, with

$$R_G^0(p_0, r_0 = \lambda) \leq R_G^0(V_o(r_0 = \theta\lambda), r_0 = \theta\lambda). \qquad (10)$$

The second proposition can then be stated:[91]

[90] See Allen and Faulhaber (1989, p. 313). Remember that this is the probability that a firm conducting an IPO is good times the probability that an initially good firm succeeds its implementation and remains good.

[91] See Allen and Faulhaber (1989, p. 313).

Proposition 2. Pooling can be an equilibrium whenever

$$\frac{R_G(\lambda)}{R_B(\lambda)} \leq \frac{R_G(\theta\lambda)}{R_B(\theta\lambda)} \tag{11}$$

and

$$C \leq V_0(\theta\lambda).$$

The proof is explained now. If a good firm owner decided to deviate from a pooling strategy, it would do so by signalling its good quality. In a pooling equilibrium this strategy must be worse than pooling. For pooling to be better than signalling, the expected payoffs for the good firm owner from signalling must be lower than the expected payoffs from pooling. For signalling in turn to be available, the good firm again needs to employ a signalling strategy that cannot be imitated by the bad firm.[92] One can therefore start to find a credible signalling strategy for the good firm when deviating from the pooling strategy. Employing that strategy means underpricing the firm's shares to a degree that renders the same strategy unprofitable for the bad firm. The good firm underprices only as much as is necessary for condition (5) to be binding when signalling. The offering price would consequently become $p_0'' = C/\alpha''$. The same applies for the case of pooling with $\hat{\alpha} = C/\hat{p}_0 = C/V_0(\theta\lambda)$. Similarly, the good firm owner only sells as little of their firm as possible to fund the implementation cost C, resulting in condition (9) to be binding, too. Now, it is possible to calculate the optimum fraction α'' when a god firm is deviating by signalling ($\hat{\alpha}$ is the fraction of the firm sold when pooling) that is required to prevent a bad firm to use the same strategy by making it at least equally good for the bad firm to use instead of pooling:

$$R_B^0(p_0'', \lambda) = R_B^0(\hat{p}_0, \theta\lambda)$$

$$\alpha'' p_0'' + (1 - \alpha'')R_B(\lambda) - C = \hat{\alpha}\hat{p}_0 + (1 - \hat{\alpha})R_B(\theta\lambda) - C$$

[92] See Allen and Faulhaber (1989, p. 320f.).

$$\Leftrightarrow (1-\alpha'')R_B(\lambda) = (1-\hat{\alpha})R_B(\theta\lambda)$$

$$\Rightarrow (1-\alpha'') = \underbrace{\frac{V_0(\theta\lambda)-C}{V_0(\theta\lambda)}}_{1-\hat{\alpha}} \cdot \frac{R_B(\theta\lambda)}{R_B(\lambda)}$$

Whenever the payoffs between pooling and signalling strategies are compared, the bad firm must imitate the good firm to avoid being recognised as bad.[93] It can therefore only assess the two strategies pooling or signalling. Any other strategy will reveal its bad type. This makes the proof easier. The term $1-\alpha''$ as described in the last equation can be inserted into condition (10), together with the last equation. By doing so, one can find the condition that states when pooling can be an equilibrium over signalling. We can omit the second step of inserting the values, as it is analogous to the previous calculation:

$$R_G^0(p_0'', \lambda) \leq R_G^0(V_o(\theta\lambda), \theta\lambda)$$

$$\Leftrightarrow (1-\alpha'')\big(\lambda R_G(\lambda) + (1-\lambda)R_B(\lambda)\big) \leq (1-\hat{\alpha})\big(\lambda R_G(\theta\lambda) + (1-\lambda)R_B(\theta\lambda)\big)$$

$$\Leftrightarrow \frac{R_B(\theta\lambda)}{R_B(\lambda)}\big(\lambda R_G(\lambda) + (1-\lambda)R_B(\lambda)\big) \leq \big(\lambda R_G(\theta\lambda) + (1-\lambda)R_B(\theta\lambda)\big)$$

$$\Leftrightarrow \frac{R_G(\lambda)}{R_B(\lambda)} \leq \frac{R_G(\theta\lambda)}{R_B(\theta\lambda)}$$

This proves the first part of proposition 2. It is obvious that the second part of proposition 2 must be given as well. No firm can price its shares at more than $V_0(\theta\lambda)$ when no information is transmitted through a signal. Implementation costs that exceed this maximum offering price cannot be within a feasible equilibrium. This proves the second part of proposition 2.

Having explored the proof from the second proposition of the model of Allen and Faulhaber (1989) in such detail, it became apparent that when pooling is an

[93] See Allen and Faulhaber (1989, p. 321).

equilibrium, the firm owner prefers the pooling strategy over a signalling strategy, given that condition (11) is fulfilled. Before we established this result, it was assumed that the players in this game were expecting a pooling equilibrium. The same result can be produced comparing the two types of equilibria in general. This can be formalised in a proposition itself:

Proposition 3. Whenever both types of equilibria exist, the firm owner prefers the pooling strategy over the separating strategy, because their expected payoffs are higher in the pooling equilibrium.[94]

The proof of this proposition can be achieved by inserting the calculated strategies for the price and the fraction of the firm sold into the objective function of the good firm owner R_G^0. To be precise, it must be shown that

$$R_G^0(p_0', \alpha') \leq R_G^0(V_0(\theta\lambda), \hat{\alpha}).$$

Remember, we have

$$(1 - \hat{\alpha}) = \frac{V_0(\theta\lambda) - C}{V_0(\theta\lambda)}$$

and

$$(1 - \alpha') = \frac{R_B(0) - C}{R_B\,(\lambda)}.$$

Now, we insert these into the above inequality:

$$\frac{R_B(0) - C}{R_B\,(\lambda)} \cdot \big(\lambda R_G(\lambda) + (1 - \lambda) R_B(\lambda)\big) \leq \frac{V_0(\theta\lambda) - C}{V_0(\theta\lambda)} \cdot \big(\lambda R_G(\theta\lambda) + (1 - \lambda) R_B(\theta\lambda)\big)$$

$$(R_B(0) - C) \cdot \left(\lambda \frac{R_G(\lambda)}{R_B\,(\lambda)} + 1 - \lambda\right) \leq (V_0(\theta\lambda) - C) \cdot \frac{R_B(\theta\lambda)}{V_0(\theta\lambda)} \cdot \left(\lambda \frac{R_G(\theta\lambda)}{R_B(\theta\lambda)} + 1 - \lambda\right)$$

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94 See Allen and Faulhaber (1989, p. 314).

Because of condition (11), one can see that the last terms of both sides of the inequality suggest we can further simplify the inequality to the sufficient condition

$$R_B(0) - C \leq (V_0(\theta\lambda) - C) \cdot \frac{R_B(\theta\lambda)}{V_0(\theta\lambda)}$$

A firm that is perceived as bad has the same expected value as the bad firm owner's own expectation about the payoff of their firm, with $R_B(0) = V_0(0)$. The last inequality then becomes

$$V_0(0) - C \leq \left(1 - \frac{C}{V_0(\theta\lambda)}\right) \cdot R_B(\theta\lambda)$$

Finally, this inequality is true, because naturally, we have $V_0(0) < R_B(\theta\lambda) < V_0(\theta\lambda)$.[95] This proves proposition 3.

2.3 Discussion

In this section, I briefly elaborate on the reception of the signalling approach in the literature and discuss the arguments brought forward. The discussion of this matter is also continued in section 3.3.

Excessive Cost of Signalling by Underpricing

A main point for criticism surrounding the model presented here is that signalling by underpricing can be a very expensive form of signalling, when there are other dimensions of signals that can be chosen.[96] This issue is possibly the weakest link in the IPO signalling narrative. One way, this can be demonstrated, is to observe that the absolute cost of signalling, defined by the difference between 1.) the expected value of

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[95] See Allen and Faulhaber (1989, p. 322).

[96] See Ritter (2011, p. 9), see also Daniel and Titman (1995, p. 18), see also Jenkinson and Ljungqvist (2001, p. 78ff.).

the firm's cash flow from the good firm owner's perspective to 2.) the signalling IPO price is not relevant in the presented rationale at all. Instead, the optimality of the signalling mechanism is solely determined by the next best opportunity which happens to be in this case to be recognised as a bad firm by investors. Even the prices that can be achieved by signalling are underpriced in some circumstances when compared to fundamental values. However, under the given assumption that signalling by underpricing is the only choice for a firm owner to signal good quality of their firm, it is a rational approach to determining the profitability of signalling.

It is argued by the authors of the presented model that the advantage of signalling by underpricing is that it does not require monitoring which is costly for investors.[97] For example, if the firm signalled by hiring high quality managers, investors would need to produce or acquire information about firm managers. With signalling by underpricing the information is directly observable by price differences between the primary and secondary market price. Signalling by underpricing therefore provides an easier way of modelling. Despite their argument, there are other signals than the fraction of the firm sold and the underpricing that can be observed, some without incurring additional cost, for instance

1. the length of the lock-up period,
2. accounting done by one of the big four accounting firms,
3. appointing a reputable underwriter
4. appointing high quality non-executive directors that risk their reputation[98]

In its pure form, as presented in the model above, it is possibly extreme as it would require the firm to underprice excessively. It was stated on page 35 that a good firm that is signalling by underpricing will price its shares strictly below the fair value of a bad firm, with $p_0' < V_0(0)$. Depending on the implementation cost, higher uncertainty regarding firm values could therefore lead to excessive underpricing for good quality

[97] See Allen and Faulhaber (1989, p. 306).

[98] See Brau and Fawcett (2006, p. 418), see also Jenkinson and Ljungqvist (2001, p. 81).

firms using a signalling strategy, if in this instance underpricing was defined by the total difference between offering price and expected share value from good owner perspective. However, a climate of high uncertainty regarding firm values – as recorded in hot issue periods, where many IPOs hit the market accompanied by higher than usual underpricing[99] – is precisely when signalling allows you to be distinguished from bad firms to ripen in better terms for subsequent offerings. Consequently, it is important to record that the signalling narrative is particularly relevant for firms that enjoy higher gains when being perceived as good. This reflects the notion of proposition 1, which is that a signalling strategy can only exist if the expected payoffs are relatively higher for good firms than for bad firms.[100]

It can be argued therefore that empirical research surrounding the signalling hypothesis should focus on trying to identify firms that are more likely to use a signalling approach.[101] For instance, firms that will issue capital more likely in the future, or firms that may be assumed to have a great informational advantage considering their prospects, compared to potential investors.

Even though only higher proceeds in subsequent offerings of equity are described here as a positive effect of price signalling, one can argue that there might be others, as well. For example, a similar effect could be hypothesised to lead to better outcomes for:

1. The public profile of the company[102]
2. More analyst coverage[103]

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[99] See Ritter (1984), see also Allen and Faulhaber (1989, p. 304).

[100] Ritter (2011, p. 9) argued that underpricing will only be a signal chosen by good quality firms if the strategy space is profoundly restricted, citing Daniel and Titman (1995). The latter source indeed argued that signalling by underpricing can be an optimal choice if there is a benefit associated with signalling for good firms, or a cost associated with sending false signals for bad firms. The model of Allen and Faulhaber (1989) incorporates this thought with the condition stated in proposition 1. Ritter's criticism is therefore unsubstantiated, because it ignores the very notion that signalling by underpricing of course is an expensive vehicle to signal good quality and is only feasible if it increases returns by more than the next best strategy which is pooling or not signalling.

[101] See Francis et al. (2010).

[102] See Aggarwal, Krigman and Womack (2002, p. 109).

[103] See Mola and Loughran (2004, p. 2).

3. Debt contracts issued by the company
4. Supplier and customer relationships
5. Mergers and acquisitions (M&A)[104]

It therefore argued here that the rationale that price signalling is too costly for firms is too short-sighted. Furthermore, as investigated in section 3, some of the money left on the table by underpricing might be recouped by the investment bank through profit sharing agreements from which the issuing firm may benefit in turn.

Moreover, the argument that an underpriced IPO can have more benefits than a better price at the SEO may explain why the evidence produced by empirical research on that matter has partly been inconclusive.[105] Often, one prediction that empirical researchers have synthesised from the Allen and Faulhaber (1989) model and comparable signalling models is that underpriced issues should be more likely to reissue equity capital to recoup the losses of signalling.[106] Researchers have documented mixed evidence on hypotheses generated from this prediction as was previously stated in section 1.4. Although, this prediction may not always hold if there are substantial other gains of signalling by underpricing. Furthermore, although signalling models require original owners to initially commit to reissuing equity in a secondary offering, it does not require them to follow through with this prior commitment.[107] For example, a qualitative review by Brau and Fawcett (2006, p. 406) found that the most important reason for CFOs to conduct an IPO in the first place is to create currency for future acquisitions. This circumstance can be used to argue that although firms initially plan to improve their valuation at an SEO, they may also benefit from signalling by underpricing through better terms in M&A deals. Such deals will not be included in IPO and SEO data, making it more difficult to find evidence on the signalling hypothesis. Even though the respective evidence gathered by researchers so far on signalling theoretical models

[104] See Brau and Fawcett (2006).

[105] See (Welch, 1989; Garfinkel, 1993; Jegadeesh, Weinstein and Welch, 1993).

[106] See (Garfinkel, 1993, p. 75; Welch, 1989; Jenkinson and Ljungqvist, 2001, p. 82).

[107] A similar argument was raised in van den Assem, van der Sar and Versijp (2017, p. 395).

is mixed at best, researchers should not jump to conclusions and entirely write off the signalling hypothesis.

Why is a good firm owner selling shares below value at the SEO?

One assumption worth scrutinising is that the good firm owner who successfully implemented their innovation, values their own future cash flow consistently with the investors. Looking back at equation (2):[108]

$$R_G(r_0) = \delta\left[\pi_G\left(H + V_H(r_0)\right) + (1 - \pi_G)\left(L + V_L(r_0)\right)\right]$$

The term $V_j(r_0)$, with $j = H, L$ is dependent on investors' perception of probability r_0, with

$$V_j(r_0) = \delta\left[H\left(r_j\pi_G + \left(1 - r_j\right)\pi_B\right) + L\left(1 - r_j\pi_G - \left(1 - r_j\right)\pi_B\right)\right].$$

This means that the good firm owner does not evaluate the alternative of keeping their shares instead of selling them in an SEO. We can look at this alternative valuation in place of $V_j(r_0)$. Instead of relying on selling their shares to the investors, the good firm's original owner may keep their shares and with it the right to future firm cash flows e_2 at $t = 2$ which in expectation from $t = 1$ perspective and before the SEO can be written as:

$$E(e_2) = \delta[\pi_G H + (1 - \pi_G)L].$$

Observe that $E(e_2)$ is not dependent on investor's perception of r_0 but solely of the quality of the firm after implementation. Clearly, we have $E(e_2) > V_j(r_0)$ for successfully implemented good firms. This result is intuitive. If the original owner does not sell their shares in an SEO, they do not rely on the valuations of investors that have Bayesian beliefs. That said, a rational, successful good firm owner should always keep their shares when they do not receive at least $E(e_2)$ in return for their remaining

[108] See Allen and Faulhaber (1989, p. 310).

equity in an SEO. This argument is valid independent on what dividend was paid just before $t = 1$.

The assumption that owners sell their remaining shares in an SEO is explicit and would therefore conditionally introduce irrational investor behaviour, unless the owners of the firm were risk averse or assumed to suffer from liquidity shocks. This consequently means that a good firm owner who is issuing equity in an IPO will do so because they must finance their innovation and implementation cost C. This capital requirement comes with wealth losses and supports the validity of the pecking-order framework of finance at least for high quality firm owners which states that issuers prefer internal finance over debt finance which again their favour over equity finance.[109] Even with the minimum capital requirement, it can be argued here that a good firm owner would face lower wealth losses if they pursued the implementation of their innovation by conducting an IPO using a pooling strategy only, avoiding an SEO altogether. However, it is not that simple because an initially good firm can face the possibility of a failed implementation. In this setting, it would clearly be better for a firm owner to pursue the SEO, even when a low dividend was paid just before $t = 1$, because investors still anticipate the chance that their firm might be good. Therefore, one can conclude that abolishing the SEO commitment assumption alters the analysis by changing a good firm owner's objective function by giving them the possibility to let go the pursuit of an SEO.

There is another limitation to the argument that good firm owners forego wealth at the SEO. The point of signalling is to condition investors on the quality of the firm and their perception of r_0. If the original owners did not offer their shares in a subsequent SEO, the costly signalling process could be without purpose and the original owners would have induced underpricing for nothing in return. It is therefore often argued that it is a necessary assumption of signalling models to have subsequent offerings of

[109] See Myers (1984).

equity.[110] Although, as mentioned before, it can additionally be suggested that being perceived as a good quality firm may come with advantages that could be beneficial enough for firm owners to sacrifice some of their holdings and burn money in the IPO. The rationale on this issue is continued in the discussion of the new model after having introduced profit sharing agreements and endogenous underwriting spreads. Refer to pages 90ff. for this specific matter. It was established so far that it is required to introduce a minimum capital requirement to fund the investment C and that firm owners must commit to an SEO at $t = 0$ for the signalling rationale to be valid.

[110] See Jenkinson and Ljungqvist (2001, p. 82).

3. Profit Sharing Agreements and IPO Signalling

I propose a multi-stage signalling model where profit sharing is modelled in the form of commissions in the objective function of the investment bank underwriting an IPO. The model is built on the framework of Allen and Faulhaber (1989). The idea of this model is probably closest to the model of Fulghieri and Spiegel (1993). However, their study is limited to investigate the distribution of dollars through IPO underpricing to an investment bank's customers. Their approach can neither explain causes of underpricing nor the effect of profit sharing on issuing firms (see Fulghieri and Spiegel, 1993, p. 526). It will be shown that using the framework of Allen and Faulhaber (1989), a dominance shift from the pooling equilibrium to a separating equilibrium can be achieved, creating a more profitable outcome for high quality issuing firms and investment banks. The results of the model contribute to the IPO signalling literature by modelling a more active role of the underwriter by anticipating an underwriter's desire to maximise their own objective function. This contrasts with previous theoretical models that established a more passive role for the underwriter.[111] Additionally, the model introduced below contributes to the agency theory strand of the IPO literature by including profit sharing agreements for the first time within a dedicated decision theoretical framework. This approach was developed by addressing the increasing interest of researchers to understand the complex, multilateral relationship between issuers, underwriting investment banks and buy-side client investors of investment banks that allegedly often results in rent seeking behaviour and conflicts of interest. Therefore, it is attempted to derive a discussion and implications considering these fields of research within section 3.3 which is preceded by the description and results in sections 3.1 and 3.2.

[111] See Jenkinson and Ljungqvist (2001, p. 86), see also Katti and Phani (2016, p. 39f.), see also Grinblatt and Hwang (1989, p. 397). Fulghieri and Spiegel (1993) modelled the underwriter's incentives in a signalling model but excluded the firm's objective function.

3.1 Description

In this model, there are good and bad types of firm G and B owned by risk-neutral original owners. Both types of firm are going public and a firm has probability θ to be of good type and $1-\theta$ to be of bad type. In the remainder of the model, the subscripts G and B describe variables and parameters for respectively good and bad type firms. The original owners of the firm offer a fraction α of their shares for sale at $t=0$ to finance an investment opportunity with cost C. The owners do not have sufficient liquidity to fund the investment without exterior finance.

After funds C have been invested, the firm is implementing its innovation. Consistent with Allen and Faulhaber (1989), a good firm can deteriorate in quality if it fails to implement its innovation. It has probability λ to remain good and $1-\lambda$ to become bad. The result of the implementation is known to the firm's owners only after they have invested the funds. After implementation, the asset of the firm consists of a payment to shareholders at $t=3$ that is discretely distributed with values H and L at probability w_i and $1-w_i$ respectively where $w_G > w_B$. That gives us the expected payoffs

$$R_i = w_i H + (1-w_i)L$$

with $i = G, B$ and $H > L$. For simplicity, it is assumed that the discount rate is zero and the firm is liquidated at the end. The total number of firm shares outstanding is normalized to 1.

The Timing

In a signalling setting, it is necessary to examine a minimum of two equity offerings.[112] Thus, an IPO and a consecutive SEO is modelled. The timeline of the model is shown in figure 2. The original owners sell a fraction α of the firm at the IPO at $t=0$ at the

[112] See Jenkinson and Ljungqvist (2001, p. 79).

offering price p_0 and use the IPO proceeds to implement their innovation. The investment bank charges an underwriting fee $\alpha q p_0$ proportional to the proceeds with $0 < q < 1$ representing the underwriting spread. Trading of the shares starts at $t = 1$ at price p_1. New information about the quality of the firm arrives on the market after trading has started. The price for the SEO is therefore different to the IPO and first trading price. The remainder of the firm $1 - \alpha$ is sold at $t = 2$ priced at p_2. Again, the investment bank charges an underwriting fee $q(1 - \alpha)p_2$ that is proportional to the SEO proceeds.

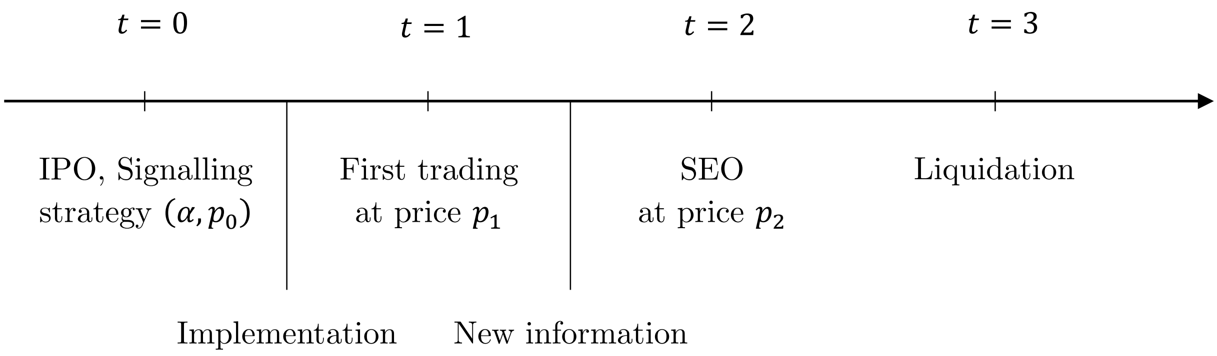

Figure 2: Timeline of the model

Information structure

Each firm owner is aware of their firm quality at time $t = 0$. A good firm owner knows that their firm's final quality is dependent on the implementation of the innovation. The investment bank expends a fixed amount f to become informed to the same level as the firm. The result of the implementation is only known to the firm and its owners. It is neither directly observable by the investment bank nor by the investors.

The investors are separated into two groups. There are buy-side investor clients who have an implicit or explicit profit sharing agreement that is maintaining a long-term relationship with the investment bank. The second group of investors consists of primary and secondary market investors. Both groups of investors are not informed about the quality of the firm.

First, the buy-side investor clients are regularly directing trades to the investment bank paying commissions to obtain profitable IPO allocations.[113] It can be read in Goldstein, Irvine and Puckett (2011), the strategies investors use to artificially increase an underwriting investment bank's commission revenue. Similar to Hao (2007), it is assumed that the investment bank does not have the power to retain all profits from underpriced share allocations.[114] Instead, a proportional payment $\alpha(p_1 - p_0)k$ is made, where the first two factors describe the total amount of underpricing measured by the IPO price and the first trading price. The parameter $k < 1$ specifies the fraction of the total amount of underpricing that will eventually be captured by the investment bank through commissions.[115] k is exogenous to the model. It was estimated in a recent study that an underwriter can potentially recoup approximately 45 % of the money left on the table at an average IPO.[116]

Modelling of how many shares each investor group receives is excluded. For simplicity, this information is incorporated in the parameter k. One can argue that the investment bank could always sell the entire issue to its long-term clients, if the firm did not impose any rules on shareholder composition. It is not necessary to assume that the long-term clients liquidate acquired shareholdings directly after the IPO, since an agreement between a long-term investor client and the investment bank can define the required commission as being dependent on the underpricing that concludes on the market on the first day of trading. The investment bank does not indicate to its long-term clients which IPOs will be underpriced. It is assumed that the investment bank allocates IPO shares to its buy-side investor clients for good and bad firm IPOs. The buy-side client

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113 In contrast to Benveniste and Spindt (1989), the investment bank is not relying on informed investor's valuation. The profitable allocations are not bound by a truth telling constraint, but rather by a commitment to share profits by directing trades to the investment bank. Similar to Benveniste and Spindt (1989), an underwriter could punish disloyal investors by banning them from future allocations.

114 See Hao (2007, p. 106).

115 Theoretically, $k > 1$ is also possible, since it was described on page 22 that the revenue from buy-side investor clients is more valuable to an investment bank than the direct fees collected from IPOs. Refer to page 78 for a discussion on this.

116 See Goldstein, Irvine and Puckett (2011, p. 1196).

investors know ex post how much commission business to generate for the investment bank.

The second group of investors consists of uninformed primary and secondary market investors. Based on the signal sent at $t = 0$, they form an expectation r_0 that a firm is good at liquidation, with $r_0 \in [0,1]$. However, the uninformed investors know the probability distribution and values of the firm's cash flow for each type of firm, the successful implementation probability λ and the initial probability of a firm being of good quality θ.

The value of the firm to investors

Similar to the model of Welch (1989), the uninformed investor's valuation of the firm at $t = 2$ is dependent on new information introduced to the market shortly before.[117] This information y either indicates a positive or a negative development for the firm with $y \in \{h, l\}$. Good firms have a probability γ_G to be the subject of a positive release of information $y = h$, bad firms have a probability γ_B to be the subject to $y = h$. Positive information is less likely to be released for bad firms than for good firms i.e. $0 < \gamma_B < \gamma_G < 1$. This is effectively putting higher marginal cost to signalling for bad firms than for good firms because new information gives uninformed investors an indication whether the firm is of good or bad quality. A release of $y = h$ subsequently results in an update of their Bayesian beliefs (probabilities), hence, in higher prices for the firm's shares at the SEO.[118] Updating the uninformed investors beliefs this way is a deviation from the original framework of Allen and Faulhaber (1989) in which investors observe the distribution of dividends or firm earnings instead. There are various explanations and examples as to why new information between the offerings might affect prices in this way. First, with time uncertainty resolves and new information is likely to be disseminated. For example, it can be argued it is the

[117] See Welch (1989, p. 423).

[118] If investors believe the firm can be of good quality with $r_0 > 0$.

expiration of a lock-up period for firm insiders or original owners that have not sold shares at the IPO introducing new information to the market. These firm insiders might choose to liquidate part of their holdings and in doing so put negative pressure on the market price.[119] Second, firms receive increased media attention after IPOs and information might become cheaper to acquire and consequently be easier to obtain for investors putting firms under more scrutiny.[120] In this setting, it can be assumed good information is more likely to be revealed for good firms and bad information is more likely to be revealed for bad firms.

The probability $r_h(r_0)$ that a firm is good from an uninformed investor's perspective in $t = 2$ conditional on the arrival of $y = h$ shortly before and dependent on the prior belief r_0 can be derived using Bayes' rule:[121]

$$r_h = \frac{\gamma_G r_0}{r_0 \gamma_G + (1 - r_0)\gamma_B} \tag{12}$$

The Bayesian probability $r_l(r_0)$ of a firm being good, conditional on the release of unfavourable information can similarly be written as:

$$r_l = \frac{(1 - \gamma_G)r_0}{(1 - \gamma_G)r_0 + (1 - \gamma_B)(1 - r_0)}$$

The value of the firm from investors' perspective after observing the information y accordingly is the expected payoff for investors at $t = 3$:

$$V_y(r_0) = r_y R_G + \left(1 - r_y\right) R_B. \tag{13}$$

[119] Field and Hanka (2001, p. 481) showed for 1.948 US IPOs between 1988 and 1997 that at the expiration of the lock-up period, cumulative abnormal returns (CAR) relative to the CRSP index were around -1.5 % on average with 63 % of all IPOs having recorded negative CARs. If these abnormal returns were based on informed investors trading on inside information, one could argue that a positive return suggests the arrival of positive information, whereas a negative return suggests negative information.

[120] See Liu and Ritter (2011) and Pollock, Rindova and Maggitti (2008).

[121] See Appendix B for the proof. r_0 will be dropped from r_y for notational economy.

Investors who participate in the IPO at $t = 0$ anticipate the release of new information and value the firm at $t = 0$ at

$$V_0(r_0) = \big(\gamma_G r_0 + \gamma_B(1 - r_0)\big)V_h + \big((1 - \gamma_G)r_0 + (1 - \gamma_B)(1 - r_0)\big)V_l \,. \qquad (14)$$

The first term is simply the probability that a good signal is released for either type of firm times the expected value of a firm that was subjected to $y = h$. The second term is respectively the probability that a negative signal arrives on the market times the valuation of a firm subjected to a negative release of information.

The value of the firm to original owners

Firm owners have an informational advantage considering the firm's quality when information y arrives. To their detriment, they have no means of influencing their firm's share price at this stage. Since they want to sell the remaining fraction $1 - \alpha$ of the firm at $t = 2$, they update their expected payoff to $W_i(r_0)$ just after the implementation and before the new information arrives.

$$W_i(r_0) = \gamma_i V_h(r_0) + (1 - \gamma_i)V_l(r_0). \qquad (15)$$

This is what a quality i firm owner believes the entire firm will be valued at by investors at the SEO. For example, $W_G(r_0 = \lambda) = W_G(\lambda)$ represents the value of the firm's cash flow from an owner's perspective before the release of information when investors had prior beliefs $r_0 = \lambda$. On the other hand, $W_B(0)$ is the value of a bad firm's cash flow from owner perspective before the release of information when the firm was previously recognised as bad by investors with $r_0 = 0$. An owner's estimate of what the firm's future cash flow is worth therefore differs to the valuation of investors because they are better informed about their firm's prospects as they already know the outcome of the implementation. However, they commit to selling the remainder of their shares at the SEO which ultimately means that their payoffs are dependent on investors' prior beliefs r_0 and information y. For example, an initially good firm that fails to implement its innovation has expected payoffs of $W_B(r_0)$ from the owner's perspective, the same as an initially bad firm.

At this point it can be mentioned that the original model of Allen and Faulhaber (1989) failed to give arguments to help explain why a risk-neutral owner of a good firm would sell their shares even though they are potentially undervalued at the SEO.[122] In this model for example, the firm is undervalued from a good owner's perspective when the implementation succeeds and the firm owner expects the payoff of the firm to be $R_G = w_G H + (1 - w_G)L$. However, even if the market recognized the firm to be good at $t = 0$, the reservation price of an uninformed investor would not exceed the value of a firm that was recognized as good and benefitted from the release of positive information $V_h(\lambda)$ which is clearly smaller than the valuation of the original owner after successful implementation.

There is an explanation for why a firm owner would still sell undervalued shares. The general motivation for firms to list on a stock exchange for the first time is to finance an investment opportunity, diversify a firm owner's investment portfolio or create currency for other companies to acquire their firm.[123] Firm owners may have personal motivations to liquidate their holdings, i.e. the need for liquidity or a risk aversion.[124] It was stated before that owners are risk-neutral, since it simplifies the analysis greatly. I therefore assume in this model that a good firm owner commits to selling the remainder of their shares at $t = 2$ for liquidity reasons. In other studies, it was argued that the losses of the selling shareholders through money left on the table are not necessarily perceived as net losses, since in most IPOs, the selling shareholders retain a great fraction of the issuing firm which itself will have appreciated greatly in value

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[122] See discussion of the previous chapter in section 2.3.

[123] See Rock (1986, p. 195) and Brau and Fawcett (2006, p. 406).

[124] For example, the founder of Facebook, Mark Zuckerberg sold 41.35 million shares worth approximately US$2.27 billion in an SEO. The company claims he sold the shares to satisfy taxes incurred with the exercise of stock options granted to him Facebook Inc. (2013). In comparison, Mark Zuckerberg sold 30.2 million shares worth approximately US$1.15 billion at the Facebook IPO (Facebook Inc., 2012).

after the IPO.[125] Although this argument was not made in a signalling context, it demonstrates the essential signalling mechanism as described in Allen and Faulhaber (1989).

In Appendix B it is explained that a good firm owner sells just enough shares in the IPO to cover the cost of the implementation C and to sell more shares at the expectedly higher price in the SEO. That means that all the IPO proceeds are received by the firm and all the SEO proceeds are received by the selling shareholders of the firm. Therefore, one can argue that neither of the first two personal motivations for firm owners to sell equity has been satisfied until they liquidate equity at the SEO at $t = 2$. Selling the shares at the SEO and potentially incurring a loss can therefore be considered justifiable from their perspective.

Anticipating their future valuation $W_i(r_0)$ gives us the objective function of the original owners W_i^0 at $t = 0$ assuming prices reflect public information. The good firm owner knows their firm might deteriorate if it fails to implement its innovation. Therefore, their expected profits are:

$$W_G^0(p_0, r_0) = \underbrace{\alpha(1-q)p_0}_{Net\ IPO\ proceeds} + \underbrace{(1-\alpha)(1-q)\big(\lambda W_G(r_0) + (1-\lambda)W_B(r_0)\big)}_{Net\ expected\ SEO\ proceeds} - C \tag{16}$$

The last summand states the cost of investment. Equivalently, bad firm owners know that they cannot improve the quality of their firm and therefore expect total proceeds of

$$W_B^0(p_0, r_0) = \alpha(1-q)p_0 + (1-\alpha)(1-q)W_B(r_0) - C. \tag{17}$$

It can be distinguished at this point that W_G^0 and W_B^0 are objective functions of a good and bad firm owner respectively, whereas W_G and W_B represent from their respective perspectives the expected investor valuation after implementation and before the

[125] See Loughran and Ritter (2002, p. 414).

release of information which is independent of what fraction of the firm is held by them at the SEO.

The objective function of the investment bank

Finally, to address the main research question to be answered in this model, commissions are taken under consideration in the objective function of the underwriter. Summing up the payments made to the underwriter introduced above, the investment bank's objective function Π is introduced as:

$$\Pi(p_0, r_0) = \underbrace{\alpha q p_0}_{IPO\ fee} + \underbrace{\alpha k(p_1 - p_0)}_{profit\ sharing\ revenue} + \underbrace{(1-\alpha) q p_2}_{SEO\ fee} - f \qquad (18)$$

The parameter f on the right-hand side represents the cost of the investment bank to become informed. For simplicity, it is assumed that paying this cost, the underwriter acquires information revealing the true quality of the firm at $t = 0$. The investment bank does not expend further resources to track the quality of the firm throughout its implementation process. Hence, it also does not know if a good firm succeeds in implementing its innovation.

Based on this information, the investment bank advises the firm on the optimal pricing strategy, but it is the firm which ultimately must agree to the pricing of the IPO. It is mentioned in various other studies that in signalling models, the role of the underwriter has been virtually irrelevant.[126] In general, this can be interpreted as a weakness to those models, when in fact underwriters have in the past played a crucial role in the IPO process that in consequence led to conflicts of interest.[127] For example, it was argued in a recent review that issuing firms might not be fully aware of the circumstance that their underwriter's interests, especially while using bookbuilding, are

[126] See (Jenkinson and Ljungqvist, 2001, p. 78; Katti and Phani, 2016, p. 39f.; Grinblatt and Hwang, 1989, p. 397).

[127] Refer to section 1.1 for examples on IPO manipulations by the underwriting investment banks.

not necessarily aligned with their own.[128] It was hinted in section 1.2 that bookbuilding often offers the underwriter substantial discretion in allocating shares, which is not necessarily the case with other methods of conducting IPOs. Hence, ignoring the role of the underwriter is a limitation of previous IPO signalling theories. In contrast, in this model, the underwriter can influence the pricing strategy by offering the firm discounts on subsequent offerings. Both, the investment bank and the original owners are maximising their objective function where the pricing strategy (α, p_0) is contained in both profit functions.

3.2 Results

Since the model presented here requires an array of different notations, I would like to give an overview of the equations introduced so far that are being used again later in the rationale. Also refer to the table of symbols at the beginning on this matter.

Table 2: Summary of equations so far

The expected value of the firm to investors at $t = 0$: $V_0(r_0) \quad = \quad (\gamma_G r_0 + \gamma_B(1-r_0))V_h + ((1-\gamma_G)r_0 + (1-\gamma_B)(1-r_0))V_l$	(14)
The anticipated market valuation of the firm by firm owners after implementation before the release of information: $W_i(r_0) \quad = \quad \gamma_i V_h(r_0) + (1-\gamma_i)V_l(r_0)$	(15)
The objective function of a good firm owner at $t = 0$: $W_G^0(p_0, r_0) \quad = \quad \alpha(1-q)p_0 + (1-\alpha)(1-q)(\lambda W_G(r_0) + (1-\lambda)W_B(r_0)) - C$	(16)
The objective function of a bad firm owner at $t = 0$: $W_B^0(p_0, r_0) \quad = \quad \alpha(1-q)p_0 + (1-\alpha)(1-q)W_B(r_0) - C$	(17)

[128] See Ritter (2013, p. 41).

Separating and pooling equilibria

The IPO price p_0 and α determine the IPO pricing strategy. Both are endogenous variables in this model and both are ultimately set by the firm and its advisor the investment bank. The IPO pricing strategy (α, p_0) acts as a public signal to uninformed primary and secondary market investors who observe it. It will be called a signalling strategy when firms send signals when pricing their IPOs. The prices p_1 and p_2 are both depending on the signalling strategy. A signal, if credible, will change investor's prior beliefs r_0 at $t = 0$ defining the probability r_0 from an investor's point of view that a firm is good. For example, if a firm successfully conveys its high quality to the market in a signal, investors will form prior beliefs $r_0 = \lambda$.

Apart from the conditions for the equilibria itself, two conditions exist for a general IPO signalling model to work.[129] First, the firm needs to raise at least the cost C for the implementation of the innovation. Second, the price of the firm at the IPO must not exceed investors' valuation:

$$\alpha(1 - q)p_0 \geq C \tag{19}$$

$$p_0 \leq V_0(r_0) \tag{20}$$

The model has a separating and a pooling Perfect Bayesian Equilibrium. For a separating equilibrium to exist, good firms must be able to gain more from sending a costly signal than bad firms. In terms of the general signalling literature, this is represented by the single-crossing property that is implemented here by introducing new information y that tends to be more favourable for good firms.[130] The information y is not fully revealing but gives investors more precise information about the quality of the firm. If it were fully revealing, uninformed investors' expectations r_0 would be irrelevant, since the information in the market would be complete and good firms would

[129] See Jenkinson and Ljungqvist (2001, p. 80f.).

[130] The single-crossing property generally formalises the requirement for a signal that it must be more expensive to low quality players compared to high quality players (Molho, 1997, p. 79).

not need to send costly signals.[131] For example, a good firm owner does not know what quality their firm will have, because their firm might deteriorate in quality after the implementation. If they knew that the release of new information before the SEO was fully revealing, they would either be identified as good or bad, depending solely on the outcome of the implementation. The market price for their shares at the SEO would subsequently be independent of investors' expectations at $t = 0$. Their course of action would therefore be to sell shares at the highest price possible at $t = 0$, that is $p_0 = V_0(\theta\lambda)$, the price, at which investors have no information about the quality of the firm. The result is a pooling equilibrium where good and bad firms use the same strategy.

The same equilibrium will result if $\lambda = 1$ and good firms certainly remained good. If investors had prior beliefs that a firm sending a good signal is good no matter what information y arrived (with $r_0 = \lambda = 1$), bad firms would send the same signal to imitate good firms and remain undiscovered.[132] The result again is a pooling equilibrium.

However, within a separating equilibrium, a firm that chooses not to signal can just ask an offering price of $p_0 = V_0(r_0 = 0)$ and thus conditions investor's prior beliefs of $r_0 = 0$, if, and only if investors know that the equilibrium is in fact separating. Because then, investors know that good firms will use a signalling strategy which bad firms cannot afford. Therefore, firms that do not signal are bad firms in a separating equilibrium. When a credible signal is sent, investor's prior beliefs will become $r_0 = \lambda$. For a credible signal and a separating equilibrium to exist, the good firm owner's profit must be higher than or equal to his profit when no signal was sent. In contrast, a bad firm owner's profit must be less than or equal to when no signal was sent. Inserting the offering price $p_0 = p_s$ from the separating signal (p_s, α_s) and investors' prior

[131] See Allen and Faulhaber (1989, p. 311). Also refer to page 30 for a description. The difference here is that the information is not conveyed by a dividend payment but a general information signal. This deviation simplifies the notation of the equations by removing one dividend payment.

[132] Ebd.

expectations r_0 in equations (16) and (17) yields the following conditions for a separating equilibrium:

$$W_G^0(p_s, r_0 = \lambda) \geq W_G^0(V_0(r_0 = 0), r_0 = 0) \tag{21}$$

$$W_B^0(p_s, r_0 = \lambda) \leq W_B^0(V_0(r_0 = 0), r_0 = 0) \tag{22}$$

The left-hand sides of conditions (21) and (22) each reflect the use of the signalling strategy first for the good firm owner and second for the bad firm owner, where the right hand sides reflect the outcome when being recognised as a bad type of firm. Given conditions (19) – (22), a signalling strategy for the good firm owner can be described using their expectation about their firm's future cash flows $W_G(r_0)$ and $W_B(r_0)$ as defined in (15).

Proposition 1. Separation between firms is possible and can be an equilibrium if [133]

$$\frac{W_G(\lambda)}{W_B(\lambda)} \geq \frac{W_G(0)}{W_B(0)} \tag{23}$$

and

$$\frac{C}{1-q} < V_0(0) = W_B(0). \tag{24}$$

Now, equation (24) is intuitive. If investors believe that the firm is bad, the proceeds after subtracting the underwriting fee must cover at least the cost of implementation when the entire firm is sold at the IPO. If this were not fulfilled, good firms would not be able to meet the minimum capital requirement to invest into the implementation with cost C, because a requirement for a signal to be credible is that bad firms cannot imitate the signal. That again induces the good firm to underprice its shares below $V_0(0)$. Even if condition (24) was binding, a good firm owner would not agree on an

[133] See Appendix B for proof. The result is confirming proposition 1 of Allen and Faulhaber (1989, p. 312).

expensive signalling policy that is too costly, since they would have to sell all their shares at the IPO to induce it. That would leave them with no shares to sell at the SEO, and hence no possibility to recover the cost of signalling.

Condition (23) represents the requirement that good firms' gains through signalling in a separating equilibrium must be relatively higher than bad firms' gains through signalling. This is assuming that separation will occur, and investors value the firm at $V_0(0)$ when a firm does not send a signal.

In a separating equilibrium, good firms then choose the pricing strategy

$$p_s = \frac{C}{(1-q)\alpha_s}$$

and

$$\alpha_s = 1 - \frac{W_B(0) - C/(1-q)}{W_B(\lambda)}$$

to signal their good firm quality.[134] Remember, when trading of the firm's shares starts, investors know that the firm has been good before implementation. They believe that a good firm has probability λ to remain good. Therefore, the first trading price of a good firm assumes the value $p_1 = \lambda W_G(\lambda) + (1-\lambda)W_B(\lambda)$.

In a pooling equilibrium, firms do not signal their quality and IPO prices do not contain new information. All firms choose the pricing strategy (p_p, α_p) and investors value firms at $p_0 = p_p = V_0(r_0 = \theta\lambda) = V_0(\theta\lambda)$. Two conditions must be fulfilled for a pooling equilibrium to exist:

$$W_G^0(p_0, r_0 = \lambda) \leq W_G^0(V_0(\theta\lambda), r_0 = \theta\lambda) \quad (25)$$

$$W_B^0(p_0, r_0 = \lambda) \leq W_B^0(V_0(\theta\lambda), r_0 = \theta\lambda) \quad (26)$$

First, (25) is the condition that good firm owners' expected payoffs are lower when their firm deviates from the pooling strategy choosing the signalling over the pooling strategy. Respectively, condition (26) requires that a pooling strategy is better for bad

[134] See Appendix B.

firm owners, too, than deviating and choosing a signalling strategy. Only then, firms will pool and use the same strategies in their IPOs. Using these conditions, it can be derived under which circumstances a pooling equilibrium can be obtained.

Proposition 2. Pooling amongst firms is possible and can be an equilibrium if [135]

$$\frac{W_G(\theta\lambda)}{W_B(\theta\lambda)} \geq \frac{W_G(\lambda)}{W_B(\lambda)} \tag{27}$$

and

$$\frac{C}{1-q} \leq V_0(\theta\lambda). \tag{28}$$

Again, equation (28) is straightforward because any firm must be able to meet the minimum capital requirement to fund their innovation when selling the entire firm at the IPO. If this were not true, no firm could sell its shares to investors because the minimum required price would exceed the reservation price of investors. This occurs in an economy if the necessary funds to implement innovations regularly exceed their expected payoffs. Their return does not compensate investors sufficiently after subtracting underwriting fees.

Condition (27) can be interpreted as follows: a pooling equilibrium only exists if the relative gains of signalling are lower than the relative gains of pooling comparing good and bad type firms. In this condition, it is considered that a good firm owner again sells as little shares as possible to enjoy a higher valuation in expectation at the SEO. It can be observed that the difference between the relative market's valuation of good and bad firm prospects after the IPO and after the implementation finally imply the existence of a pooling equilibrium and determine the absolute differences between the

[135] See Appendix B for proof.

objective functions of good and bad firm owners at $t = 0$ when signalling or not signalling. The relative market valuations of firms after the IPO are then enough to explain the existence of a pooling equilibrium. With rational expectations and fully opportunistically acting firm owners, the expected payoffs of good firm owners compared to bad firm owners are higher at the SEO due to the market's capability of information production which in turn induces them to sell as little as possible at $t = 0$ in all possible strategies.

This can be verified by thinking back to the pooling equilibrium in which the market's information is fully or close to fully revealing. It is straightforward to show that $\gamma_G \to 1$ and $\gamma_B \to 0$ results in a pooling equilibrium. It can consequently be argued that the benefit of signalling by underpricing is low whenever the market is very productive in generating new information about a firm's prospects after the IPO. Costly signalling is hence more likely if the uncertainty about firm prospects is expected to persist.

The result of a pooling equilibrium is a game in which good and bad firms choose the same pricing strategy

$$p_p = V_0(\theta\lambda)$$

and

$$\alpha_p = \frac{C}{(1-q)V_0(\theta\lambda)}.$$

The first trading price for both types of firm assumes the value $p_1 = V_0(\theta\lambda)$, because shortly after the IPO, investors remain uninformed. There is neither ex-ante nor ex-post underpricing. In this equilibrium, bad firms must imitate the actions of good firm with (α_p, p_p), otherwise they will be recognised as bad. For instance, if a bad firm owner decided to sell a higher fraction than α_p at the IPO to benefit from a higher IPO price $p_p > V_0(0)$, investors would know that they are dealing with a bad firm, since good firms have higher returns in expectation at the SEO and therefore only sell a minimum of α_p to finance the implementation cost C.

Moreover, in the original framework it was shown that a pooling equilibrium is more frequently occurring with higher values of λ, because a high success rate for innovations renders the urgency to employ a costly signalling strategy increasingly redundant.[136] The complexity of the equations did not allow the original model to derive this result in general, instead numeric examples were given to illustrate this. An analogous reflection of possible combinations of θ and λ is presented in section 3.3.

So far, this model has confirmed the results of Allen and Faulhaber (1989) for the incorporation of underwriting fees. The next paragraph's results deviate from their findings and show how a separating equilibrium can dominate a pooling equilibrium given underwriting fees and profit sharing.

The dominating separating equilibrium

Allen and Faulhaber (1989) have shown in their analysis that a pooling equilibrium always dominates a separating equilibrium when both type of equilibria exist.[137] In this paragraph, it is presented that the opposite can be shown when taking profit sharing agreements, underwriting fees and discounts for the issuer into consideration. First, I want to develop a hypothesis on how underwriters can influence the IPO pricing process.

Some have argued that the role of the underwriter is too limited in signalling models, when actually the underwriter plays a crucial role in the bookbuilding process.[138] The firm owners ultimately choose the final offering price in the model of Allen and Faulhaber (1989). In contrast, having introduced underwriting fees in this study, it is considered that the underwriter has more negotiating power in the pricing process by setting an underwriting fee b for the SEO instead of q. This variable directly influences

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[136] See Allen and Faulhaber (1989, p. 314ff.).

[137] See Allen and Faulhaber (1989, p. 314, p. 322). Also, review page 39f. for a description.

[138] As argued in section 1.2. See also Katti and Phani (2016, p. 39f.) and Grinblatt and Hwang (1989, p. 397).

a firm owner's objective function in equations (16) and (17) and thus affects the decision on determining a pricing strategy. With this negotiating power I posit, an investment bank can change an issuer's stance on the signalling strategy. For example, an investment bank can set a lower SEO underwriting fee $b < q$ to incentivise the use of a signalling strategy that results in underpricing and subsequently higher commissions for the investment bank.[139]

It is assumed that the IPO underwriting fee q is non-competitive and exogenously given. Support for this assumption was delivered by Chen and Ritter (2000) who investigated 1,111 IPOs in the U.S. between 1995 and 1998 and found that underwriters do not compete with respect to their fees. Instead, the study documents IPO underwriting fees to be clustered at 7 % of total proceeds for the majority of IPOs, indicating tacit collusion.[140] It could theoretically be argued that the prevalence of this value is evidence that IPO underwriting fees are indeed competitive, given that the marginal cost of underwriting and conducting an IPO was at 7 % of the proceeds. However, the size of IPOs varies significantly and the absolute fee for an IPO in consequence, also. In fact, it is established that IPOs also vary in other dimensions like risk, earnings history or additional services offered by the underwriter.[141] These variations should have a sizeable impact on the fees in relative terms. Since they do not, it is followed that banks are not in full competition regarding IPOs, at least in the United States. A more recent study has confirmed and even reinforced the 7 % fee clustering in the US but found the European IPO market to have lower underwriting

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[139] A similar argument was made in a recent study investigating "quid pro quo" allocations. Jenkinson, Jones and Suntheim (2018, p. 6) reasoned that investment banks could return some of the profits made through "quid pro quo" allocations, although this was not explicitly mentioned in relation to returning profits made by underpricing. However, there is no point to this argument if not directly related profits made through IPO allocations, which in turn are yielded by the resulting underpricing.

[140] See Chen and Ritter (2000), and Ritter (2011, p. 19).

[141] See Chen and Ritter (2000, p. 1106f.).

fees on average and more variable fees than in the US.[142] Both, Abrahamson, Jenkinson and Jones (2011) and Chen and Ritter (2000) find that the total amount of underpricing as an indirect cost to the issuer does not explain the lack of competition.[143]

Moreover, Liu and Ritter (2011) state that non-price dimensions may explain the lack of competition regarding the IPO underwriting fees. As well, they assume underwriting fees to be exogenous to their model.[144] They argue that firms choose underwriters based on other services they can provide, e.g. analyst coverage.[145] It is argued here that one important dimension is the fraction k of the absolute underpricing that an investment bank can recover from its long-term clients that can make an underwriter more attractive to potential issuing firms.

For the investment bank to convince a good firm owner to tolerate a lower offering price and signal by underpricing, it has to offer him at least as much profit than pooling would otherwise yield. The discounted SEO underwriting fee b is applied only to good firm's that allow a signalling strategy at $t = 0$, with $b < q$. The investment bank does not offer bad quality firms a discount, because they do not leave money on the table in their IPOs. On the contrary, in the boundary of this model they are priced at the expected value in a separating equilibrium and they are overpriced in a pooling equilibrium.

Before it is continued, it is clarified how investors value the firm, at what time and how that valuation translates to market prices. The firm and its owners make the decision about the signalling strategy at $t = 0$. The owners' payoffs depend on the market price of the firm's shares at the SEO. In a separating equilibrium, good firms are recognised to be of good quality. Through the IPO process, this information is

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142 See Abrahamson, Jenkinson and Jones (2011). They do not find an explanation for the difference in clustering. Ljungqvist, Jenkinson and Wilhelm (2003, p. 81) find the same results for the US market, although, the same banks were found to offer an average spread of 5 % in non-US markets.

143 Abrahamson, Jenkinson and Jones (2011) find the opposite to be true.

144 See Liu and Ritter (2011, p. 16f.)

145 Ebd.

openly disseminated amongst investors. The share price of the firm thus adjusts to this information and the expected SEO price becomes

$$S \equiv E\big(p_2 \big| (\alpha_s, p_s)\big) = \lambda W_G(\lambda) + (1-\lambda) W_B(\lambda)$$

A good firm owner's expected gross payoff at the SEO is therefore $(1-\alpha_s)S$. In fact, at $t = 0$ the expected SEO price equals the expected first trading price with $E(p_1) = E(p_2)$. That simply underlines the circumstance that investors anticipate at all times that a good firm can still deteriorate in quality. In a separating equilibrium they know that the firm is initially good with certainty. However, they expect it to remain good with probability λ only. Investors will therefore trade firm shares at $p_1 = S$ at $t = 1$. In contrast, they will have more information about the post-implementation quality of an initially good firm after the release of information y. The realised trading price p_2 at $t = 2$ will hence differ from p_1, although they are equal in expectation.

In a pooling equilibrium, the expected market price of a good firm $E\left(p_2 \middle| (\alpha_p, p_p)\right)$ in $t = 0$ can be noted as U:

$$\begin{aligned} U &\equiv E\left(p_2 \middle| (\alpha_p, p_p)\right) \\ &= \lambda\big(\gamma_G V_h(\theta\lambda) + (1-\gamma_G) V_l(\theta\lambda)\big) + (1-\lambda)\big(\gamma_B V_h(\theta\lambda) + (1-\gamma_B) V_l(\theta\lambda)\big) \\ &= \lambda W_G(\theta\lambda) + (1-\lambda) W_B(\theta\lambda) \end{aligned}$$

A good owner's expected gross payoff at the SEO is therefore $(1-\alpha_p)U$ in a pooling equilibrium.

The owner of the firm makes the decision about the pricing strategy at $t = 0$. When both signalling and no-signalling strategies are available, the firm owner must weigh the cost and benefits of each and determine which is more profitable to him. The underwriting investment bank makes a similar decision, because the signalling and the no-signalling strategy also affect their expected payoffs. This allows us to state a new proposition:

Proposition 3. The underwriter can influence the original owner's decision on sending a costly signal when both separating and pooling equilibria exist by offering a discount on the SEO fee and decreasing q *sufficiently to* b, *if*

$$k \geq k_s = \frac{(1-\alpha_p)U - (1-\alpha_s)S}{\alpha_s(S-p_s)} \tag{29}$$

With $b < q$.[146]

The intuition behind this proposition is that the underwriter commits to offering a long-term relationship to the issuer by lowering the SEO underwriting fee on a future equity offering and the issuer will accept a temporary loss by leaving money on the table at the IPO to signal the good quality of the firm and generate high initial returns for IPO investors. This is only profitable for the investment bank if it can capture enough of the total money left on the table with its long-term clients and profit sharing agreements. Condition (29) can then be interpreted as follows:

$$k \geq k_s = \frac{\overbrace{(1-\alpha_p)U}^{\substack{Good\ firm\ gross\ SEO\ proceeds \\ in\ a\ pooling\ equilibrium}} - \overbrace{(1-\alpha_s)S}^{\substack{Good\ firm\ gross\ SEO\ proceeds \\ in\ a\ separating\ equilibrium}}}{\underbrace{\alpha_s(S-p_s)}_{Absolute\ underpricing\ when\ separating}}$$

In the proof below, it is established that the total SEO proceeds before costs and without the discount are higher in the pooling equilibrium than in the separating equilibrium.[147] Only by giving the original owner a discount on the future offering can the underwriter convince a good firm owner to use the signalling strategy. Taking this as true, the inequality can further be interpreted. The proportion k the investment bank must be able to recover from its long-term clients has to be greater than the

[146] Proof, see below, pp. 70ff.

[147] See on page 72.

relation between the improvement in SEO proceeds a good firm can reach by pooling instead of signalling, compared to its money left on the table when separating. Informally speaking, the investment bank's attractiveness to a firm regarding its ability to recover the underpricing through profit sharing agreements must be greater than a firm's expected proceeds when pooling and leaving the information revelation to the market alone. The greater the absolute underpricing is, the less an investment bank must be able to recover via additional trading commissions to make a profit with advising a signalling strategy. The more underpricing is necessary for a firm to separate the more likely an investment bank can offer a discount to a firm and make a profit while doing so. If the capacity of the investment bank is not high enough to recover initial returns with $k < k_s$, the firm owner will opt for a pooling strategy.

Another interpretation can be given for the last condition after rearranging it:

$$k \geq \frac{(1-\alpha_p)U - (1-\alpha_s)S}{\alpha_s(S-p_s)}$$

$$\Leftrightarrow \quad \underbrace{\alpha_s k(S-p_s)}_{\substack{\text{Underwriter commission} \\ \text{revenue}}} \quad + \quad \underbrace{(1-\alpha_s)S}_{\substack{\text{Firm owner SEO} \\ \text{signaling proceeds}}} \quad \geq \quad \underbrace{(1-\alpha_p)U}_{\substack{\text{Firm owner SEO} \\ \text{pooling proceeds}}}$$

The separating equilibrium dominates the pooling equilibrium, if the combined net (after cost C) SEO proceeds of the underwriter and the good firm owner for the signalling strategy are greater than the net SEO proceeds of a good firm owner pursuing a pooling strategy. Therefore, the combined proceeds of underwriter and good firm owner determine the optimality of the signalling strategy. The pooling equilibrium can be eliminated using to the intuitive criterion.

According to this information, another inference can be made.

Proposition 4. An investment bank recovering enough of the total underpricing can produce higher expected proceeds for an owner of a good firm by selling IPO shares preferably to its long-term clients, when both pooling and separating equilibria exist.

This proposition is equivalent to the second theorem of Benveniste and Spindt (1989), who find that underwriters can yield higher proceeds to an issuer by selling shares preferentially to regular investing clients under the assumption that issuers have a minimum sales requirement in their IPO.[148]

Proof of Proposition 3 and 4

Refer to table 3 for a summary of equations necessary for the proof. The equations are formally derived in the Appendix B.

Table 3: Overview of the IPO and SEO prices and proportions

Good and bad firm IPO pooling equilibrium fraction sold: $$\alpha_p = \frac{C}{(1-q)V_0(\theta\lambda)}$$
Good and bad firm IPO pooling equilibrium price at $t = 0$*:* $$p_p = V_0(\theta\lambda)$$
Good firm IPO separating equilibrium fraction sold: $$\alpha_s = 1 - \frac{W_B(0) - C/(1-q)}{W_B(\lambda)}$$
Good firm IPO separating equilibrium price at $t = 0$*:* $$p_s = \frac{C}{(1-q)\alpha_s}$$
The expected SEO price of a good firm that used a signalling strategy: $$S = \lambda W_G(\lambda) + (1-\lambda)W_B(\lambda)$$
The expected SEO price of a good firm that used a pooling strategy: $$U = \lambda W_G(\theta\lambda) + (1-\lambda)W_B(\theta\lambda)$$

[148] Compare to Benveniste and Spindt (1989, p. 355).

Inserting b into the objective function of the good firm owner (16) gives us the following condition for the good firm owner to deviate in a pooling equilibrium and instead choose the signalling by underpricing strategy:

$$W_G^0(p_s, \lambda, b) \geq W_G^0(p_p, \theta\lambda, q) \tag{30}$$

If an investment bank gives the firm just enough of a discount to make it indifferent towards sending a signal, it results in condition (30) to be binding. In both pooling and separating equilibria, the good firm sells as little as possible at the IPO to avoid costs of pooling and costs of signalling. Condition (19) therefore always binds with $\alpha(1-q)p_0 = C$. Inserting this simplifies (30) to:

$$\alpha_s(1-q)p_s + (1-\alpha_s)(1-b)\cdot S - C \; = \alpha_p(1-q)p_p + \left(1-\alpha_p\right)(1-q)\cdot U - C$$

$$(1-\alpha_s)(1-b)\cdot S \; = \left(1-\alpha_p\right)(1-q)\cdot U$$

Isolating b in this equation ultimately yields the optimum SEO underwriting fee, for which a good firm is indifferent between the signalling and pooling strategy:

$$b = \mathit{1} - \frac{1-\alpha_p}{1-\alpha_s}\cdot(1-q)\cdot\frac{U}{S} \tag{31}$$

Before the proof is continued, it can be shown that this optimum SEO fee is in fact always lower than its counterpart in the pooling case, i.e. $b < q$. For this to be true, we need to show that by not offering the good firm a discount at all when signalling, the pooling strategy equates to a higher expected payoff for the good firm owner. This translates to the following inequality:

$$W_G^0(p_s, r_0 = \lambda, q) < W_G^0(p_p, r_0 = \theta\lambda, q)$$

$$\alpha_s(1-q)p_s + (1-\alpha_s)(1-q)\cdot S - C < \alpha_p(1-q)p_p + \left(1-\alpha_p\right)(1-q)\cdot U - C$$

$$\Leftrightarrow (1-\alpha_s)\cdot S < \left(1-\alpha_p\right)\cdot U$$

That is essentially analogous to the notion of proposition 3 of Allen and Faulhaber (1989, p. 314) and therefore means here that the investment bank must lower its SEO underwriting fee because the expected payoffs of a good firm owner are otherwise lower using the signalling strategy compared to their expected payoffs when not deviating in the pooling equilibrium. For the proof, we expand the last expression above by inserting parameters $U,\ S,\ \alpha_S$ and α_p (see table 3 for the parameter overview):

$$\frac{W_B(0)-\frac{C}{1-q}}{W_B(\lambda)}\left(\lambda W_G(\lambda)+(1-\lambda)W_B(\lambda)\right)<\left(1-\frac{C}{(1-q)V_0(\theta\lambda)}\right)\left(\lambda W_G(\theta\lambda)+(1-\lambda)W_B(\theta\lambda)\right)$$

$$\Leftrightarrow\left(W_B(0)-\frac{C}{1-q}\right)\left(\lambda\frac{W_G(\lambda)}{W_B(\lambda)}+1-\lambda\right)<\left(V_0(\theta\lambda)-\frac{C}{1-q}\right)\frac{W_B(\theta\lambda)}{V_0(\theta\lambda)}\left(\lambda\frac{W_G(\theta\lambda)}{W_B(\theta\lambda)}+1-\lambda\right)$$

It can be seen, that the last term on the left-hand side of the inequality is always greater than the last term of the right-hand side of the inequality due to (27). The difference of the leading terms is

$$\left(V_0(\theta\lambda)-\frac{C}{1-q}\right)\frac{W_B(\theta\lambda)}{V_0(\theta\lambda)}-\left(W_B(0)-\frac{C}{1-q}\right)>0$$

$$\Leftrightarrow\left(W_B(\theta\lambda)-\frac{W_B(\theta\lambda)}{V_0(\theta\lambda)}\cdot\frac{C}{1-q}\right)-\left(W_B(0)-\frac{C}{1-q}\right)>0.$$

This difference is positive because $W_B(\theta\lambda)>W_B(0)$ and$V_0(\theta\lambda)>W_B(\theta\lambda)$. Accordingly, the optimum SEO underwriting fee b in the separating equilibrium is strictly lower than its undiscounted counterpart in the pooling equilibrium q, because otherwise as shown above the expected return for a good firm owner would be higher by not deviating. Only by offering the discount, can the investment bank induce a good firm owner to sell their shares at the IPO with ex-ante underpricing to yield a higher price with lower fees at the SEO.

Next, we want to find out under which condition the investment bank's profit is higher by using b. Naturally, it is only profitable for the investment bank to offer the discount, when doing so generates higher expected returns by underpricing than by negotiating not to signal but to use a pooling strategy. The investment bank will not receive additional commissions from its client based on profit sharing, if a good firm decides not to deviate when pooling because then it will be valued the same at the IPO at $t = 0$ and at the start of trading at $t = 1$ with $p_p = p_0 = p_1$. There will not be ex ante underpricing if a good firm chooses to pool. That is of course assuming underpricing is consequently measured by p_0 and p_1. Only the expected market price after the release of new information is higher for an initially good firm, because it is more likely to be the subject of a positive release of information. This however does not affect p_1.

Next, there has to be a lower boundary for the proportion k of the total underpricing that has to be recovered by the investment bank, to make signalling worthwhile for the investment bank. The objective function of the investment bank from equation (18) can be modified to incorporate the lower SEO underwriting fee by substituting q with b for the expected SEO proceeds:

$$\Pi(p_0, r_0) = \alpha q p_0 + \alpha k(p_1 - p_0) + (1 - \alpha) b p_2 - f$$

This expected profit in case of advising the firm to send a signal by underpricing and separate, must be equal or higher than in case of advising the firm not to send a signal and pool:

$$\Pi(p_s, r_0 = \lambda) \geq \Pi\left(p_p, r_0 = \theta\lambda\right) \tag{32}$$

$$\alpha_s q p_s + \alpha_s k(S - p_s) + b(1 - \alpha_s)S - f \geq \alpha_p q p_p + q\left(1 - \alpha_p\right)U - f$$

Rearranging and using the general fact that at an IPO, a good firm only ever raises the proceeds necessary to finance its cost of implementation in both type of equilibria, with $\alpha_s q p_s = \alpha_p q p_p$, simplifies the above inequality to[149]

$$\alpha_s k(S - p_s) + b(1 - \alpha_s)S \geq q\left(1 - \alpha_p\right)U.$$

[149] Also refer to the proofs of the pooling and separating equilibria in Appendix B, where the same fact is established.

Now, we insert equation (31) for b and continue rearranging to yield the resulting condition (29):

$$\alpha_s k(S-p_s)+\left(1-\frac{1-\alpha_p}{1-\alpha_s}\cdot(1-q)\cdot\frac{U}{S}\right)(1-\alpha_s)S \geq q(1-\alpha_p)U$$

$$\Leftrightarrow \alpha_s k(S-p_s) \geq (1-\alpha_p)U-(1-\alpha_s)S$$

$$\Leftrightarrow k \geq \frac{(1-\alpha_p)U-(1-\alpha_s)S}{\alpha_s(S-p_s)} = k_s$$

Finally, $k_s < 1$ must be given for proposition 3 to be economically feasible. To obtain the result from proposition 3, the investment bank's absolute proceeds from profit sharing arrangements cannot be higher than the absolute amount of underpricing, i.e. the money left on the table. If $k_s > 1$ was given, the investment bank would not make a profit by advising the firm owner to signal, because the "necessary rate of recovery" is not in the feasible domain of k.[150] To show that $k_s < 1$ is always true and a feasible threshold for k always exists, the parameters can be rearranged:[151]

$$k_s = \frac{(1-\alpha_p)U-(1-\alpha_s)S}{\alpha_s(S-p_s)} = \frac{\overbrace{U-S}^{<0}+\overbrace{\alpha_s S-\alpha_p U}^{x}}{\underbrace{\alpha_s S - C/(1-q)}_{z}}$$

It can be seen that $U-S<0$, because $\theta\lambda < \lambda$. Next, looking at the remaining term from the right-hand side of the numerator x and the denominator z, it can be stated that $x < z$, since $\alpha_p U > C/(1-q)$. That is so, because $C/(1-q) = \alpha_p V_0(\theta\lambda) < \alpha_p U$ or $V_0(\theta\lambda) < U$.[152] That demonstrates that $k_s < 1$ is always given. It was implicitly

[150] Although, as mentioned in the introduction investment banks' revenues from trading commissions are much higher than their revenues from IPO underwriting fees. It would be possible to allow $k > 1$, if buy-side investor clients directed more trades than necessary to the investment bank. This situation is further discussed on page 78.

[151] Remember that we have $\alpha_s p_s = C/(1-q)$.

[152] See Appendix B for proof.

assumed that the revenue of the investment bank is greater than the cost of becoming informed, with f low enough that $\Pi > 0$.

3.3 Discussion and Implications

This section presents the discussion of the model described in the last chapter, also regarding the theories and studies reviewed in chapter 1. In the last section, it was shown that the presence of profit sharing agreements and a more active role of the underwriter in setting underwriting spreads, leads to a shift of dominance from the pooling equilibrium towards the separating equilibrium using the intuitive criterion, whenever the investment bank is attractive enough in the sense that its long-term client base is sufficiently extensive to allow for the underpricing to be captured and eventually, partly returned to the firm. There are a few points that can be discussed regarding this result.

The role of the underwriter

It was stated in proposition 3 that the underwriter needs to be sufficiently able to capture the total amount of underpricing given to the investors at the IPO, with $k \geq k_s$. This parameter represents the quantity and quality of the investment bank's long term-clients. This circumstance has been simplified and consolidated in the exogenous parameter k. That means on the one hand, an investment bank needs to gather enough long-term clients constituting a sufficient spending power and liquidity to buy the necessary fraction of the issuing firm. On the other hand, these long-term clients must be loyal enough to hold up their end of the bargain and generate the stipulated amount of commission business. One way the issuer and underwriter could boost their investor backing and raise k endogenously is to hire more co-managers or underwriting members and form an underwriting syndicate. The book runner within the syndicate determines the allocation of shares, although some of this authority can be delegated to other members in the syndicate.[153] This theoretically allows them to allocate shares to their favoured clients as well, while potentially increasing k. In theory, the issuer and investment bank will benefit from forming a syndicate when the investment banking branch's investor client spending power of the lead underwriter is insufficient, for example for larger issues. The more co-managers and members in the syndicate, the higher the potential for k.

Furthermore, forming a syndicate can also have other consequences. It can increase information production, reduce uncertainty about the firm's value and enhance the underwriter's estimate of the market's reception of the issue.[154] In this model, the assumption was made that the underwriter is informed about the prior quality of a firm and investors are not. This assumption of superior information endowment is critical to both the new model described above, and the model of Allen and Faulhaber (1989). Hence, forming a syndicate could be an effective way to reduce the uncertainty about a firm's value which in turn is strengthening the underwriter's superior information endowment rationale.

Furthermore, syndication can increase competition during the underwriting process for subsequent offerings.[155] Underwriters naturally have an incentive to underwrite multiple equity offerings for issuers, since it not only increases revenue in the long-term, but also may reduce cost to repeatedly work with the same issuer.[156] In a recent study, Liu and Ritter (2011) reach a comparable conclusion, namely that the long-term relationship and other services classified as non-price dimensions are included in an issuer's objective function and are therefore anticipated by the underwriter apart from competition on price dimensions such as the IPO underwriting fee.[157] Additionally,

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[153] See Liu and Ritter (2010, p. 2027).

[154] See Corwin and Schultz (2005, p. 481).

[155] Ebd.

[156] See James (1993). In the study it was argued that IPO underwriters have lower information production cost if the time between IPO and SEO is shorter.

[157] See Liu and Ritter (2011, p. 6f.).

Hansen (2001) postulated that the clustering of IPO fees is demonstrating that profits are generated by commission business instead of direct fees.[158] This points to supporting the hypothesis of Chen and Ritter (2000) that underwriters do in fact tacitly collude to avoid price competition on IPO fees. Competition seems to play a greater role when it comes to forming long-term relationships with issuers.

Individual Welfare Aspects

It can now be analysed, the degree to which the introduction of profit sharing agreements is influencing the individual welfare of the IPO participants. At first, it is useful to determine the welfare of each stakeholder when investigating both type of equilibrium. The dominance of the separating equilibrium over the pooling equilibrium can only be achieved if discounts are given to good firms and $k \geq k_s$. If the last condition is not fulfilled, the pooling equilibrium dominates the separating equilibrium. In the following paragraphs, it will be discussed how the introduction of SEO discounts for good firms as an incentive to signal by underpricing influences the IPO stakeholders' welfare. The discussion will only include such scenarios which are affected by this new strategy, meaning scenarios in which both separating and pooling equilibria exist and $k > k_s$. This shift towards the separating equilibrium will be called the 'separation shift' to unequivocally refer to this scenario.

In a pooling equilibrium, bad firms profit from uncertainty amongst investors about the quality of firms. All firms are priced at $p_0 = V_0(\theta\lambda)$. Good firms are subject to a lower average valuation and their owners consequently give up on some of their assets. There is no ex ante underpricing meaning that the net winners are bad firms, when the net losers are good firms. By definition, investors make an expected profit of zero, whenever a pooling strategy is chosen, because no additional information is revealed in $t = 1$ when p_1 is formed. In expectation, shares of bad firms will underperform, and

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[158] See Hansen (2001, p. 342ff.). It was investigated, whether side payments like soft-dollar commissions are the source of profits for investment banks.

shares of good firms will overperform in the long term. The investment bank collects fees only for the IPO and the SEO if it can secure an underwriting contract for the second offering.

In comparison, in the dominating separating equilibrium, underpricing takes place to signal high firm quality. The total amount of underpricing constitutes a cost to good firms, since they are the only ones being able to employ the strategy. At the same time, the signalling strategy comes with higher expected returns for good firms and their owners. Therefore, good firm owners benefit from the separation shift. That means, bad firms are recognised as bad more frequently and are sold at fair value with no profits to be made. Hence, shifting the dominance towards the separating equilibrium is clearly a disadvantage for bad firms.

Furthermore, uninformed investors that get to participate at an IPO are better off with more frequently occurring signalling by underpricing, because they pick up the gains of initial returns, but have no profit sharing agreements with the underwriter. They will be more informed about their primary and secondary market investments as information is disseminated more frequently. Market prices reflect information more accurately and since there is ex ante underpricing when investing in good firms, uninformed investors participating in IPOs will make an expected profit on average.

Long-term clients of the investment bank have a profit sharing agreement with the investment bank and will profit from the separation shift only if $k < 1$. They clearly profit as they pick up the gains of underpricing and return parts of it by directing trades to the investment bank. Of course, they profit less than an uninformed investor that has no profit sharing agreement with the underwriting investment bank. However, if ex ante underpricing is induced, oversubscription takes place and it can be assumed that the profit sharing investor client will be more likely to receive underpriced shares than the uninformed investor. Taking this into account, an investor client should have higher expected profits by submitting a bid at an IPO than an uninformed investor.

It can be added at this point that the investors that are called long-term clients of the investment bank here are regularly (affiliated) mutual funds that in turn represent other investors.[159] The relationship of mutual fund managers to their investors can potentially suffer from conflicts of interest, as well. For example, a fund manager can allocate the high performing IPO investments in a small size, well performing fund that is charging higher fees than the other funds in the same family.[160] Higher past performing funds in turn attract more money for the fund family.[161] At the same time, having a low performing fund within the fund family does not entail a significant negative spill over effect on money inflow for the mutual fund family.[162] This rationale suggests that it may even be possible to have $k > 1$, since it does not necessarily have to imply a negative effect on the mutual fund manager. As stated in section 1.3, the soft-dollar commissions generated within a profit sharing agreement are typically paid for by the fund investors not by the fund manager. The money inflow that is induced by a high performing fund within the fund family with a given fee structure should on the other hand be beneficial to the fund manager, as they are generating more revenue. In theory, having a profit sharing agreement with $k > 1$ is a construct that can be feasible for both investment bank and its buy-side investor clients.

To continue, the investment bank itself is making a profit as long as its expected return is greater than its underwriting cost f, which is regularly assumed to be the case. It was shown with the proof of proposition 3 that the underwriter's profit is greater with the separation shift if $k \geq k_s$. In this case, the underwriter can give the firm a discount on subsequent offerings while benefiting from profit sharing agreements. The net effect is therefore positive.

Another effect that has not yet been modelled is that the investment bank will possibly face lower price stabilisation costs after the IPO, if it decides to recommend a lower offering price and induce ex ante underpricing more frequently. One way, this effect can be modelled within the framework is to assume that the investment bank is

[159] See Reuter (2006).

[160] See Ritter and Zhang (2007, p. 341).

[161] See Gaspar, Massa and Matos (2006, p. 74).

[162] See Nanda, Wang and Zheng (2004).

employing price stabilisation efforts at cost f_s only if it is convinced that the current share price is not reflecting fundamental firm values;[163] that is, if an initially good firm becomes subject to a negative release of information shortly after the IPO. However, modelling this circumstance in this framework turns out to be problematic. Intuitively, the investment bank would use this measure only if a good firm used a pooling strategy, otherwise, the offering price would be set below the price of a bad firm. From the investment bank's perspective, good information will then be released with probability $\lambda\gamma_G + (1-\lambda)\gamma_B$, whereas bad information will be released with probability $1 - (\lambda\gamma_G + (1-\lambda)\gamma_B)$. In the latter case, the firm's share price will decrease to $V_l(\theta\lambda)$ on the secondary market, below the offering price of $V_0(\theta\lambda)$ contrary to the underwriter's initial estimate of the firm's value. The problem that arises now is that the underwriter does not know if the firm was subject to a negative information release because it is bad (a failed good firm) or because it is successfully good. This problem might be overcome by the outright assumption that stabilisation efforts are employed anyway, especially, since it can be seen in figure 3 later in the text that the pooling strategy plays a role only with combinations of high θ and high λ, making it more likely that a firm is good after implementation. But, this does not solve a second problem, that prices in this framework are not dictated by a demand curve, but by investor beliefs. Accordingly, if the investment bank decided to employ price stabilisation, it is required to assume that investors can observe these efforts. In some countries, stabilisation efforts can be observed due to mandatory disclosure requirements after the usual 30-day maximum period in which stabilisation efforts are tolerated.[164] Ultimately, the investment bank can send a costly signal by stabilising the price conditioning investors'

[163] This is similar to the method used in Hao (2007) of modelling price stabilisation, although in their model, price stabilisation is undertaken, whenever the price on the secondary market is lower than the IPO offering price. In contrast, here asymmetric information is given and it is preferred to engage into price stabilisation only, if firm fundamentals differ from prices.

[164] In the EU, the possibility of price stabilisation has to be disclosed in the prospectus and if such measures were taken, have to be disclosed after the maximum period in which stabilisation is allowed, as stipulated in regulation (EC) 2273/2003. In the US, underwriters are not necessarily required to disclose stabilisation efforts ex post Aggarwal (2000).

beliefs. This should finally increase the share price to its fundamental value from the perspective of the investment bank $\lambda R_G + (1-\lambda)R_B > V_l(\theta\lambda)$. The investment bank could benefit from this measure by generating higher returns on fees at the SEO, although the issuer is not bound to issuing equity with the same underwriter and the increase of valuation may not outweigh the cost of stabilisation. Finally, the possibility of price stabilisation would introduce a second mode of signalling that would render the model more complex which is not in the focus of this dissertation.[165] However, it can be shown that the investment bank could face higher costs if the firm decided to use a pooling strategy. Limited indication is given that more frequently occurring signalling strategies could also help the investment bank reduce expected price stabilisation costs, which in turn should lower the required value for k_s. The introduction of profit sharing agreements therefore naturally has straight positive effects on the welfare of underwriting investment banks.

How informative are market prices?

Secondary market prices in this model are not fully informative, since they cannot entirely reflect the private information that is held by the owners of the firm. This can be explained by legal and motivational trading restrictions on informed investors who in this case are the owners of the firm. First, the owner of the firm has the most precise information on the firm's future payoffs. Second, if they can trade on this information in the form of legal insider trading, they must comply with rules for legal insider trading, often making it more difficult to retain profits of such trades.[166] Furthermore,

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[165] In this scenario, the price stabilisation would reveal that the firm was initially good. Owners of good firms could then anticipate this effect and in turn would alter the conditions for the existence of a pooling equilibrium. One could argue that therefore it could be more likely for good firms to be subjected to a positive release of information than bad firms, with $\gamma_G > \gamma_B$.

[166] For example, in the U.S., legal trades made by firm insiders need to comply with Sec. 16(b) of the Securities Exchange Act of 1934, making it more or less impossible for insiders to legally profit on trades that were made within six months of each other. If a bad firm insider therefore decides to sell and signal that the stock is overvalued, they would not be able to profit from this action unless the trade was made more than six months after the IPO.

in the setting of a signalling model, the owners always retain shares for the secondary offering. It might not be in their interest to influence prices before that date. For example, firm shares in this model would be overvalued, if in a separating equilibrium, a good firm failed to implement its innovation or in a pooling equilibrium, bad firms or failed good firms were able to profit from the overvalued offering price $p_0 = V_0(\theta\lambda)$. It is not in their interest to send negative signals to the market and decrease the value of their holdings. On the other side, a good firm owner whose firm successfully implemented its innovation will not buy more shares and signal that their firm's shares are undervalued since their initial motivation is to increase the liquidity in their personal assets. Moreover, in both, pooling and separating equilibria, a good firm owner has not received a single dollar from the IPO because their firm's shares would have been underpriced and the firm would have spent the proceeds on financing the implementation of the innovation. Hypothetically, if they were now to buy more shares on the secondary market to signal that the shares are undervalued, they could have spent the same dollar amount on financing the investment before the IPO and avoided signalling cost through underpricing in the first place. A good firm owner's rational approach is therefore to wait until the SEO before selling their remaining shares and benefiting from the release of new information that is more likely to be in their firm's favour. This rationale explains why prices are still not fully incorporating all insider information on the secondary market. However, they are more informative with more frequently occurring signalling strategies as described in proposition 3. If firms signal their good quality more often, because they are being offered discounts on other equity or debt sales, they enhance the information that is incorporated into the stock price.

On Discretionary Share Allocation

It was established previously in the text that one necessary requirement to enable the investment bank and the issuer to benefit from profit sharing agreements is the capability to allocate shares at their discretion. There has been a debate about whether underwriters should be allowed to have this kind of power considering the agency problems that arise within this context. For instance, Liu and Ritter (2010) argued that if discretion in allocating IPO shares is allowed by regulators, rent seeking behaviour will not disappear. The potential for misconduct regarding this discretion was further recognised by Ljungqvist and Wilhelm (2002) who reasoned that despite extreme outcomes like cash kickbacks from investors, issuing firms still have the potential to benefit from discretionary allocations by information revelation.[167]

How can the results of the model introduced here contribute to this debate? If a policy maker introduced more legislation to restrict the allocation of shares, it would effectively remove an underwriter's ability to reduce the cost of signalling by giving discounts. In theory, this implies that granting issuers and underwriters the ability to allocate shares at their discretion may have a positive effect on price informativeness. This is quite relatable to the information revelation theory as presented by Benveniste and Spindt (1989) who describe that allocating investors different quantities of shares at the discretion of the underwriter will ultimately result in granting certain regular investors more profits than others to compensate them for their transparency during the bookbuilding phase. In their model, this is finally improving the aftermarket price informativeness while maximising expected IPO proceeds.[168]

However, this discretion is also an unjust way of distributing profits among rent seeking institutions and investors. The model introduced above suffers from the limitation that the decisions about the issuer's strategy that covers the IPO and SEO underwriting spreads, as well as the ex ante underpricing, are difficult to make simultaneously and requires underwriter and issuer to have rational expectations and complete information about the signalling game. If one assumed that an investment bank is endowed with superior information about the rules of the game in addition to a position of power sourced from its reputation and experience of repeatedly underwriting offerings, it could easily abuse its standing over the issuer and prefer its regular buy-side clients and its

[167] See Ljungqvist and Wilhelm (2002, pp. 192, 196).

[168] See Benveniste and Spindt (1989, p. 352f.).

own desire to maximise profits over its issuer client's liquidity motive. Then of course, allowing for a discretionary allocation of shares, it seems doubtful at least and unethical at worst as the game would also be subject to moral hazard. In a recent study it was estimated that investment banks may be able to capture 45 % of the money left on the table at an IPO.[169] It is not farfetched to assume that the selling shareholders of an issuer do not have complete information about the pricing and allocation methods of investment banks, as for them, the sudden increase in liquidity is first and foremost a positive development. Other researchers have stressed this point in their rationales and named several reasons as to why issuers frequently tolerate leaving money on the table, including:

1. Issuers intend to create 'currency' by having publicly traded shares.[170] In other words, issuers clarify their valuation as a first step of being acquired by another company.
2. Issuers value analyst coverage over wealth losses.[171]
3. Raising capital for investments, diversification of assets and the desire to clarify the company's valuation and have publicly traded stock.[172]

Even though, there are potential agency conflicts at hand, it is argued here that they are not sufficient to bury discretionary share allocations. It can be reasoned that issuers should be capable of making rational decisions about the underwriter they should hire, the allocation schedule from which to choose and to which investors to allocate shares. If it is too costly for an issuer to acquire the information that is required to make these decisions, they can hire an advisor who specialises in information production about IPOs from an issuer perspective. For instance, European IPO firms have increasingly started to hire IPO advisers to help them make these decisions, effectively mitigating

[169] See Goldstein, Irvine and Puckett (2011, p. 1196).

[170] See Brau and Fawcett (2006, p. 406).

[171] See Mola and Loughran (2004, p. 2).

[172] See Ritter (2011, p. 9).

the agency conflicts.[173] Additionally, EU lawmakers have recently identified these issues and introduced new regulation to specifically target underwriting conflicts of interest regarding the issuance of financial instruments in general. For instance, underwriting investment banks are now required to non-publicly record and justify allocations they have made, especially when oversubscription occurred during an IPO.[174] It remains uncertain whether this will effectively stop misconduct by investment bankers in the EU.

Therefore, it is argued here that the discretionary allocation of shares in IPOs helps to achieve a separation shift that in turn can benefit market participants by inducing higher price efficiency. At the same time, it can enable issuers and firm owners to yield higher proceeds. However, it is expected that the benefits of this discretion could easily be consumed by the investment bank, especially if it is assumed to have a higher standing in negotiating the pricing strategy at an IPO.

Issuer Underwriter Relationship

From section 3.2, it can be inferred that issuers are less likely to change underwriters if ex ante underpricing occurred. There are two ways underpricing can come about. First, the conditions (23)-(24) that lead to proposition 1 hold and a separating equilibrium takes places; second, additionally conditions (27)-(29) that lead to proposition 2 and proposition 3 hold and the separating equilibrium dominates the pooling equilibrium intuitively. In the latter case, the underwriter has to offer a discount to the firm to induce signalling and hence underpricing.

[173] See Jenkinson, Jones and Suntheim (2018, p. 9f.).

[174] See Articles 38 – 43 of the regulation EU 2017/565 (EU, 2017) that is supplementing the MiFiD II regulation EU 2017/65.

In figure 3 a number example is constructed, in which separation is always possible, with $w_G = 0.6$, $w_B = 0.4$, $H = 50$, $L = 10$, $C = 5$, $\gamma_G = 0.9$ and $\gamma_B = 0.2$.[175]

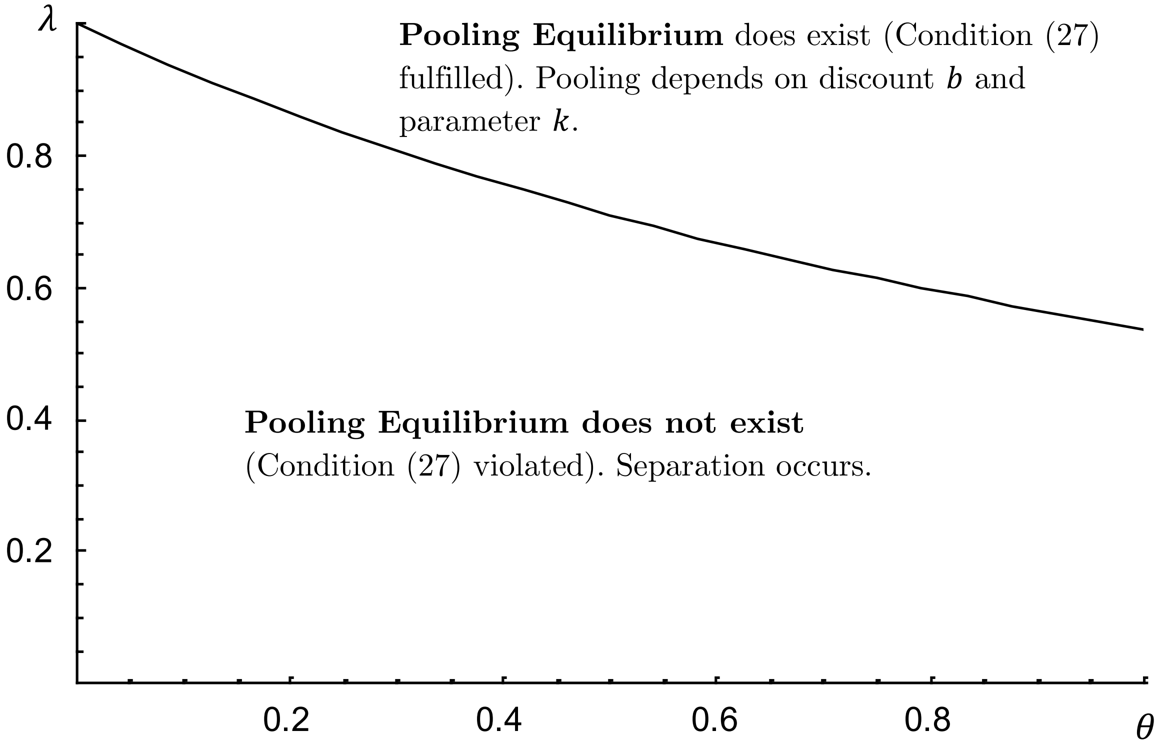

Figure 3: Possible combinations of $\boldsymbol{\theta}$ and $\boldsymbol{\lambda}$ that result in a pooling equilibrium

Even though a good firm owner can always pursue a signalling strategy if pooling is available, they will only do so if it is more profitable for them. That means that the upper right region in figure 3 is showing a combination of θ and λ where a pooling equilibrium will occur only if the underwriter does not have sufficient capacity k to give a discount to the good firm with $k < k_s$. The example showcases that signalling is more likely to be a profitable strategy for firm owners per se, if probabilities θ and λ are sufficiently low. Although this example cannot be generalised, it provides limited evidence that the underwriter will only grant the issuer a discount if θ or λ are sufficiently high, because only then both pooling and separating equilibria exist. If firms

[175] The area of the region in the upper right varies much depending on the parameter constellation. This specific parameter constellation was chosen to highlight a second argument later in the discussion.

are regularly of low quality, or innovations are failing frequently, it is naturally more rewarding for good firms to distinguish themselves from bad firms.

In figure 4, the resulting minimum threshold k_s for the underwriter to offer the firm a discount while making a profit is shown (with $q = 0.07$). The region of higher θ and λ on the upper right in figure 4 where pooling and separating equilibria both exist can be recognised from figure 3.

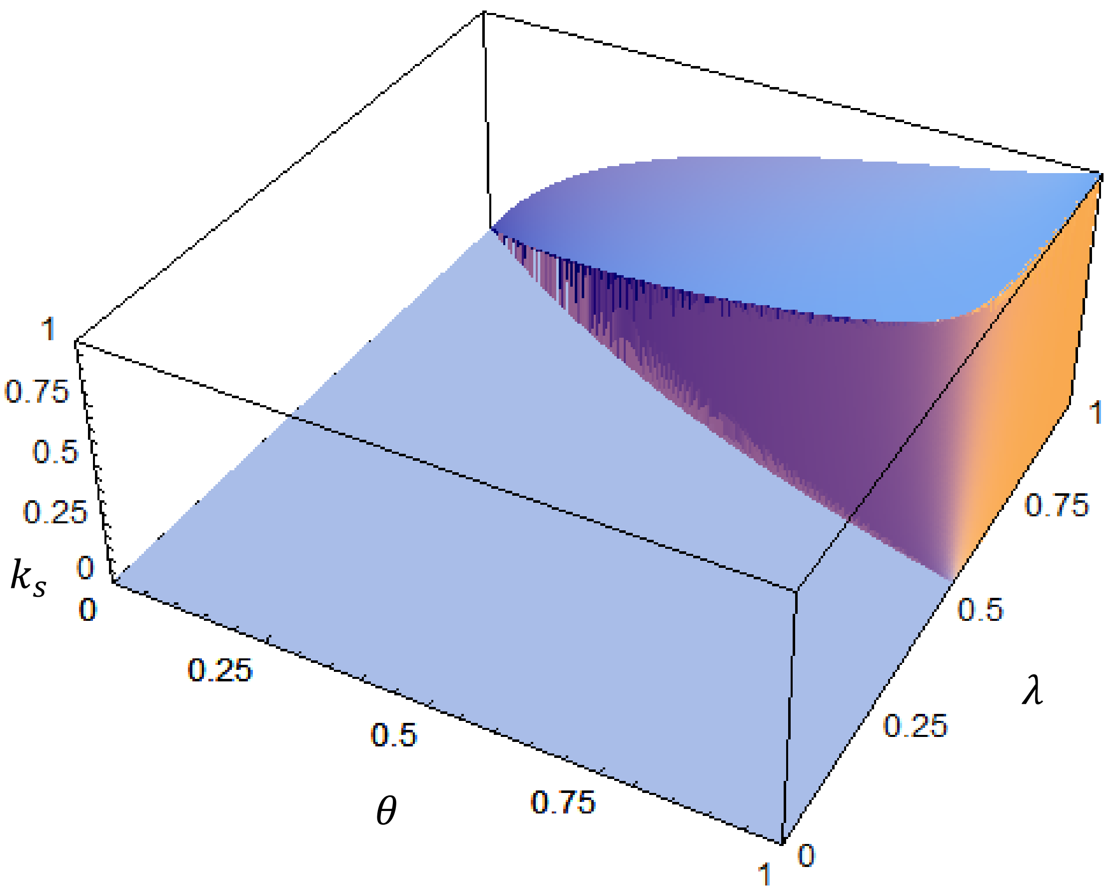

Figure 4: The minimum profit sharing factor k_s dependent on θ and λ.

For this example, condition (29) becomes more restrictive, the higher the probability θ that a firm is good in the market. It is less attractive for a good firm owner to use a signalling strategy when firms are better on average, since this translates to higher average prices when using pooling strategies. Ex ante underpricing will not take place if the firm pursues a pooling strategy. In this scenario, underwriters must offer higher discounts to firm owners on future deals.

Yet, a firm owner that adheres to their commitment to sell equity in an SEO will therefore get better conditions when remaining with the same underwriter if $\theta\lambda$ is sufficiently high. This is an implication that could be tested in future research. So far, there is work that implies that firms do tend to remain with the same underwriter. A study of Krigman, Shaw and Womack (2001) found that between 1993 and 1995, there were 2,049 IPOs out of which 578 (28 %) conducted an IPO, out of which only 180 (31 %) switched underwriter. That means that a majority of 69 % of firms that had an SEO within three years of their IPO remained with their lead underwriter.[176] James (1993) found that around 72 % of firms who conducted an SEO did not switch lead underwriter. In the same study, it was established that underwriters that conducted more than one equity offering for the same issuer, offered around 0.7 % lower IPO spreads.[177] This finding suggests that underwriters take into consideration future offerings of equity while dealing with IPOs. It supports the argument that underwriters prefer a long-term relationship with their clients. The example showcased in figure 4 would predict that discounts are more likely if λ is high and θ is low, because then the threshold for k_s is sufficiently low. However, this is not a general implication that can be drawn for other parameter constellations.

Cost of Signalling and Wealth Losses at the SEO

The discussion from section 2.3 is briefly addressed here. How does the result of the new model change the criticism brought forward in section 2.3?

It was previously stated that a signalling strategy comes at an excessive cost when there are alternative, cheaper signals available to the firm.[178] The newly developed

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[176] See Krigman, Shaw and Womack (2001, S. 252f.). They used IPO data ranging from 1993-1995, including SEOs that were held up to three years after the IPO.

[177] See James (1993, p. 1874). It is noteworthy that the clustering of fees at 7 % for IPOs has been found to occur mostly from the 1990s (Chen and Ritter, 2000, p. 1105), whereas the study of James (1993) established the lower fees for the period of 1980-1983.

[178] See Ritter (2011, p. 9), see also Daniel and Titman (1995, p. 18) and Jenkinson and Ljungqvist (2001, p. 78ff.).

model above suffers the same limitation. Furthermore, the absolute cost of signalling is still not evaluated by the good firm owner. Instead, the difference to the next best solution determines the optimality of the signalling strategy. Having presented proposition 4, it can be concluded that the cost of signalling can be lowered, if an underwriter passes on the profits sourced from quid pro quo agreements in the form of lower underwriting spreads. This means the entire money left on the table does not have to be written off by the firm. Some of it is returned to it by discounts on future offerings. Despite the firm receiving back some of the total amount of underpricing, the cost of signalling and the restricted space of signals remain a limitation of this model. However, the baseline narrative of profit sharing by underpricing should not be affected by this whenever an investment bank can find another reason to ex ante underprice an IPO, or to artificially raise the demand on the secondary market, as was demonstrated with the laddering and the analyst lust hypothesis.[179]

Furthermore, it can be mentioned that limiting the space of possible strategies to signalling by underpricing is similarly restrictive to assuming that underpricing does not come with other benefits attached as argued on page 84f. In this context, an additional benefit of signalling by underpricing could exist when anticipating a momentum effect as proposed by Hao (2007) or Aggarwal, Krigman and Womack (2002). The information momentum effect is used to explain stock price increases of IPO stocks after positive initial returns have been observed by investors, leading to inflated share prices on the secondary market. Employing this observation in the model above could be used to argue that an intrinsically underpriced IPO will lead to even higher or even more inflated share prices at the SEO.[180] However, in the context of this model, investors are assumed to have rational expectations effectively limiting the extent of this very argument.

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179 See Cliff and Denis (2004) and (Hao, 2007) respectively.

180 Furthermore, Jaggia and Thosar (2004) showed that inflated secondary market share prices during the internet bubble caused long-run underperformance of IPOs.

The second point raised in section 2.3 considers the issue that good firm owners are still selling their shares below their estimate of the shares' value. With the introduction of profit sharing agreements, the argument that successful, good firm owners forego some of their assets, can be weakened but not fully resolved. It was assumed on page 54f. that good firm owners who find themselves in this predicament sell their shares below their own estimate of their share's valuation for liquidity reasons. If firm owners followed a pure rational expectations approach instead, one can conclude that they would rather keep their shares instead of conducting an SEO. This on the other hand would render the signalling rationale pointless and in turn reduce the possible IPO strategies to pooling only. However, one can assume that owners are willing to give up some of their assets to enjoy a liquidity boost that is first realised at the SEO.

One example of forgoing wealth in the new model is a good firm owner that used a signalling strategy, succeeded to implement their innovation and whose firm was the subject of a positive release of information. They will be confronted with the choice to adhere to the plan and conduct an SEO at $t = 2$ or keep their fraction of the firm and receive the risky, but higher expected payoff at $t = 3$. We can formulate this particular scenario in an equation and call the difference Δ. But first, one can remember that the valuation of a firm that was subject to a positive release of information $y = h$ is perceived by investors to be worth V_h, with

$$V_h(\lambda) = r_h(\lambda)R_G + \left(1 - r_h(\lambda)\right)R_B$$

and r_h being the investor belief that a firm is good after observing $y = h$ and R_G and R_B being the expected payoffs of a good or bad firm respectively. Thus, we can write the difference for the good firm owner with their remaining fraction of the firm $1 - \alpha_s$ as

$$\mathit{\Delta} = (1 - \alpha_s)(1 - b)V_h(\lambda) - (1 - \alpha_s)R_G.$$

The first term on the right-hand side is what the owner expects to receive in an SEO. Investors have Bayesian beliefs about the quality of the firm as they are asymmetrically informed. The second term on the right-hand side of the equation is what the owner expects to receive by remaining invested. It is straightforward to see that by keeping their shares, the owner saves not only the underwriting fee, but also the loss that comes from the lower valuation of the investors that still believe there is a chance that their firm is bad and are therefore only willing to pay V_h for the shares. It follows that $\Delta < 0$ for $b > 0$. However, it is not obvious to see that b can indeed be negative and $1 - b > 1$. There is nothing that stops the underwriter from offering the firm owner a negative SEO fee as compensation for underpricing if the underwriter yields higher profits doing so.

Using the same example as shown in figure 3 and figure 4, we can set $\theta = 0.6$ and $\lambda = 0.7$ which results in both separating and pooling equilibria to exist. In this scenario, an underwriter must offer a fee of $b = -2.54\,\%$ of the total SEO proceeds in order to convince the good firm owner to signal at $t = 0$. Offering a negative fee will further result in an expected return for the underwriter that is approximately 47 % (3.11) higher than the expected return resulting if the good firm owner used a pooling strategy (2.11). At the same time, good firm owners that find themselves in the situation described above will receive higher total proceeds conducting the SEO, with $\Delta = 0.106 > 0$. An arrangement as such, including a negative fee $b < 0$, comes with the limitation that it may not be possible to implement with direct fees in practice because direct fees are observable to the public. An investment bank could instead find other means of payment. The practice known as spinning was indeed a way investment banks used to pay off firm executives to condone the underpricing of their own IPOs during the Internet Bubble.[181]

However, since this is a rather theoretical argument, it is concluded here that the introduction of profit sharing agreements and SEO discounts cannot fully resolve the issue of SEO wealth losses in general. In theory, it could resolve the issue if the investment bank offered the owner a negative SEO fee that outweighed the losses

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[181] See Liu and Ritter (2010), see also Loughran and Ritter (2004, pp. 25-27).

through lower investor valuations. The possibility of negative SEO fees could also help explain why issuers tend to remain with the same underwriter after their IPO.[182]

3.4 Future Research

Researchers today are busy in determining to what extent profit sharing agreements influence the process of issuing equity. They are regularly confronted with the problem that the data necessary to link IPO allocations to investment bank commission revenues is proprietary. It was already established that there is a significant relationship between IPO allocations and investor revenue for the investment bank. There are several points on which one can elaborate that may enhance future research on this topic based on the findings of this dissertation.

First, further investigation is needed to determine if underpricing at the IPO entails lower SEO underwriting fees with the same underwriter in future offerings. This could indicate that issuers tolerate intrinsic underpricing for lower underwriting fees or potentially other services by the investment bank. Furthermore, it can be analysed in future research to what degree issuers profit from underpricing, and whether it is associated by benefits other than potentially lower cost in subsequent offerings. One hypothesis that could be tested in this context is to see if M&A deals that succeeded IPOs regularly have better outcomes for selling shareholders of underpriced IPOs.

Moreover, it is predicted that investment banks that regularly underwrite underpriced IPOs will retain their issuing clients for subsequent offerings and other investment banking services more frequently. This again showcases the argument that the cost of underpricing must be remunerated with other benefits that in the model presented in this dissertation manifest in lower fees on subsequent deals. Although, only SEOs were modelled as such deals, it can be argued that this should include any type of service that an investment bank offers to an issuer.

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[182] See Krigman, Shaw and Womack (2001).

Next, a few suggestions can be made to help further the empirical research done on the IPO signalling hypothesis. Future studies can concentrate on firms that require financing, i.e. debt and equity, on a more regular basis. Especially for these firms, a signalling strategy would be beneficial.[183] Also, to represent the two contrasting assumptions made within information revelation and signalling models, it is noteworthy that it can be essential to separate firms into samples of issuer-underwriters that are likely to have superior or inferior information compared to investors. For example, it was described in a recent theory that private information about firm prospects can be distinguished in inside information considering market specific factors and firm specific factors, which are respectively held by investors and firm managers.[184] It is suggested here that it could be helpful to use a similar approach to calculate a proxy and determine the degree of asymmetric information that exists between the issuer-underwriter and investors. The model of Allen and Faulhaber (1989) representative for the signalling hypothesis and the model of Benveniste and Spindt (1989), representative for the information revelation hypothesis, are not mutually exclusive theoretically, if one was to strictly apply the assumptions about who is holding the more superior information. This is especially important as the evidence provided by researchers so far has been mixed for both hypotheses.

3.5 Conclusion

Profit sharing agreements between underwriting investment banks and their regular buy-side client investors require a lead underwriter or bookrunner of an IPO to allocate ex ante underpriced shares in return for increased trading commissions directed to the brokerage arm of the same investment bank. In this dissertation, it was demonstrated that modelling profit sharing agreements within a signalling context gives underwriters the ability to pass on increased profits to issuers and compensate them for tolerating

[183] See Francis et al. (2010, p. 82).

[184] See Bade and Hirth (2016).

ex ante underpricing. In doing so, underwriters regularly shift the dominance from a pooling to a separating equilibrium conditional on their ability to sufficiently collect profits from buy-side client investors. This result is contributing to the literature by mitigating previous limitations that were inherently attached to signalling theoretical frameworks, like excessive underpricing and a too passive role of the underwriting investment bank. Furthermore, it was argued that more frequently occurring separating equilibria enable more informative prices on the secondary market. This positive externality for uninformed investors can be understood as an argument to continue allowing discretionary allocations of shares at IPOs. However, conflicts of interest between underwriting investment banks and issuing firms may persist when the market power of underwriting investment banks is taken into consideration. A worst-case scenario in this sense is rent-seeking behaviour of investors and underwriters to the detriment of issuing firms and their investment projects. It is therefore deemed a positive development that European IPO firms increasingly hire IPO advisers to mitigate agency conflicts and represent their interests.

References

Abrahamson, M., Jenkinson, T., & Jones, H. (2011). Why Don't U.S. Issuers Demand European Fees for IPOs? *The Journal of Finance, 66*(6), 2055-2082.

Aggarwal, R. (2000). Stabilization Activities by Underwriters after Initial Public Offerings. *The Journal of Finance, 55*(3), 1075-1103.

Aggarwal, R. K., Krigman, L., & Womack, K. L. (2002). Strategic IPO underpricing, information momentum, and lockup expiration selling. *Journal of Financial Economics, 66*, 105-137.

Allen, F., & Faulhaber, G. R. (1989). Signaling by Underpricing in the IPO Market. *Journal of Financial Economics, 23*(2), 303-323.

Alvarez, S., & Gonzalez, V. M. (2005). Signalling and the Long-run Performance of Spanish Initial Public Offerings (IPOs). *Journal of Business Finance & Accounting, 32*(1-2), 325-350.

Aussenegg, W., Pichler, P., & Stomper, A. (2006). IPO Pricing with Bookbuilding and a When-Issued Market. *Journal of Financial and Quantitative Analysis, 41*(4), 829-862.

Bade, M., & Hirth, H. (2016). Liquidity Cost vs. Real Investment Efficiency. *Journal of Financial Markets, 28*, 70-90.

Baur, J., & Vincenti, A. J. (2008). Festpreise - Bookbuilding - Auktionen - Emissionsverfahren und das Underpricing von IPO. In F. Keuper, A. Vocelka, & M. Häfner (Eds.), *Die moderne finanzfunktion* (pp. 350-381). Wiesbaden: Gabler Verlag.

Bayless, M. E., & Diltz, D. J. (1994). Securities Offerings and Capital Structure Theory. *Journal of Business Finance and Accounting, 21*(1), 77-91.

Beatty, R. P., & Ritter, J. R. (1986). Investment Banking, Reputation, and the Underpricing of Initial Public Offerings. *Journal of Financial Economics, 15*(1-2), 213-232.

Benveniste, L. M., & Busaba, W. Y. (1997). Bookbuilding vs. Fixed Price: An Analysis of Competing Strategies for Marketing IPOs. *The Journal of Financial and Quantitative Analysis, 32*(4), 383-403.

Benveniste, L. M., & Spindt, P. A. (1989). How Investment Bankers Determine the Offer Price and Allocation of New Issues. *Journal of Financial Economics, 2*(24), 343-361.

Brau, J. C., & Fawcett, S. E. (2006). Initial Public Offerings: An Analysis of Theory and Practice. *The Journal of Finance*, 399-436.

Chen, H.-C., & Ritter, J. R. (2000). The Seven Percent Solution. *The Journal of Finance, 55*(3), 1105-1131.

Cliff, M. T., & Denis, D. J. (2004). Do Initial Public Offering Firms Purchase Analyst Coverage with Underpricing? *The Journal of Finance, 59*(6), 2871-2901.

Conrad, J. S., Johnsen, K. M., & Wahal, S. (2001). Institutional Trading and Soft Dollars. *The Journal of Finance, 56*(1), 397-416.

Cornanic, A., & Novak, J. (2013). Signaling by underpricing the initial public offerings of primary listings in an emerging market. *IES Working Paper.*

Cornelli, F., & Goldreich, D. (2001). Bookbuilding and Strategic Allocation. *The Journal of Finance*, 2337-2369.

Corwin, S. A., & Schultz, P. (2005). The Role of IPO Underwriting Syndicates: Pricing, Information Production, and Underwriter Competition. *The Journal of Finance, 60*(1), 443-486.

Daniel, K., & Titman, S. (1995). Financing Investment Under Asymmetric Information. *Handbooks in operations research and management science, 9*, 721-766.

Degeorge, F., Derrien, F., & Womack, K. L. (2010). Auctioned IPOs: The US evidence. *Journal of Financial Economics, 98*(2), 177-194.

Deutsche Boerse AG. (2000). *Principles for the Allotment of Share Issues to Private Investors.* Frankfurt am Main: Exchange Expert Commission at the Federak Ministry of Finance.

EC. (2003). No 2273/2003. Official Journal of the European Union.

Engelen, P.-J., & Van Essen, M. (2010). Underpricing of IPOs: Firm-, issue- and country-specific characteristics. *Journal of Banking & Finance , 34*(8), 1958-1969.

EU. (2017). Commission Delegated Regulation (EU) 2017/565. Official Journal of the European Union.

Facebook, Inc. (2012). *Amendment No. 8 to Form S-1.* Retrieved November 11, 2017, from www.sec.gov/Archives/edgar/data/1326801/000119312512235588/d287954ds1a.htm#toc287954_4

Facebook, Inc. (2013). *Form 424b5.* Retrieved November 08, 2017, from www.sec.gov/Archives/edgar/data/1326801/000119312513482951/d646653d424b5.htm

Field, L. C., & Hanka, G. (2001). The expiration of IPO Share Lockups. *The Journal of Finance, LVI*(2), 471-500.

FINRA. (2003). *Restrictions on the Purchase and Sale of Initial Equity Public Offerings.* Retrieved December 12, 2017, from http://finra.complinet.com/en/display/display_viewall.html?rbid=2403&element_id=4894&record_id=11709&filtered_tag=

Fjesme, S. L., Michaely, R., & Norli, Ø. (2011). Using Brokerage Commissions to Secure IPO Allocations. *Centre for Corporate Governance Research.*

Francis, B. B., Hasan, I., Lothian, J. R., & Sun, X. (2010). The Signaling Hypothesis Revisited: Evidence from Foreign IPOs. *The Journal of Financial and Quantitative Analysis, 45*(1), 81-106.

Fulghieri, P. & Spiegel, M., 1993. A theory of the distribubtion of underpriced initial public offers by investme

nt banks. *Journal of Economics & Management Strategy, 2*(4), 509-530.

Garfinkel, J. A. (1993). IPO Underpricing, Insider Selling and Subsequent Equity Offerings: Is Underpricing a Signal of Quality? *Financial Management, 22*(1), 74-83.

Gaspar, J.-M., Massa, M., & Matos, P. (2006). Favoritism in Mutual Fund Families? Evidence on Strategic Cross-Fund Subsidization. *The Journal of Finance, 61*(1), 73-104.

Goldstein, M. A., Irvine, P., & Puckett, A. (2011). Purchasing IPOs with Commissions. *The Journal of Financial and Quantitative Analysis, 46*(5), 1193-1225.

Grinblatt, M., & Hwang, C. Y. (1989). Signalling and the Pricing of New Issues. *The Journal of Finance, 44*(2), 393-420.

Hanley, K. W. (1993). The Underpricing of Initial Public Offerings and the Partial Adjustment Phenomenon. *Journal of Financial Economics, 32*(2), 231-250.

Hansen, R. S. (2001). Do investment banks compete in IPOs?: the advent of the "7% plus contract". *Journal of Financial Economics, 59*, 313-346.

Hao, G. Q. (2007). Laddering in initial public offerings. *Journal of Financial Economics, 85*, 102-122.

Horan, S. M., & Johnsen, D. (2008). Can third-party payments benefit the principal? The case of soft dollar brokerage. *International Review of Law and Economics, 28*(1), 56-77.

Ibbotson, R. G. (1975). Price Performance of Common Stock New Issues. *Journal of Financial Economics, 2*, 235-272.

Jaggia, S., & Thosar, S. (2004). The medium-term aftermarket in high-tech IPOs: Patterns and implications. *Journal of Banking & Finance, 28*(5), 931-950.

Jain, B. A., & Kini, O. (1994). The Post-Issue Operating Performance of IPO Firms. *The Journal of Finance*, 1699-1726.

James, C. (1993). Relationship-Specific Assets and the Pricing of Underwriter Services. *The Journal of Finance, 47*(5), 1865-1885.

Jegadeesh, N., Weinstein, M., & Welch, I. (1993). An empirical investigation of IPO returns and subsequent equity offerings. *Journal of Financial Economics, 34*(2), 153-175.

Jenkinson, T., & Jones, H. (2004). Bids and Allocations in European IPO Bookbuilding. *The Journal of Finance, 59*(5), 2309-2338.

Jenkinson, T., & Jones, H. (2009). IPO Pricing and Allocation: A Survey of the Views of Institutional Investors. *The Review of Financial Studies, 22*(4), 1477-1504.

Jenkinson, T., & Ljungqvist, A. (2001). *Going public: The theory and evidence on how companies raise equity finance* (2nd ed.). New York: Oxford University Press.

Jenkinson, T., Jones, H., & Suntheim, F. (2018). Quid Pro Quo? What Factors Influence IPO Allocations to Investors? *The Journal of Finance.* DOI: 10.1111/jofi.12703.

Jenkinson, T., Morrison, A. D., & Wilhelm, W. J. (2006). Why are European IPOs so rarely priced outside the indicative price range? *Journal of Financial Economics, 80*(1), 185-209.

Kaneko, T., & Pettway, R. H. (2003). Auctions versus book building of Japanese IPOs. *Pacific-Basin Finance Journal, 11*(4), 439-462.

Katti, S., & Phani, B. (2016). Underpricing of Initial Public Offerings: A Literature Review. *Universal Journal of Accounting and Finance, 4*(2), 35-52.

Krigman, L., Shaw, W. H., & Womack, K. L. (2001). Why do firms switch underwriters? *Journal of Financial Economics*, 245-284.

Kutsuna, K., & Smith, R. (2004). Why Does Book Building Drive out Auction Methods of IPO Issuance? Evidence from Japan. *The Review of Financial Studies, 17*(4), 1129-1166.

Leland, H. E., & Pyle, D. H. (1977). Informational Asymmetries, Financial Structure, and Financial Intermediation. *The Journal of Finance, 32*(2), 371-387.

Levin, D., & Smith, J. L. (1994). Equilibrium in Auctions with Entry. *The American Economic Review, 84*(3), 585-599.

Liu, X., & Ritter, J. R. (2010). The Economic Consequences of IPO Spinning. *The Review of Financial Studies, 23*(5), 2024-2059.

Liu, X., & Ritter, J. R. (2011). Local underwriter oligopolies and IPO underpricing. *Journal of Financial Economics.*

Ljungqvist, A. P., & Wilhelm, W. W. (2002). IPO allocations: discriminatory or discretionary? *Journal of Financial Economics, 65*(2), 167-201.

Ljungqvist, A. P., Jenkinson, T., & Wilhelm, W. J. (2003). Global Integration in Primary Equity Markets: The Role of U.S. Banks and U.S. Investors. *The Review of Financial Studies, 16*(1), 63-99.

Loughran, T., & Ritter, J. R. (2002). Why don't issuers get upset about leaving money on the table in IPOs? *The Review of Financial Studies, 15*(2), 413-444.

Loughran, T., & Ritter, J. R. (2004). Why has IPO underpricing changed over time? *Financial Management*, 5-37.

Michaely, R., & Shaw, W. H. (1994). The Pricing of Initial Public Offerings: Tests of Adverse-Selection and Signaling Theories. *The Review of Financial Studies, 7*(2), 279–319.

Miller, E. M. (1977). Risk, Uncertainty, and Divergence of Opinion. *The Journal of Finance, 32*(4), 1151-1168.

Mola, S., & Loughran, T. (2004). Discounting and Clustering in Seasoned Equity Offering Prices. *The Journal of Financial and Quantitative Analysis, 39*(1), 1-23.

Molho, I. (1997). *The Economics of Information. Lying and Cheating in Markets and Organizations.* Oxford: Blackwell Publishers.

Myers, S. (1984). The Capital Structur Puzzle. *The journal of Finance, 39*(3), 574-592.

Nanda, V., Wang, J. Z., & Zheng, L. (2004). Family Values and the Star Phenomenon: Strategies of Mutual Fund Families. *The Review of Financial Studies, 17*(3), 667-698.

NASD. (2003). *NASD Charges Robertson Stephens with Sharing in Millions of Dollars of Customers' Profits in Exchange for "Hot" IPO Shares.* Retrieved December 12, 2017, from http://www.finra.org/newsroom/2003/nasd-charges-robertson-stephens-sharing-millions-dollars-customers-profits-exchange

NASD. (2004). *Report of the Mutual Fund Task Force Soft Dollars and Portfolio Transaction Costs.* Retrieved December 13, 2017, from http://www.finra.org/sites/default/files/Industry/p012356.pdf

Nielssona, U., & Wójcik, D. (2016). Proximity and IPO underpricing. *Journal of Corporate Finance, 38*, 92-105.

Perera, W., & Kulendran, N. (2016). New evidence of short-run underpricing in Australian IPOs. *Investment Management and Financial Innovations, 13*(2), 99-108.

Pollock, T. G., Rindova, V. P., & Maggitti, P. G. (2008). Market Watch: Information and Availability Cascades among the Media and Investors in the U.S. IPO Market. *The Academy of Management Journal*, 335-358.

Reuter, J. (2006). Are IPO Allocations for Sale? Evidence from Mutual Funds. *The Journal of Finance, 61*(5), 2289-2324.

Ritter, J. (1984). The "Hot Issue" Market of 1980. *The Journal of Business, 57*(2), 215-240.

Ritter, J. R. (2003). Differences between European and American IPO markets. *European financial management, 9*(4), 421-434.

Ritter, J. R. (2011). Equilibrium in the IPO market. *Annual Review of Financial Economics, 3*, 347-374.

Ritter, J. R. (2013). Reenergizing the IPO Market. In M. N. Baily, R. J. Herring, & Y. Seki, *Financial Restructuring to Sustain Recovery* (pp. 123-146). Washington, DC: Brookings Institution Press.

Ritter, J. R., & Welch, I. (2002). A Review of IPO Activity, Pricing, and Allocations. *The Journal of Finance, 57*(4), 1795-1828.

Ritter, J. R., & Zhang, D. (2007). Affiliated mutual funds and the allocation of initial public offerings. *Journal of Financial Economics, 86*(2), 337-368.

Rock, K. (1986). Why New Issues are Underpriced. *Journal of Financial Economics, 15*, 187-212.

SEC. (2002). *Press Release 2002-127.* Retrieved December 8, 2017, from https://www.sec.gov/news/press/2002-127.htm

SEC. (2003a). *Press Release 2003-54.* Retrieved December 12, 2017, from https://www.sec.gov/news/press/2003-54.htm

SEC. (2003b). *Litigation Release No. 18385.* Retrieved December 8, 2017, from http://www.sec.gov/litigation/litreleases/lr18385.htm

SEC. (2017). *Press Release 2017-234.* Retrieved from https://www.sec.gov/news/press-release/2017-234

Sherman, A. E. (2000). IPOs and Long-Term Relationships: An Advantage of Book Building. *The Review of Financial Studies, 13*(3), 697-714.

Sherman, A. E. (2005). Global trends in IPO methods: Book building versus auctions with endogenous entry. *Journal of Financial Economics*, 615-649.

van den Assem, M. J., van der Sar, N. L., & Versijp, P. (2017). CEOs and CFOs on IPOs: The Process and Success of Going Public. *De Economist, 165*(4), 381-410.

Welch, I. (1989). Seasoned Offerings, Imitation Costs, and the Underpricing of Initial Public Offerings. *The Journal of Finance, 44*(2), 421-449.

Appendix A

In this section, the mathematical proofs of the model of Allen and Faulhaber (1989) are presented in more detail.

Using Bayes' rule to derive conditional investor expectations

Bayes' general rule can be stated as $P(X|Y) = \frac{P(Y|X)P(X)}{P(Y)}$, with $X \in \{G, B\}, Y \in \{H, L\}$. The initial probability that a firm is good from an investor's perspective is $P(G) = r_0$. The probability that a good firm pays a high dividend H is $P(H|G) = \pi_G$. Finally, the probability that a high dividend is paid in general is $P(H) = r_0\pi_G + (1 - r_0)\pi_B$. Now, $r_H(r_0)$ can be stated as the probability that a good firm pays a high dividend times the probability that a good firm is at hand over the probability that a high dividend is paid by either firm:

$$P(G, h) = r_H(r_0) = \frac{\pi_G r_0}{\pi_G r_0 + \pi_B(1 - r_0)}$$

Appendix B

In this section, the mathematical proofs of the model described in chapter 3 are presented in more detail.

Deriving the conditional probabilities r_h and r_l

Taking Bayes' rule as $P(X|Y) = \frac{P(Y|X)P(X)}{P(Y)}$, and $X \in \{G, B\}, Y \in \{h, l\}$ we have:

The initial probability that a firm is good from investor perspective is $P(G) = r_0$. The probability that a good firm is the subject of a positive release of information is

$P(h|G) = \gamma_G$. Finally, the probability that favourable information about either firm is released is $P(h) = r_0\gamma_G + (1 - r_0)\gamma_B$. Now, (12) can be stated as

$$P(G|h) = r_h(r_0) = \frac{P(h|G)P(G)}{P(h)} = \frac{\gamma_G r_0}{r_0\gamma_G + (1 - r_0)\gamma_B}.$$

Proof of the existence of the separating equilibrium

This paragraph constitutes the proof of the existence of a separating equilibrium from section 3.2. Remember, the following conditions are necessary to hold for its existence:

$$\alpha(1 - q)p_0 \geq C \tag{19}$$

$$p_0 \leq V_0(r_0) \tag{20}$$

$$W_G^0(p_s, \lambda) \geq W_G^0(V_0(0), 0) \tag{21}$$

$$W_B^0(p_s, \lambda) \leq W_B^0(V_0(0), 0) \tag{22}$$

The minimum capital requirement from condition (19) is required in all IPO signalling models because otherwise, separation can be induced by underpricing an infinitely small fraction of the firm $\alpha \to 0$ at the IPO in order to condition investor beliefs.[185] An infinitely small fraction of the firm in turn does only cause infinitely small costs for the issuing firm.

The objective functions of good and bad firm owners are:[186]

$$W_B^0(p_0, r_0) = \alpha(1 - q)p_0 + (1 - \alpha)(1 - q)W_B(r_0) - C$$

$$W_G^0(p_0, r_0) = \alpha(1 - q)p_0 + (1 - \alpha)(1 - b)\big(\lambda W_G(r_0) + (1 - \lambda)W_B(r_0)\big) - C$$

An equation used on the following pages is$V_0(0) = W_B(0)$:

[185] See Jenkinson and Ljungqvist (2001, p. 80f.).

[186] In the objective function of the good firm owner it can be anticipated that they will receive a discount on their SEO with $b < q$ which is introduced shortly before proposition 3. However, this is not necessary since it is later shown this discount is not always given. The ultimate results do not change when the discount is omitted as can be seen later in the proof. Intuitively, it is assumed that the underwriter does not grant a bad firm the discount b, meaning that bad firms pay q on both the IPO and the SEO proceeds.

$$V_0(0) = \left(\gamma_G \cdot 0 + \gamma_B(1-0)\right) \cdot V_h + \left((1-\gamma_G) \cdot 0 + (1-\gamma_B)(1-0)\right) \cdot V_l$$

$$= \gamma_B \cdot V_h + (1-\gamma_B) \cdot V_l = W_B(0)$$

A good firm trying to send a signal knows that to do so it must underprice its IPO to be of observably good quality. The price in a separating equilibrium p_s must inevitably be lower than a known bad firm's value, with $p_s < V_0(0)$. It must be low enough that a bad firm imitating a good firm will incur signalling costs that cannot outweigh its benefits of achieving a higher SEO price p_2. Moreover, a good firm keeps its fraction sold at the IPO α_s as low as possible to sell more shares at the expectedly higher price p_2. Thus, (19) is binding:

$$\alpha_s(1-q)p_s = C$$

Finally, we insert the last equation into condition (22), which is binding, too, because the good firm underprices as little as possible:

$$\alpha_s(1-q)p_s + (1-\alpha_s)(1-q)W_B(\lambda) - C = \alpha(1-q)W_B(0) + (1-\alpha)(1-q)W_B(0) - C$$

Also, the bad firm which is recognized as bad is not bound to sell as little as possible at the IPO. Furthermore, $V_0(0) = W_B(0)$ is used now:

$$(1-\alpha_s)(1-q)W_B(\lambda) = (1-q)V_0(0) - C$$

$$\Longrightarrow \quad \alpha_s = 1 - \frac{V_0(0) - C/(1-q)}{W_B(\lambda)}$$

The introduction of the underwriting fees q and b changes the rationale of the original work of Allen and Faulhaber (1989), especially since proposition 3 handles a case where a good firm receives a discount with the underwriting fee $b < q$. A good firm determines how much it must sell α_s by anticipating what an imitating bad firm would have to do. Only then, the signal becomes credible.

The last step is to insert the resulting α_s into the profit function of the original owner (21) and prove that by signalling, they can increase their expected profit. When a good firm gives up on signalling, it is perceived to be bad from the investors' perspective. Condition (20) requires it to price its IPO at a maximum of $p_0 = V_0(0)$. This can be inserted into (19) giving us the minimum fraction, it must sell $\alpha = \frac{C}{(1-q)V_0(0)}$ when not signalling. Once again, it is assumed that the good firm does not get the discount on the SEO fee when it chooses not to signal. It can potentially receive the discount when signalling which is why b is considered here even though it is shown in the proof of proposition 3 that receiving b is dependent on the value of the exogenous parameter k. In order to remain comprehensive, both alternatives will be addressed. Finally, one can use this and initially continue using b and further simplifying condition (21):

$$(1-\alpha_s)(1-b)\big(\lambda W_G(\lambda)+(1-\lambda)W_B(\lambda)\big)$$
$$\geq \left(1-\frac{C}{(1-q)V_0(0)}\right)(1-q)\big(\lambda W_G(0)+(1-\lambda)W_B(0)\big)$$

$$\left(\frac{V_0(0)-C/(1-q)}{W_B(\lambda)}\right)(1-b)\big(\lambda W_G(\lambda)+(1-\lambda)W_B(\lambda)\big)$$
$$\geq \left(\frac{V_0(0)-C/(1-q)}{V_0(0)}\right)(1-q)\big(\lambda W_G(0)+(1-\lambda)W_B(0)\big)$$

With $V_0(0)=W_B(0)$ and $1-b>1-q$, the final sufficient condition can be computed:

$$\frac{W_G(\lambda)}{W_B(\lambda)} \geq \frac{W_G(0)}{W_B(0)} \qquad q.e.d.$$

For the sake of completeness, if the inequality was not simplified with $1-b>1-q$, the result would become:

$$\frac{W_G(\lambda)}{W_B(\lambda)} \geq \underbrace{\left(\frac{1-q}{1-b}\right)}_{<1}\left(\frac{W_G(0)}{W_B(0)}+\underbrace{\frac{1-\lambda}{\lambda}\cdot\frac{(b-q)}{(1-q)}}_{<0}\right)$$

However, this does not change the main outcome that a separating equilibrium exists. On the contrary, it is straightforward to see that it widens the domain of parameters where a separating equilibrium exists, i.e. the first term on the right-hand side of the inequality is <1 and the second term is smaller than its counterpart in the equation above. Accordingly, the condition is weaker than its counterpart above. If the discount was omitted to start with, meaning that the good firm paid q on both the IPO and SEO (or $q=b$), the inequality would intuitively return to its original version from proposition 1. The original version is used here because the discount is not always given, but rather dependent on k.

Proof of the existence of the pooling equilibrium

The proof for the existence of a pooling equilibrium is similarly structured. In a pooling equilibrium, good and bad firms both price their IPOs at $p_p = V_0(\theta\lambda)$. Investors do not receive any information from firms and firms do not receive discounts on their IPO or SEO underwriting fees. A good firm using a pooling strategy can expect a more likely release of favourable information before its SEO, meaning it will again sell as little as possible at $t = 0$, resulting in (19) to be binding, thus $\alpha_p = \frac{C}{(1-q)V_0(\theta\lambda)}$. A bad firm must copy the strategy of a good firm and sell an equivalent fraction α_p of its firm at $t = 0$, otherwise it will be recognised as bad. It can now be demonstrated under which conditions the pooling equilibrium exists. First of all, it was argued above that the pooling strategy (α_p, p_p) must yield higher proceeds for both types of firm than any other strategy meaning that (25) and (26) hold:

$$W_G^0(p_0, r_0 = \lambda) \leq W_G^0(V_0(r_0 = \theta\lambda), r_0 = \theta\lambda) \qquad (25)$$

$$W_B^0(p_0, r_0 = \lambda) \leq W_B^0(V_0(r_0 = \theta\lambda), r_0 = \theta\lambda) \qquad (26)$$

Inserting the values, we have:

$$W_G^0\big(p_p, r_0 = \theta\lambda\big) = \alpha_p(1-q)p_p + \big(1-\alpha_p\big)(1-q)\big(\lambda W_G(\theta\lambda) + (1-\lambda)W_B(\theta\lambda)\big) - C$$

$$= \big(1-\alpha_p\big)(1-q)\big(\lambda W_G(\theta\lambda) + (1-\lambda)W_B(\theta\lambda)\big)$$

and

$$W_B^0\big(p_p, r_0 = \theta\lambda\big) = \alpha_p(1-q)p_p + \big(1-\alpha_p\big)(1-q)W_B(\theta\lambda) - C$$

$$= \big(1-\alpha_p\big)(1-q)W_B(\theta\lambda).$$

In this setting, the bad firm owner must copy the good firm's strategy to sell as little as possible at the IPO. Otherwise, it will be recognised as bad. If a good firm decided to price any differently to the above strategy, it would do so to signal its good quality with a price satisfying the credibility condition that a bad firm's profit must not be higher when using the same strategy instead of pooling. Again, this condition would bind, because a good firm would not unreasonably underprice any further than necessary and choose p''. Furthermore, a good firm would only sell as little as possible α'' to fund its innovation resulting in condition (19) to be binding with $p'' = \frac{C}{\alpha''(1-q)}$. At the same time, a bad firm cannot deviate from a pooling strategy as described because that will clearly reveal their low quality. We can rewrite (26) – given that IPO proceeds on the left and right-hand side of the equation cancel each other out with the implementation cost C on both sides – and solve for α'':

$$(1-\alpha'')(1-q)W_B(\lambda) = \left(1-\alpha_p\right)(1-q)W_B(\theta\lambda)$$

$$\Rightarrow \alpha'' = 1 - \left(1-\alpha_p\right)\frac{W_B(\theta\lambda)}{W_B(\lambda)}$$

Accordingly, α'' is the fraction of the firm that a good firm would sell in its IPO, if it were to deviate from a pooling strategy. This again is only valid given underwriting spreads are equal for IPOs and SEOs.[187] Now, inserting (α_p, p_p) and (α'', p'') into (25), the final condition for the existence of the pooling equilibrium can be computed:

$$(1-\alpha'')(1-q)\left(\lambda W_G(\lambda) + (1-\lambda)W_B(\lambda)\right) \leq \left(1-\alpha_p\right)(1-q)\left(\lambda W_G(\theta\lambda) + (1-\lambda)W_B(\theta\lambda)\right)$$

$$\Leftrightarrow \left(1-\alpha_p\right)\frac{W_B(\theta\lambda)}{W_B(\lambda)}\left(\lambda W_G(\lambda) + (1-\lambda)W_B(\lambda)\right) \leq \left(1-\alpha_p\right)\left(\lambda W_G(\theta\lambda) + (1-\lambda)W_B(\theta\lambda)\right)$$

[187] It must be noted that in contrast to the proof of proposition 1, it is not applicable here to anticipate a discount b on the SEO underwriting fee as introduced shortly before proposition 3, even though by deviating from the pooling equilibrium, a good firm may be eligible for it. That is because proposition 3 essentially represents this very alternative. If the discount was anticipated at this stage, a pooling equilibrium could not be obtained because as proved with proposition 3, the firm will find it more profitable to separate rather than pool.

$$\Leftrightarrow \frac{W_G(\lambda)}{W_B(\lambda)} \leq \frac{W_G(\theta\lambda)}{W_B(\theta\lambda)} \qquad q.e.d.$$

Proof of $V_0(\theta\lambda) < U$

In this section, it will be briefly shown that the pooling price $p_p = V_0(\theta\lambda)$ is smaller than the expected aftermarket price that results after information has been released $E(p_2) = U$, hence additional commissions through profit sharing agreements are expected to be positive for the investment bank. The arguments $r_0 = \theta\lambda$ of the functions V_l and V_h are dropped because they are the same for this calculation. It can be calculated:

$$U = \lambda(\gamma_G V_h + (1-\gamma_G)V_l) + (1-\lambda)(\gamma_B V_h + (1-\gamma_B)V_l)$$

$$= \left(\lambda\gamma_G + \gamma_B(1-\lambda)\right)\cdot V_h + \left((1-\gamma_G)\lambda + \gamma_B(1-\lambda)\right)\cdot V_l$$

$$> V_0(\theta\lambda) = \left(\theta\lambda\gamma_G + \gamma_B(1-\theta\lambda)\right)\cdot V_h + \left((1-\gamma_G)\theta\lambda + (1-\gamma_B)(1-\theta\lambda)\right)\cdot V_l$$

The last inequality is true because $\gamma_G > \gamma_B$ and $\theta\lambda < \lambda$.