

Has There Always Been Underpricing and Long-Run Underperformance? - IPOs in Germany Before World War I

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Abstract

This paper provides empirical evidence on initial public offerings (IPOs) by investigating the pricing and long-run performance of IPOs on the German capital market before World War I.

Our results indicate that even though significant underpricing of IPOs has existed, it is considerably lower than that observed on today's markets. Employing a mixture of distributions approach we also find evidence of price stabilization of IPOs.

In our sample long-run underperformance is not significant from zero, neither when calculated on the basis of buy-and-hold returns nor on the basis of calendar time portfolios.

Finally, we find no evident impact of a changing institutional setting on underpricing and long-run performance after the establishment of a tighter stock market regulation.

Keywords: Initial Public Offerings, Underpricing, Long-Run Underperformance, Price Support, Impact of Changing Stock-Market Regulation and Institutional Setting on Underpricing

JEL Classification: G10, G14

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1 Introduction

One of the best known patterns in empirical research on initial public offerings (IPOs) is the phenomenon of underpricing, i.e. the fact that market prices on the first trading day typically exceed the offering price. Underpricing seems to exist independent of the point in time, the country and the terms of the respective issue. A second important characteristic of IPOs frequently documented in the empirical literature is their long-run underperformance, i.e. the fact that investors buying IPO shares on the secondary market earn substantial negative abnormal returns over longer holding horizons. Third, as reported by various authors, the volume of IPOs and the extent of initial returns tend to cluster in periods of so called 'hot issue markets'.

Most previous IPO studies focus on relatively similar periods after World War II, so that latent common economic factors on international markets might be responsible for the overwhelming evidence of substantial underpricing and long-run underperformance of IPOs. However, by using a unique sample of representative data collected on the 'historic' German capital market in the time between 1882 and 1914, an out-of-sample test of existing results on underpricing and the performance of German IPO shares can be performed. Also, the establishment of the first common stock market regulation in 1896 on (economically and politically) unified German grounds allows us to explicitly test the impact of institutional changes on the extent of underpricing and the performance of IPO shares.

We observe an average underpricing of 4.8 percent on the historic German capital market, indicating that in our sample underpricing is considerably lower than observed for post World War II periods. Furthermore, underpricing and IPO volume not only vary across industry sectors but also over time and thus confirm the existence of hot issue markets.

On our quest for reasons explaining initial returns, we argue that this may be due to price supporting activities on the part of underwriting banks. While doing so, we presume that these banks engage in price supporting activities to avoid falling prices on the secondary market. When employing a mixture of distributions approach we indeed find evidence in favor of this hypothesis.

Furthermore, in contrast to empirical studies on the German capital markets after World War II the performance of IPO shares for longer holding periods turns out to be neither better nor worse than the performance of the respective benchmark in our sample.

Given the development of stock market regulation towards tighter rules for investor protection, binding and stricter rules for the parties involved in the IPO-process and improved information dissemination among market participants, we expect this development, culminating in the Securities Exchange Act of 1896, to be a major source of the observed reduction of uncertainty. However, no evident impact of the regulation efforts on underpricing can be observed and only weak evidence in favor of increased price support activities by underwriting banks is found.

The remainder of the paper is organized as follows: Section 2 gives an overview of some theories in the context of underpricing and the long-run performance of IPOs and motivates further research on this issue. Section 3 presents a brief description of the stock market in the *Deutsches Reich* after 1870. In Section 4, the database and methodology are described. Empirical results are documented in Section 5. The paper concludes with a summary in Section 6.

2 Theories on IPO Underpricing and Underperformance

Some authors try to assess the compatibility of underpricing with economic equilibrium. These studies mainly focus on asymmetric information that creates ex ante uncertainty about the value of the company among the main parties involved in an IPO. While some models focus on information asymmetries among investors¹, others concentrate on asymmetries between issuers and investors², between issuers and underwriters³ or between underwriters and investors⁴.

The second group of approaches focuses on behavioral explanations for underpricing. Authors like Miller (1977) argue that underpricing might be due to heterogeneous expectations of optimistic and pessimistic investors. A similar approach by Shiller (1990) suggests that the market is subject to fads, i.e. investors behave irrationally in the sense that they value newly listed firms above fair value. This implies that companies could 'time' IPOs strategically, since

¹ For underpricing as a result of information asymmetries between investors facing the problem of valuing the shares, see, e.g., Rock (1986).

² See, e.g., Allen and Faulhaber (1989), Grinblatt and Hwang (1989) and Welch (1989) for signaling with underpricing. See also Beatty and Ritter (1986), according to which underwriters, as repeat payers, have an incentive to price IPO-shares below 'fundamental' value.

³ See, e.g., Baron and Holmström (1980) and Baron (1982) who provide Principal-Agent explanations of IPO underpricing. For a comprehensive overview of theoretic approaches explaining underpricing, see Ritter and Welch (2002).

⁴ See, e.g., Benveniste and Spindt (1989) and Welch (1992) for information gathering of underwriters by means of underpricing.

they could predict when over-optimism in the market is likely to occur and favorable offer prices can be obtained.⁵

The third group of theories focuses on aspects of corporate ownership and control (see, e.g., Brennan and Franks (1997) or Stoughton and Zechner (1998)). Other authors, like Tinic (1988) or Hughes and Thakor (1992), concentrate on factors such as the liability extending to statements made in issuing prospectus. The latter argue, that underpricing, i.e. the deliberate choice of a lower offering price, may be used as an 'insurance' against legal liability impending in case secondary market prices drop below offering prices.

A closely related issue is whether there is any true underpricing in terms of deliberate initial 'mispricing' at all or if the observed large positive means of the distributions of initial returns are artificially induced by the activities of underwriting banks to stabilize prices on the secondary market. This idea has first been put forward by Ruud (1993). Ruud argues that new issues may be initially correctly priced, but that the observed positive price jumps in the after-market are due to underwriters' price support in order to maximize the probability of placing all shares or to avoid legal liability. Thus, prior evidence of IPO underpricing may simply be attributable to incorrect modeling of the cross-sectional distribution of early IPO returns. What is perceived as underpricing is not the unconditional expectation of true initial returns but the expectation conditional upon underwriter intervention in order to avoid negative returns. In our empirical analysis we will examine whether initial returns are drawn from one single distribution, as usually assumed in the literature, or if the approach of Ruud holds true and returns are drawn from a mixture of price-stabilized and underpriced issues.

Only few of the above mentioned underpricing theories provide useful frameworks for analyzing the second empirical issue: the typically observed long-run underperformance of IPOs. Some behavioral approaches argue that, as more information becomes available, investors adjust their initial overvaluation, which causes prices to drop in the long-run.⁶ Also the idea of price support seems to be consistent with both the phenomenon of positive initial returns and of long-run underperformance. As long as price-supporting activities continue, secondary market prices tend to be above equilibrium values. When support is finally withdrawn prices will adjust downwards towards market equilibrium. The performance of IPOs will thus deteriorate when measured over longer periods.

⁵ Ritter (1991) provides an in-depth discussion on so-called 'windows of opportunity'. For a comprehensive overview of approaches in the context of behavioral finance see Fama (1998).

⁶ In addition to Shiller (1990) and Miller (1977), see also Aggarwal and Rivoli (1990), Loughran *et al.* (1994), and Miller (2000) who provide a detailed theoretical overview and further empirical evidence.

Similar to the long-run underperformance of new issues, mainly the behavioral approaches seem to be able to offer a satisfactory explanation for existence of hot issue markets, accounting fads for the occurrence of waves in the IPO-market. Following Jenkinson and Ljungqvist (2001), factors like buoyant stock markets, deregulation, business cycles and macroeconomic upswings, changing type and quality of companies going public, etc. might also be responsible for this phenomenon. These exogenous factors seem to change fundamental parameters determining the costs and benefits of going public in certain periods and obviously cause many firms to take advantage of a seemingly good 'IPO climate'.⁷

Our study analyzes the German market for new issues at a time, when investors, issuers, and underwriters interacted within a different legal framework and at a different stage of economic development than today. For this reason, our following empirical work should be interpreted as a further exploratory analysis motivated by theory, rather than an actual test of individual theories.

3 German Equity Markets before World War I

The establishment of the *Deutsches Reich* in 1871 created the first truly unified German market. The end of the war against France and thus the end of political uncertainty contributed to a widespread economic optimism (*Gründerboom*). This optimism and the liberalization of capital market regulation lead to a dramatic increase in the number of newly floated companies.⁸

This period of abundance ended in a Europe-wide crisis in 1873, accompanied by a dramatic decline in stock prices. The reasons for this *Gründerkrise* were mainly seen in over-speculation and poor regulation of stock markets, which strongly encouraged fraud and induced mistrust among investors.

3.1 Practices on the German Stock Market Before 1896

The *Gründerkrise* had left the impression that the lack of experience of investors had been taken advantage of. The fact that investors did not lose all their confidence in stock markets in general and in the issuing business in particular was especially due to the increasing

⁷ See also Ritter and Welch (2002).

⁸ For a detailed description of the German capital market in the time from 1871 to 1875, see Weigt (2004).

competition among issuers. In order to generate sufficient demand for their shares, issuers had to augment efforts to disseminate information to potential investors.

To strengthen the position of investors and to increase transparency on stock markets, the instrument of an issuing prospectus was established, which contained information on the motives of going public, on prospective earnings and on the rights of buyers⁹, thus permitting a more profound analysis by potential investors. The prospectus was published in the financial press, whose role as an active medium for 'quality control' became increasingly important.

The necessity to explicitly set information dissemination duties for issuers was seen more by the local stock market authorities than by the government. The Berlin stock market authority was the first to officially regulate the admission of shares for trading and quotation. Even though no binding obligation existed for issuers, the inspection of the prospectus by an independent institution provided a 'signaling effect' regarding the quality of the securities¹⁰. Although a standardized regulation over all stock exchanges in the *Deutsches Reich* did not yet exist, other German stock exchanges soon followed the example of Berlin. Therefore, a development towards a certain uniform 'best' practice can be assumed.

Since the 1870s, more and more companies used the help of underwriting banks in the process of going public. The incentives for underwriters to provide prospective and existing clients with sufficient information increased, mainly due to their interest in establishing long-term relationships. They not only published the prospectus but also guaranteed quality and correctness of the information provided with their name.¹¹

Shares were allocated either by *Subskription* or by *freihändige Begebung*. *Subskription* was chosen when a certain amount of capital had to be raised in a certain time or if a favorable market climate should rapidly be exploited. The total amount of shares was announced and offered to the public at a specific price and at a specific date through the press or by underwriting banks. At that date the shares were allocated to subscribers and were paid either completely, or a stage payment was agreed. In contrast, if shares were sold to investors gradually and in smaller amounts via a bank, one speaks of a *freihändige Begebung*.

⁹ According to Borhardt and Meyer-Stoll (1999) and Riesser (1971), legislation at that time constituted hardly any liability for issuers, which led to great losses on the part of investors and underwriting banks in the case of company bankruptcy. Through a reform of German stock corporation law in 1884, broader rules regarding the duty of issuers to inform investors and the liability of issuers in the case of bankruptcy were first enforced.

¹⁰ Neither before nor after the new securities exchange act had been passed in 1896, local supervisory authorities took the responsibility and the risk to express more than a purely formal judgment of the issues. Statements regarding the substantial quality of an issue were never made.

¹¹ See, e.g., Borhardt and Meyer-Stoll (1999), Kleiner (1914), and Gömmel (1992) for a detailed description.

Before 1896, issuing practice did not require the admission for listing to coincide with the allocation and placement of shares. In order to avoid the legal responsibilities in the context of an official listing, issuers often directly allocated (parts of the) shares to investors via direct sales by banks. If admission for listing on the stock exchange was requested afterwards, (parts of the) shares had already been issued to investors and the subsequent listing did not represent a placement of the issue in the narrower sense but merely the 'creation' of an official quotation. If these shares were part of an IPO, the request for listing gave no information about how many shares had already been placed. Through these 'pre-offers', issuers tried to induce oversubscription, creating a favorable climate (including attractive prices) for the placement of further issues.¹²

Following Borchardt and Meyer-Stoll (1999), even though this custom existed, the majority of shares were issued by allocating them to investors via the stock exchange. Furthermore, the fact that admission, allocation and placement of the shares did not coincide is of no essential relevance for this study, since in our sample, the median time between the first offer and the first price quoted on the stock market is just six days¹³. One may therefore conclude, that shares in our sample were issued directly. Also, the amount of shares issued is of minor interest for the empirical analyses conducted in this paper.

Between the admission and the official quotation, issuing banks were able to withhold parts of the offering in order to place them later when conditions seemed more favorable. Also, underwriters often actively managed the allotment of the shares, i.e. they gave preference to certain investors, especially to those who committed themselves not to sell the shares for a certain period of time. In the course of the quotation process, the public, and especially issuing banks, could intervene through limiting, modifying or withdrawing orders.

After the allotment of the shares and the beginning of trading, underwriters controlled aftermarket performance via support purchases or sales up to the moment when their own inventories were completely sold. Underwriters were thus able to actively intervene in the valuation of shares to be traded on the stock market and thus to influence pricing on the secondary market. Price support was thus perfectly legal and an established fact, since it was seen as a way to protect investors against uncontrolled price movements.¹⁴

¹² Following Kleiner (1914), before 1896 new shares of companies already trading on the stock market were often issued without publication of a prospectus. The shares were sold at a price lower than the subsequent issue price and before being officially admitted to stock market trading.

¹³ See Section 4 and footnote 23, respectively.

¹⁴ The active intervention of underwriters in the pricing process on the secondary market is extensively discussed by Lotz (1926).

3.2 Securities Exchange Act of 1896

Finally, in 1896, a unified legislation for all stock exchanges was established and came into force in January 1897. Among other things, this act provided rules for the new issue market and introduced a common and binding regulation of the mechanics of going public. The keeping of rules was supervised by an independent institution (*Zulassungsstelle*), which granted or denied the final permission to go public. This authority also verified the completeness and the contents of documents required for listing, and verified if all information necessary to evaluate the issue was publicly accessible. More detailed information had to be disclosed in the issuing prospectus, and listing requirements were tightened.¹⁵ Furthermore, the underwriter and the issuing company were jointly and severally liable for the contents of the prospectus. To ensure a fair valuation of the shares on the secondary market and to prevent banks from manipulating prices before the official listing, trading and official quotation of share prices could not start before the IPO shares were fully allocated to the initial subscribers. In case of violation of these rules the *Zulassungsstelle* would not admit an IPO.

The main goal of this new regulation was to reinforce confidence of investors in the German stock market. Through the introduction of restrictive listing requirements, the speculative character of issues should be reduced: companies had to prove their economic efficiency over a certain 'control period' (a company could be transformed into a stock corporation only after at least one year had passed by since the publication of the first financial statement) and were thus prevented from choosing the simple strategy of going public only when the general climate was favorable.

Furthermore, the obligation for the underwriting banks to grant credit to the issuing company provided a supplementary control of a company's quality. Since the bank had to take all of the shares onto its own books, it had a strong incentive to monitor the quality of the issuing company thoroughly, which at the same time implied higher investor protection. These rules lead to a competitive advantage for large banks on the market for new issues, since only these could easily face this higher risk. According to Wetzel (1996), compared to the time before 1896, the Stock Exchange Act was able to reach its goal: The German capital market was

¹⁵ The request for listing as well as the information contained in the prospectus had to be published in a number of domestic newspapers and were to be announced at the stock exchange.

stabilized, and confidence in German stock exchanges was reinforced. This newly installed institutional framework remained basically unchanged until the beginning of World War I.

4 Data and Methodology

The initial sample for this study is a collection of historical prices of German common stocks for the period from 1871 to 1914. These data were compiled at the Center for Financial Studies (CFS) in Frankfurt am Main and comprise end-of-the-month prices for almost 1,400 firms listed on six German stock exchanges (Berlin, Cologne, Frankfurt, Hamburg, Leipzig, and Munich) from 13 industry sectors¹⁶. In order to properly reflect actual market conditions, prices were recorded in the database only if they resulted from real transactions.¹⁷

From the initial sample a total of 934 IPOs could be identified over a thirty-year period from 1865 to 1914. To be considered as an IPO an observation had to contain either an initial offering price and/or the price of the first day of trading on the secondary market. For 297 companies there is data on both prices, so that initial returns can be computed for these firms.¹⁸ The firms in this reduced sample represent 12 of the 13 industries of the initial sample and cover the period of 1882-1914.¹⁹ We determine the rank correlation coefficient between the initial and the reduced sample for the number of IPOs per year over our sample period, which is around 0.774 and highly significant. This result and the observed relative parallelism of the data in Figure 1 indicate that the reduced sample represents the initial sample sufficiently well.

The initial return IR_i for IPO i is computed as follows

$$IR_i = \ln\left(\frac{S_i^*}{I_i}\right), \quad (1)$$

where I_i and S_i^* denote the issue price and the first price of IPO i ($i = 1, \dots, N$) recorded on the secondary market, respectively.

¹⁶ These are: breweries, banks, chemicals, electrical industry, mining, construction, metal, textile & leather, mechanical engineering, paper & glass, transportation, insurances, and others.

¹⁷ For a detailed description of the database, see Eube (1998).

¹⁸ The greater part of the relevant data was collected from various editions of Saling's *Börsen-Jahrbuch* and from the statistical report of *Börsen-Enquete-Kommission* (1893). While it seems probable that our dataset does not cover all the companies with new issues over our sample period there should be no selection bias, since we do not apply any (further) systematic criteria for the selection of IPOs.

¹⁹ In the reduced sample no IPOs were observed in the insurance industry.

In contrast to samples for more recent periods our initial returns are not necessarily computed over one calendar day. Adjusting initial returns using corresponding market returns is impossible, since daily data for a market index are not available. We basically prefer to work with original initial returns, but for purposes of a sensitivity analysis we also apply a simple linearization to obtain artificial one-day returns. Therefore, we correct initial returns for the length of time period between the date of the issue and the date of the first price recorded on the secondary market, i.e. we also analyze the properties of the return variable

$$IR_i^a = \frac{IR_i}{N_i}, \quad (2)$$

with IR_i (IR_i^a) as the (adjusted) initial return of IPO i and N_i as the number of days between the date of the issue and the day of the first recorded price on the secondary market. By performing the transformation in (2) we approximately normalize all the returns as if they had been computed over a one-day period.

As a benchmark for the measurement of the long-run performance of IPOs we use value-weighted indices for industry sectors taken from Eube (1998), who constructed a historical market index (HIMAX) for Germany between 1876 and 1914. The HIMAX is based on the historical capital market database of CFS and covers more than 65 percent of the market capitalization of the six stock exchanges. The index is set to 100 in December 1875 and is adjusted for rights issues, stock splits and dividends (assumed to be reinvested in the same stock). Following Eube (1998), returns of the index and economic growth (proxied by the change in the Net National Product) are highly correlated (with a correlation coefficient of 0.835). Thus, regarding regional and industrial aspects as well as economic growth, there is evidence that the HIMAX adequately represents the German equity market.

The long-run performance of an IPO is determined as the mean difference between the monthly log return of the firm and the monthly log return of the respective industry index. The holding periods considered range from one to five years. To be included in the sample for the analysis of long-run performance a stock had to have at least 50 percent of non-missing observations over the holding period. For example, to be included in the sample for the analysis of the performance over a five-year period a stock had to have at least 30 non-missing return observations over the five years following the IPO.

We also try to assess the robustness of these long-run performance measure by forming calendar time portfolios, i.e. in any given month we collect the stocks that had an IPO at most n years before that date, where $n=1, \dots, 5$. Then the equally weighted return of this calendar

time portfolio is computed and the performance is measured using mean and standard deviation of the time series of portfolio returns.

In order to investigate, whether (unobservable) ex ante price uncertainty can be considered as a factor responsible for IPO underpricing, in the literature proxy variables such as ex post volatility or size, sales, and further accounting data are used. Most of the latter data are hardly available for our sample period or no significant correlation can be found.²⁰ The reasons why also ex post volatility cannot be used as proxy for ex ante uncertainty for our sample are twofold.²¹ Due to the fact, that the available data only allow to compute the volatility of monthly stock returns, only longer holding periods can be considered. However, in the literature the volatility of stock returns is usually examined over a period of at most one month after IPO. It is assumed that uncertainty reduces with the increasing amount of information available through secondary market trading. Second, if substantial price support activities by underwriters are assumed, these would necessarily lead to a limited volatility and therefore to an incorrect interpretation of the correlation between the uncertainty proxy and underpricing.

The determinants of hot issue markets, i.e. the occurrence of periods with comparatively high underpricing, are analyzed by following the approach of Ljungqvist (1997): We examine the relation between underpricing and general market conditions by performing a cross-sectional regression as described by Equation (3).

$$IR_i = \gamma_0 + \gamma_1 Market_{12i} + \varepsilon_i. \quad (3)$$

The explanatory variable $Market_{12}$ is a measure of how well the market was performing relative to its own recent past. It is computed as described in Equation (4)

$$Market_{12} = \ln \left(\frac{HIMAX_t}{\frac{1}{12} \sum_{i=1}^{12} HIMAX_{t-i}} \right), \quad (4)$$

i.e. as the ratio of the HIMAX level at the end of month t in which the IPO occurred and the 12 months average index level prior to that date.

²⁰ We investigated if the age and size of a company (calculated as year of flotation minus the founding year and as the capitalization) at the time of the issue could serve as an explanatory variable for the amount of underpricing, but found no significant correlation between these variables and the amount of underpricing. See also Weigt (2004).

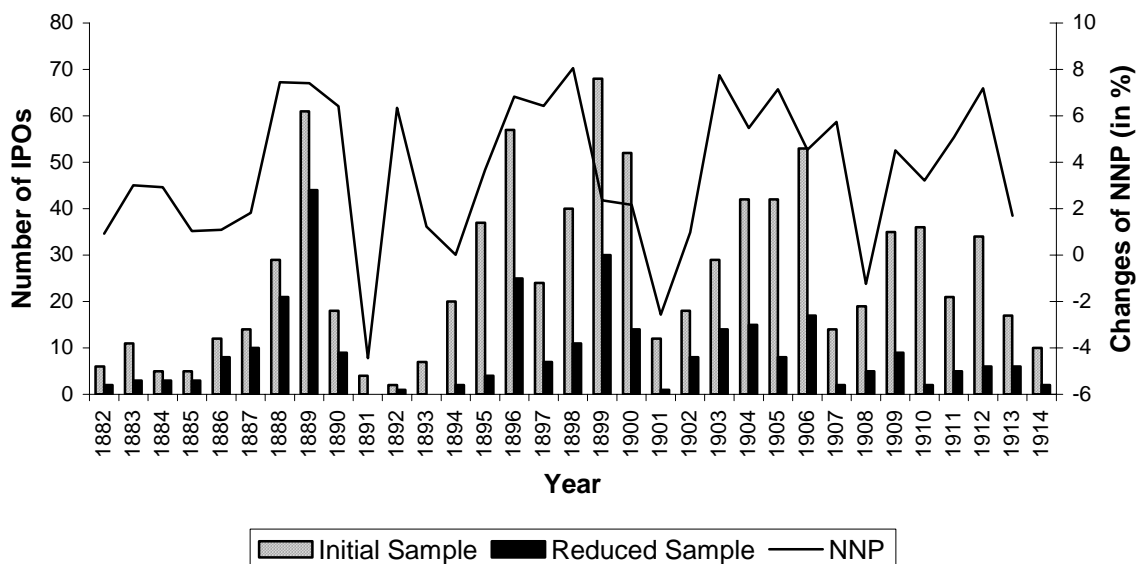
²¹ See, e.g., Wasserfallen and Wittleder (1994) or Uhlir (1989) for an empirical investigation of the relationship between ex ante uncertainty and ex post volatility of IPO shares.

5 Empirical Results

5.1 Underpricing

To analyze the market for IPOs in Germany before World War I, we first investigate the distribution of IPOs in the observation period 1882-1914. As can be seen from Figure 1, the distribution is not uniform over time: We observe 50 issues before 1888 and the largest number of offerings is found in 1889 (44). A next peak then occurs in 1896 with 25 IPOs. After 30 issues in 1899 IPO activity decreases again and after 1906 with 17 issues there is no other year with at least ten IPOs until 1914.

Figure 1: IPO Activity and Economic Development 1882-1914



Following one of the definitions of hot issue markets in the literature, we identify 'hotter' or 'colder' periods according to a (larger or smaller) number of issues.²² As can be seen from Figure 1, for the complete as well as for the reduced sample at least three hotter issuing periods can be observed. Figure 1 also shows, that IPO activity and economic growth (proxied by changes in the Net National Product, NNP) are positively correlated. This is confirmed by a linear regression, which indicates that the number of IPOs per year increased when positive changes of the NNP in the respective year could be observed.

²² See, e.g., Loughran and Ritter (1995) who evaluate IPO volume in different periods and consider the 1980s as 'hot' when compared to IPO-volume in the 1970s.

The next question is if there was indeed significant underpricing. Descriptive statistics for initial returns are shown in Table 1, the empirical density is shown in Figure 2.

Table 1: Descriptive Statistics for Initial Returns

Number of Observations	297
Number of Observations > 0	283
Mean	0.0481
Standard Deviation	0.0737
<i>t</i> -value for zero mean	11.2560
Median	0.0320
Minimum	-0.5037
Maximum	0.5674
Skewness	0.2806
Excess Kurtosis	21.3714
<i>p</i> -value Shapiro-Wilk test for normality	< 0.001

The range of initial returns is considerable, with a minimum of -50 percent and a maximum of 57 percent. However, even just 'by inspection' we find evidence in favor of underpricing with an average initial return of 4.8 percent. The standard deviation is 0.0737 which yields a standard error of the mean of 0.0043. Besides the standard *t*-test (with a resulting statistic larger than 11) also several nonparametric tests strongly reject the null hypotheses of a mean zero initial return, which leads us to conclude that there is indeed evidence for underpricing. The rejection of the hypothesis of no underpricing is further supported by the fact that 283 out of the 297 IPOs in our sample exhibit positive initial returns.

As mentioned in Section 4, the lack of correcting for a general market trend could be a problem if the statistical properties of the data changed significantly. However, when performing the transformation according to (2) the statistical analysis shows that all the main characteristics of the original initial returns remain unchanged, i.e. we observe a highly significantly positive mean and rejection of the normality hypothesis for a variety of tests.²³

The underpricing of 4.8 percent observed in our sample stands in sharp contrast to the amount of underpricing computed in the context of empirical studies examining German post World War II samples. Their results not only differ regarding the period of time and the number of IPOs examined, they also depend on whether returns were market-adjusted or if different

²³ As mentioned above, the median number of days between the issue and the first recorded price on a stock exchange is equal to six.

industry sectors or market segments were excluded.²⁴ In the extreme cases, on the 'modern' German capital market average underpricing ranges from 9.22 to 48.69 percent.²⁵ Even when studies that perform their analysis on the basis of restricted samples are excluded, the average underpricing still ranges between 12.16 and 28.5 percent, i.e. proves to be at least more than twice as high as in our observation period.²⁶

To our knowledge, the empirical analysis of Fohlin (2000) is the only study dealing with underpricing of German IPOs in the time before World War I. For the period of 1882-1892, she reports an average underpricing of 31.11 percent of a total of 335 IPOs on the Berlin stock exchange. Unfortunately, a comparison of Fohlin's and our results proves to be difficult. First, the initial return is calculated on a different basis, i.e. as the percentage increase or decrease in the share price at the issue date relative to the face value of shares, whereas we compute underpricing as described in Equation (1), i.e. as the relation between the issue price and the price on the first day of trading.²⁷ Second, some of the 335 issues in Fohlin's sample represent secondary offerings (SEOs) instead of IPOs, making a separate analysis of IPOs difficult.

For some of the analyses below it is important to check if initial returns are drawn from a normal distribution. The highly significant statistic of the Shapiro-Wilk test for normality in Table 1 indicates that the data are not normally distributed. Inspection of Figure 2 shows that we find two peaks of the density, a very pronounced one very close to zero and one at approximately 8 percent. This observation is important and justifies our analysis of the mixture of distributions in the context of price stabilization in Section 5.2.

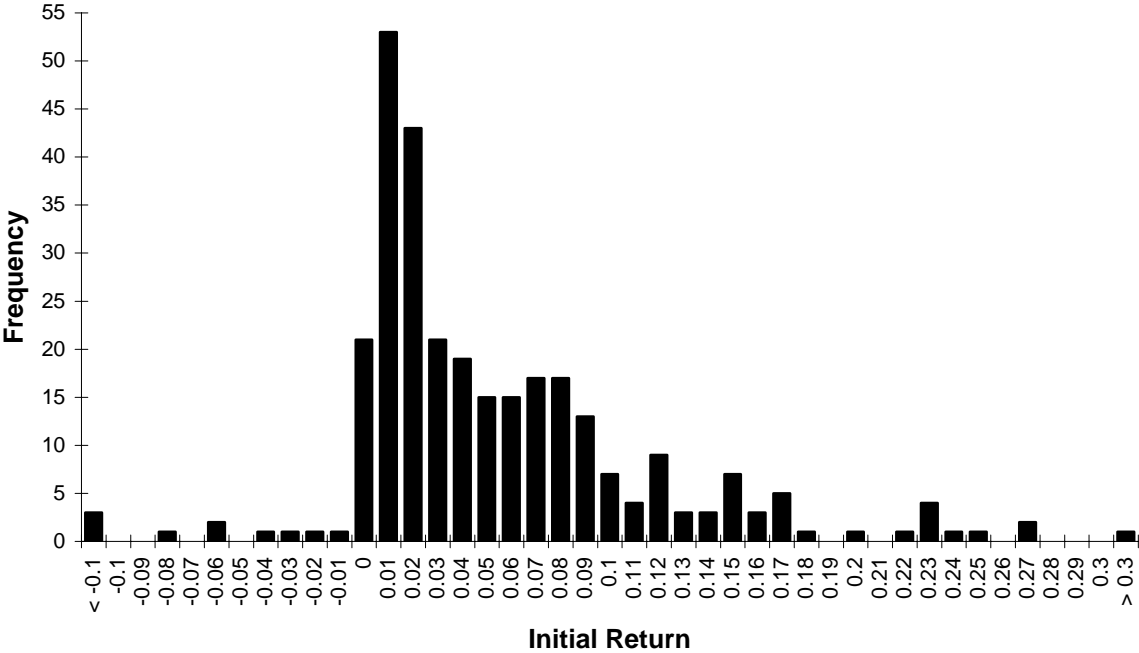
²⁴ Stehle and Ehrhardt (1999) provide an extensive overview of studies examining underpricing on the German capital market after World War II.

²⁵ See Ljungqvist (1997), who reports an average underpricing of 9.22 percent for a sample of 180 IPOs in the time between 1970 and 1933. Franzke (2004) examines 300 IPOs on Germany's *Neuer Markt* from 1977-2001 and finds an overall underpricing of 49.81 percent.

²⁶ Weinberger (1994) observes an average underpricing of 12.16 percent of 192 IPOs in the period 1980-1993 whereas the sample of Dawson and Reiner (1988) (51 IPOs) exhibits an underpricing of 28.50 percent for the period 1977-1985.

²⁷ Following the approach of Fohlin (2000) we also calculated the relation between the share price at the issue date and the face value of shares for the complete sample of 934 IPOs. Employing this method yields an average 'underpricing' of 37.26 percent.

Figure 2: Empirical Distribution of Initial Returns 1882-1914

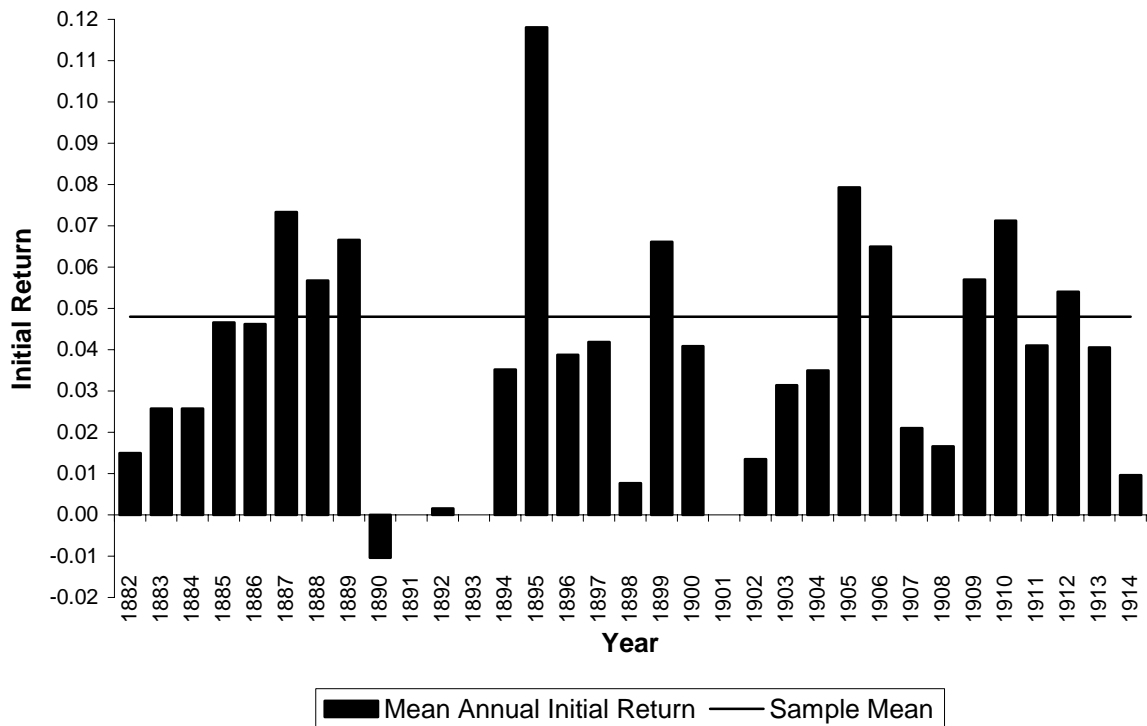


The distribution of initial returns and the number of IPOs across industries shows that we find the highest average underpricing for mechanical engineering companies (7.16 percent), for IPOs in then banking sector (6.74 percent), and in the chemical sector (5.74 percent). The lowest average initial return is observed for transportation companies (2.93 percent) and the construction industry (3.22 percent). This allows us to conclude that the occurrence of underpricing does not seem to be primarily driven by factors specific to a certain industry but is observed in all sectors of the economy. The same holds true for the number of IPOs per industry. The volume of companies going public in the different sectors is not equally distributed and varies between 43 (breweries) or 42 (metal industry) and 13 IPOs for the electrical industry or even no IPOs as observed for insurances, respectively.

Moreover, inspection of Figure 3 shows that in almost every year a positive average initial return can be observed, varying between 11.81 percent in 1895 and -1.04 percent in 1890. The evidence presented in Figure 3 confirms the observations made by Ibbotson and Jaffe (1975), Ritter (1984), Ibbotson *et al.* (1988), and Kaserer and Kempf (1995), who report a clustering of higher or lower initial returns over certain periods for the American and German capital

market, respectively, after World War II.²⁸ Therefore, also in our German pre war sample 'hotter' ('colder') periods with higher (lower) initial returns of IPO shares can be observed.

Figure 3: Average Initial Return per Year 1882-1914



Thus, regardless of the industry sector a firm going public can be accounted to a positive average initial return can be observed which varies across industries and over time. We may therefore conclude, that also for our pre World War I sample underpricing exists. However, when compared to the empirical results for post World War II samples, underpricing on the historic German market turns out to be considerably (i.e. more than 50 percent) lower.

5.2 Determinants of Underpricing

As described in Section 2, a large number of theories consider ex ante price uncertainty as a factor responsible for the underpricing of IPOs. However, we explained in Section 4, that for the period under consideration the commonly used data to proxy the (unobservable) ex ante price uncertainty are hardly available and that the analysis does not lead to significant or merely spurious results, respectively.

²⁸ Jenkinson and Ljungqvist (2001) provide an extensive overview of the international empirical evidence on this phenomenon.

Following Jenkinson and Ljungqvist (2001), factors like buoyant stock markets, deregulation, business cycles and macroeconomic upswings, changing type and quality of companies going public, etc. might be responsible for the existence of underpricing. These exogenous factors seem to change fundamental parameters determining the costs and benefits of going public in certain periods and also seem to cause many firms to take advantage of a seemingly good 'IPO climate'.²⁹ Due to the varying nature of some of these determinants, this should consequently cause the observed non-stationarity of underpricing over time.

In order to determine the influence of economic growth on the extent of underpricing, we perform a cross-sectional regression for the observed 297 IPOs according to Equation (3). As mentioned in Section 4, we use the explanatory variable $Market_{12}$ as a measure of how well the market is performing relative to its own recent past as defined in Equation (4). We find a positive influence of economic development (proxied by the HIMAX index) on the extent of underpricing, as indicated by the highly significant coefficient of 0.42 and the adjusted R^2 of 3.9 percent. We can therefore conclude, that bull-market conditions at the time of an IPO resulted in a higher level of IPO underpricing. This confirms the results of Ljungqvist (1997) reporting similar evidence for the German capital market after World War II.

If underpricing of IPOs were distributed deliberately across all observations, the distribution of our sample of initial returns would approximately be a bell-shaped curve with the peak of distribution centered at a return greater than zero. However, when examining Figure 2, we observe significant left censoring of the distribution of initial returns. This seems to provide evidence for the conjecture of Ruud (1993), that what seems to be underpricing may not primarily be due to information asymmetries but perhaps the consequence of price stabilizing activities of underwriting banks, reflected by the presumed existence of a partially unobserved left (negative) tail. Furthermore, Ruud's conjecture is underpinned by the historical evidence reported in Section 3.1, namely that the control of the aftermarket performance of IPO shares by underwriters via support purchases was a widespread practice.

Building on Ruud's idea, Asquith *et al.* (1998) suggest to estimate a mixture of distributions model for initial returns. They decompose the distribution for initial returns f into one for stabilized issues and a second one for non-stabilized issues. To do so they use a mixture of two normals with mixing parameter α , i.e. they assume $f = \alpha \cdot f_1 + (1 - \alpha) \cdot f_2$. with f_j as a normal distribution with a mean μ_j and a standard deviation σ_j ($j = 1, 2$). The choice of a mixture of two normals seems appropriate for our study as well, since the empirical density of

²⁹ See also Ritter and Welch (2002).

initial returns exhibits a definite peak around zero and another one for large positive returns at around 8 percent (see Figure 2).

The parameter vector $\Theta = (\mu_1, \mu_2, \sigma_1, \sigma_2, \alpha)^T$ of the model is inferred from the data through a maximum likelihood estimation, i.e. the joint log-likelihood $\ln L$ of initial returns IR_i ($i = 1, \dots, N$) with

$$\begin{aligned} \ln L &= \sum_{i=1}^N \ln [f(ER_i)] \\ &= \sum_{i=1}^N \ln [\alpha \cdot f_1(ER_i) + (1-\alpha) \cdot f_2(ER_i)] \end{aligned} \quad (5)$$

is maximized subject to the constraint $0 \leq \alpha \leq 1$.

It is considered as evidence in favor of price stabilization if one of the two distributions has a mean very close to zero and a low standard deviation (representing stabilized issues) while the other one exhibits a positive mean and a higher volatility (representing non-stabilized issues).

Performing the maximum likelihood estimation (5) for our sample of initial returns we obtain the estimate

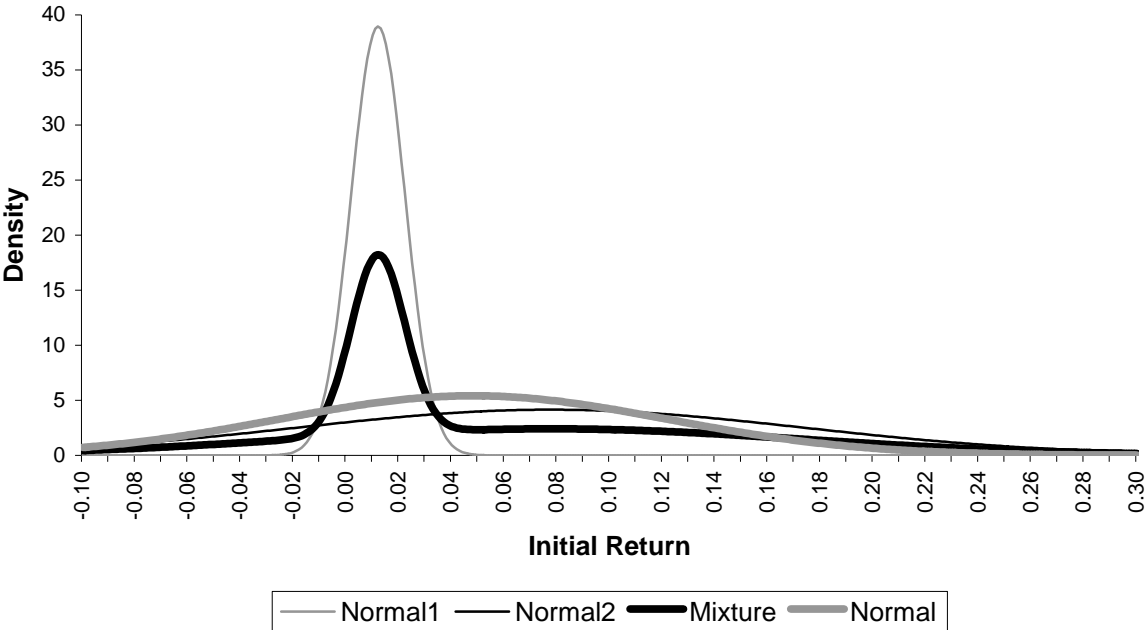
$$\begin{aligned} \hat{\Theta} &= (\hat{\mu}_1, \hat{\mu}_2, \hat{\sigma}_1, \hat{\sigma}_2, \hat{\alpha}) \\ &= (0.0120, 0.0774, 0.0102, 0.0961, 0.4190) \end{aligned} \quad (6)$$

and the likelihood ratio test indicates a significant improvement of this model over the assumption of a simple normal distribution.³⁰

Figure 4 shows the fitted single normal distribution (denoted by 'Normal') as well as the two mixing normals ('Normal1' and 'Normal2') and the resulting mixed distribution 'Mixture'. The result is perfectly compatible with the findings of Asquith *et al.* (1998). One distribution is centered near zero ($\hat{\mu}_1 = 0.0120$) with a low standard deviation ($\hat{\sigma}_1 = 0.0102$), whereas the second normal distribution has a much larger positive mean ($\hat{\mu}_2 = 0.0774$) plus a much larger standard deviation ($\hat{\sigma}_2 = 0.0961$). The resulting mixture of distributions exhibits only little probability mass below zero and a fatter right tail, which is exactly what we would expect in the presence of price support. The mixing parameter estimate $\alpha = 0.419$ indicates that approximately 42 percent of our sample of 297 IPOs appear to be associated with price-stabilization efforts after the first day of trading.

³⁰ The test statistic for the likelihood ratio test is distributed as X_r^2 with r as the difference in the number of parameters of the general model and the special case, i.e., in the situation given here $r = 2$. The special case here is a normal distribution with maximum likelihood estimates of $\hat{\mu} = 0.0481$ and $\hat{\sigma} = 0.0737$.

Figure 4: Mixture of Distributions for Initial Returns of IPOs



Since we do not always observe our initial returns over one calendar day we have to make sure that this is not a latent factor responsible for the results of the above estimation. The maximum likelihood estimation of the parameter vector for the adjusted returns defined in Equation (2) yields qualitatively the same results as the one for the original initial returns. Again, the mixture of distributions model fits the data much better than a simple normal distribution. As for the original data the first distribution exhibits a mean close to zero and a low standard deviation, whereas the second one is much wider with a large and positive mean. Therefore, independent of which return variable we use, strong evidence in favor of price stabilization can be found.³¹

This is confirmed even further by looking at the fit of normal and mixed normal distributions for one-year returns of IPOs in Figure 5. Since price stabilization will usually last over limited periods of time only, we would expect the simple normal distribution to perform better, relative to the mixture of distributions, for returns measured over longer horizons. Rerunning

³¹ In accordance to the results of Asquith *et al.* (1998) the standard *t*-test leads us to conclude, that the mean return of Normal1 and Normal2 differs significantly from zero. With respect to Normal2 this is exactly what we would have expected but in the case of Normal1 *"this result suggests either that our assumption that the price-supported are normally distributed is reasonable and some underpriced issues are being captured in the first distribution, or that the distributional model of price-supported issues is misspecified."* Since the information in our sample does not allow us to differentiate between stabilized and non-stabilized issues, this question remains to be answered.

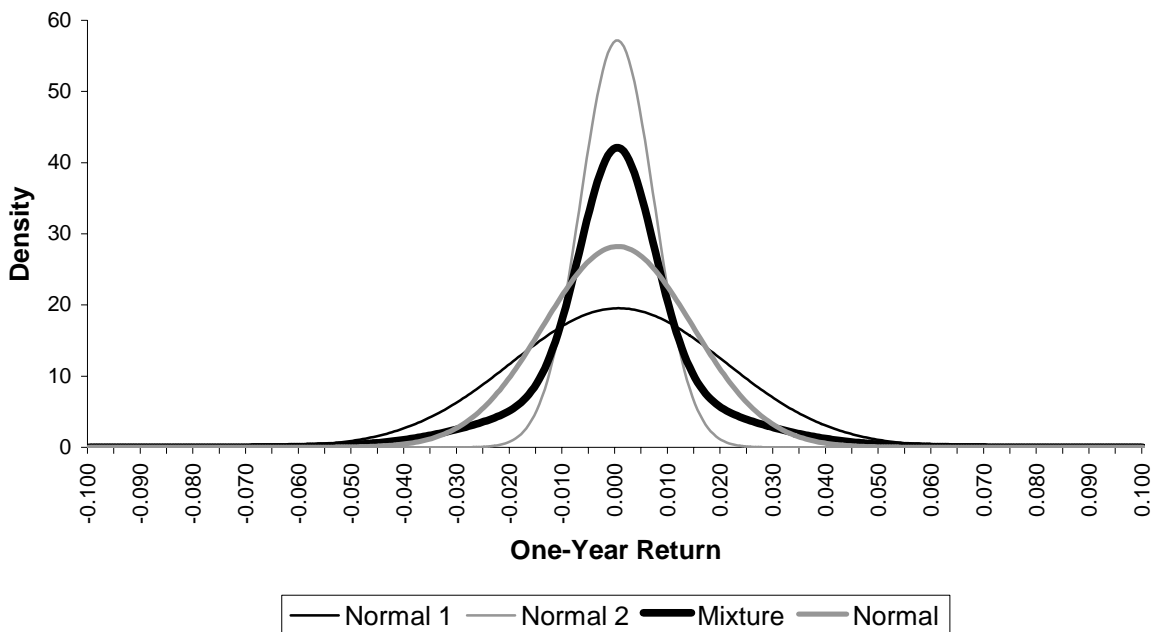
the maximum likelihood estimation for a mixture of normals of one-year returns (Equation (7)) and one-year daily returns (Equation (8)), respectively, we obtain

$$\begin{aligned}\hat{\Theta} &= (\hat{\mu}_1, \hat{\mu}_2, \hat{\sigma}_1, \hat{\sigma}_2, \hat{\alpha}) \\ &= (0.0668, 0.1310, 0.1107, 0.3240, 0.5998)\end{aligned}\quad (7)$$

$$\begin{aligned}\hat{\Theta} &= (\hat{\mu}_1, \hat{\mu}_2, \hat{\sigma}_1, \hat{\sigma}_2, \hat{\alpha}) \\ &= (0.0003, 0.0005, 0.0070, 0.0204, 0.5998).\end{aligned}\quad (8)$$

The mixture of normals is still statistically superior to the simple normal distribution as indicated by a likelihood ratio test. However, these results and Figure 5 indicate that we no longer observe such a pronounced discrepancy in mean returns between the two components of the mixture as in the case of initial returns. The means of the mixture of normals and of the simple normal are much more similar than for initial returns, and the more general distribution primarily helps to better explain the probability mass in the tails of the empirical distribution.

Figure 5: Mixture of Distributions for One-Year Returns of IPOs



To summarize, we can report that even though price support cannot be directly determined in our sample³², we find strong evidence for the existence of underwriter price support in the

³² This is due to the fact, that no exact 'original' data on the extent of supporting activities of the respective underwriting banks is available for our sample.

earlier aftermarket (Figure 4). This support is withdrawn in the course of one year, as indicated by the calculation of one-year returns and as shown in Figure 5.

5.3 Long-Run Performance

To assess the long-run performance of IPO shares we consider the respective industry index as benchmark investment as explained in Section 4. Existing empirical literature indicates that the length of the holding period is an important determinant for the long-run performance of IPOs.³³ Furthermore, due to the underpricing of IPOs, the long-run performance also depends on whether the investor has acquired the shares on the primary market at the issue price or on the secondary market at the price of the first day of trading.

Table 2 shows the number of IPOs in the respective subsamples for various holding periods. In Table 2 the entries marked 'Primary' ('Secondary') show the average return difference ('Mean') between IPOs and the industry index for investors who had acquired their shares as initial subscribers (on the first day of trading) as well as the corresponding *t*-value. In addition, the fourth column shows the number of IPOs with a negative return difference.

Table 2: Descriptive Statistics for Long-Run Performance

Holding Period	No. of Obs.	Purchase on ...	No. of Obs. < 0	Mean	<i>t</i> -value
1 year	286	Primary	101	0.0064***	4.93
		Secondary	131	0.0012	1.02
2 years	286	Primary	118	0.0030***	4.01
		Secondary	140	0.0007	0.99
3 years	287	Primary	133	0.0012	1.73
		Secondary	159	-0.0004	-0.61
4 years	287	Primary	137	0.0009	1.53
		Secondary	151	-0.0003	-0.59
5 years	287	Primary	130	0.0009	1.76
		Secondary	147	-0.0001	-0.14

***indicates significance at the 1 percent-level.

In general, long-run return differences tend to decrease with increasing holding periods. This is true independent of whether the shares were bought on the primary or on the secondary market. Investors who had subscribed for all IPOs earned significantly higher returns than the industry average for holding periods up to two years. The significance of this return

³³ See, e.g., Stehle *et al.* (2000) for a comprehensive discussion of the long-run performance on the German capital market after World War II.

advantage disappears in the third year, although the difference to the industry index still remains positive on average.

Investors who had bought their shares on the first day of trading earned negative returns relative to the benchmark when the shares were held for more than three years. However, these results as well as the results for holding periods up to three years do not prove to be significantly different from zero. Thus, in contrast to numerous other studies, no evidence in favor of a long-run underperformance of IPO stocks can be found, if shares were bought on the secondary market immediately after IPO.³⁴

As suggested in the literature (e.g., by Mitchell and Stafford (2000)) we try to assess the robustness of these long-run performance measures by forming calendar time portfolios as explained in Section 4. The results are shown in Table 3 for the case of an immediate subscription for shares on the primary market and of a purchase of the shares on the first day of secondary market trading.

Table 3: Long-Run Performance for Calendar Time Portfolios

Holding Period	Purchase on ...	Mean	<i>t</i> -value
1 year	Primary	0.0054***	3.35
	Secondary	0.0007	0.51
2 years	Primary	0.0024	1.83
	Secondary	-0.0001	-0.11
3 years	Primary	0.0016	1.64
	Secondary	-0.0004	-0.40
4 years	Primary	0.0012	1.32
	Secondary	-0.0004	-0.50
5 years	Primary	0.0012	1.32
	Secondary	-0.0003	-0.33

***indicates significance at the 1 percent-level.

We obtain the typical result also found in other studies that long-run underperformance tends to disappear when measured on this basis. Only in three cases out of the ten calendar time portfolios the mean returns are statistically different from zero and a slight overperformance of shares purchased on the primary market can be observed for holding periods up to three years. But the results prove to be fairly low and for the majority of calendar time portfolios no significant evidence can be found of a better or a worse performance than the benchmark.

³⁴ The long-run performance results could be significantly biased downwards when a large number of companies goes bankrupt. In our sample this is the case for less than five percent of the 297 firms.

When comparing our results to the outputs of studies investigating post World War II IPOs, one can see that regardless of the method employed and the type of benchmark used in those studies, the amount of under-performance of shares purchased on the secondary market for a holding period of three years stands in sharp contrast to the results obtained in our sample.³⁵

So the question if there has always been long-run underperformance can be answered with "no", since neither when calculating buy-and-hold returns (as shown in Table 2) nor when calculating returns on an alternative basis (see Table 3) we obtain indication of a significant underperformance.

5.4 Impact of Regulatory Changes

If the theories discussed in Section 2 hold true and underpricing is (at least partly) a consequence of the perception of uncertainty by investors, and if a tighter regulation of financial markets helped to reduce this structural uncertainty on German stock markets, we should observe a tendency for the underpricing of IPOs to decrease over time.

On the other hand, the increased legal liability of underwriting banks could have lead to just the opposite result, namely an increase in the amount of underpricing by which the banks could have tried to avoid being made responsible for unsatisfactory performance of the issue. Thus, the direction and size of the overall effect remains an empirical issue.

The performance of a simple test of the hypothesis that underpricing declined over time by regressing the initial returns on time (represented by the calendar year of the respective issue) does not yield any significant results. This stands in sharp contrast to the results of empirical studies of the German capital market after World War II who observe a decreasing underpricing over the observation period under consideration.³⁶ In order to verify these results, a more direct test of the hypotheses that institutional factors may be important for the occurrence of underpricing is performed and the average underpricing before and after the legal reform in 1896 (SEA) is compared in Table 4. To do so, we split the sample of IPOs into two subsamples containing issues before and after the reform act, respectively. We excluded the period from July 1896 to June 1898 (15 IPOs) so that the first subsample contains issues

³⁵ For a holding period of three years e.g. Stehle *et al.* (2000) find an underperformance of -5.04 percent and Ljungqvist (1997) of -12.11 percent for (187 and 180) IPOs on the German capital market in the period 1960-1992 and 1970-1990, respectively. Stehle *et al.* provide an in-depth analysis of the sensibility of long-run performance results regarding the period and the size of the sample examined as well as the calculation procedure and the character of the benchmark used.

³⁶ See, e.g., Kaserer and Kempf (1995), Stehle and Ehrhardt (1999), and Uhlir (1989).

up to June 1896 whereas the second is made up of issues from July 1898 on. Significantly smaller underpricing for the second period (i.e. after the reform) would favor the hypothesis that tighter regulation reduced underpricing on average.

Table 4: Underpricing Before and After the Securities Exchange Act of 1896

Period	No. of Obs.	Mean	Standard Deviation	Test for Equality of ...		
				Means (<i>t</i> -test)	Medians (Mann-Whitney test)	Variances (<i>F</i> -test)
Before SEA	133	0.0528	0.0760	0.693	1.199	1.897***
After SEA	149	0.0473	0.0552			

*** indicates significance at the 1 percent-level.

The comparison of the mean underpricing for the two groups shows, that in the period after the Securities Exchange Act of 1896 an about 1 percent lower underpricing can be observed.³⁷ This seems to provide evidence in favor of the hypothesis that uncertainty was reduced through the changing regulatory environment on the market for new issues. Nevertheless, a comparison of the means of the two samples yields no significant test statistics and only a significantly lower standard deviation can be found.

These results also suggest that the numerous measures undertaken by the German regulatory authorities in order to reduce uncertainty were of no empirically observable influence for the determinants of underpricing. Furthermore, the fact that no increasing underpricing can be observed could also imply that one cannot infer that underwriting banks chose a lower issue price in order to minimize legal liability. Finally, this result could also imply that both presumed effects, i.e. an increasing and decreasing underpricing, actually occurred but compensated each other leading to a constant underpricing over time.

In 1896, i.e. one year before the law came into effect, one of the largest peaks of the number of IPOs and in 1895 the highest level of underpricing can be observed indicating one of the 'hottest' issuing periods in our sample.³⁸ Furthermore, in our sample 22 out of 25 IPOs in 1896 occurred in the first half of the year and thus just in time before the law was passed officially. Since the contents of the Securities Exchange Act were discussed in parliament and in various

³⁷ The standard *t*-test indicates that for both portfolios, i.e. for IPOs before and after the Securities Exchange Act, the sample means differ from zero at a 1 percent-level.

³⁸ See Figure 1 for the development of IPO volume and Figure 3 for the development of underpricing over time.

commissions before the law was actually passed, market participants knew from mid 1895 on that the institutional environment would change considerably in the near future.

The hypothesis that market participants anticipated a tighter regulation on the market for new issues is further supported by both the large number of IPOs and the considerable amount of underpricing in 1896. The stock market did not exhibit major movements during 1896 (see Figure 1), so that an increase in the number of IPOs simply due to sharply rising stock prices does not seem very likely.

6 Summary

This paper investigates IPOs on the German capital market before World War I in the time between 1882 and 1914. To our knowledge, no comparable previous work in the empirical literature uses this sample period which enables us to provide a first test of the robustness of the results obtained by studies analyzing samples collected after World War II.

The first central result is that we find significant, but low underpricing. More than 95 percent of the IPOs in our sample exhibit positive initial returns, which are observed across all industry sectors of the economy. In addition, the extent of underpricing and the occurrence of IPOs vary over time, i.e. the market for IPO shares seems to have experienced 'hotter' and 'colder' periods. However, in our pre World War I sample underpricing is considerably lower than underpricing observed for post World War II samples. When examining the determinants of underpricing we find strong evidence for price stabilization indicating that initial returns are not drawn from a single normal distribution, but rather from a mixture of two normals. Furthermore, we find a positive relationship between economic development in the 12 months before IPO and the extent of underpricing as well as between economic development and IPO volume.

Examining the long-run performance of IPO shares in our sample, the second category of results obtained in the analysis of our sample does not support previous evidence, since IPOs do not perform worse than the benchmark when the shares were bought on the secondary market and held for more than three years. The results obtained in our analysis prove to be robust when calendar time portfolios are considered. This leads us to conclude, that there was no significant long-run underperformance on the German capital market before World War I.

Finally, we find no impact of a changing institutional setting on underpricing in our sample. No change in underpricing over time can be observed and an even more detailed analysis

reveals no evidence of an influence of the Securities Exchange Act of 1896, i.e. no significantly higher or lower mean underpricing (or long-run performance) in the period before the Act can be observed than afterwards. Therefore, the hypothesis that ex ante price uncertainty was reduced by the means of a tighter regulation on the market for new issues and that this consequently lead to a significantly lower underpricing cannot be supported.

Overall, the results of this paper show that the existence of underpricing per se is not specific to recent sampling periods for 'modern' capital markets. Given that general economic conditions have certainly changed between the centuries we can conclude that there has to be a set of common factors for the two periods that cause IPOs to be underpriced regardless of the time period considered, regardless of cultural and regulatory environment. On the other hand, the amount of underpricing is much lower than observed for capital markets. It is left for future research to identify the factors responsible for this aspect of our results.

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