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**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 using a unique data set collected on the German capital market before World War I.

Our findings indicate that underpricing of IPOs has existed, but has significantly decreased over time in our sample. Employing a mixture of distributions approach we also find evidence of price stabilization of IPOs. Concerning long-run performance, investors who bought their shares in the early after-market and held them for more than three years experienced significantly lower returns than the respective industry as a whole.

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

JEL classification: G10, G14

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1 Introduction

The best known pattern in modern research on initial public offerings (IPOs) is the observed empirical evidence that companies' shares are regularly underpriced when going public, i.e. market prices on the first trading day typically exceed the offering price. Underpricing seems to exist independent of the time period, the country and the terms of the respective issue. For example, empirical evidence for post war samples in Germany indicates an average underpricing between 32.1 and 9.2 percent¹.

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 horizons. For example, Ljungqvist [16] finds a long-run underperformance of around twelve percent for a holding period of three years.

Third, according to the results of Ibbotson and Jaffe [12], Ritter [21], and Ibbotson, Sindelar, and Ritter [13], the volume of IPOs and the extent of initial returns tend to cluster in periods of so called 'hot issue markets', and IPO volume shows a strong tendency to be high following periods of high underpricing. Jenkinson and Ljungqvist [14] provide an overview of the empirical evidence on this phenomenon.

Most previous IPO studies focus on relatively similar periods after World War II for U.S. or European markets, so that latent common (though hard to identify) economic factors might be responsible for the overwhelming evidence of underpricing and long-run underperformance of IPOs. In the literature it is thus often argued that a check for the robustness of existing results should be undertaken using different data sets and periods of analysis. Using a unique and 'fresh' sample of representative data, collected on the 'historic' German capital market², the robustness of 'modern' results on underpricing and the performance of IPO shares will be checked and support for mixture of distributions. Furthermore, considering the institutional and changes due to the establishment of the stock market regulation in 1896, explicit tests for the impact of such changes on the extent of underpricing and the performance of IPO shares seems worth a closer examination.

¹ These results depend on whether returns were market-adjusted or if different industry sectors or market segments were excluded. For an overview see Stehle and Ehrhardt [25].

² For a detailed description of the data and the German capital market in the time from 1875 to 1914, see Eube [8].

The remainder of the paper is organized as follows: Section 2 gives an overview of the most important theories in the context of IPOs, section 3 presents a brief description of the stock market in the *Deutsches Reich* after 1870. In section 4, the data base and methodology are described. Empirical results are documented in section 5. The paper concludes with a summary in section 6.

2 Theories on IPOs

The attempts to explain underpricing of new issues theoretically fall into three main categories. Some authors try to reassess the compatibility of underpricing with economic equilibrium. These studies mainly focus on asymmetric information which creates ex ante uncertainty about the value of the company among the three main parties of an IPO. These parties are the investors, facing the problem of valuing the shares (see, e.g., Rock [22]), the issuers, with superior information about the value of the company³, and the underwriter with private information about investor demand⁴. Other approaches focus on factors such as legal liability (see, e.g., Tinic [27] and Hughes and Thakor [11]) and price support (see, e.g., Ruud [23]), or on aspects of corporate ownership and control (see, e.g., Brennan and Franks [7], or Stoughton and Zechner [26]).

Only few underpricing theories provide useful frameworks for analyzing the long-run underperformance of IPOs. Therefore, also behavioral explanations of this phenomenon are examined in the literature. Authors like Miller [18] argue that this phenomenon may be due to heterogeneous expectations of optimistic and pessimistic investors, whose divergence of opinions narrows as more information becomes available which causes prices to drop. A similar approach by Shiller [24] suggests that the market is subject to fads, i.e. investors behave irrationally in the sense that they value newly listed firms beyond fair value, such that prices will drop over time as information on the true value becomes available to the market. This implies that companies could 'time' IPOs strategically in the sense that they could predict when over-optimism in the market is likely to occur and favorable offer prices can be obtained. As more information becomes available, investors adjust their initial overvaluation, which causes long-run returns to fall⁵. Because underpricing theories do not seem to be convincing regarding the occurrence of hot-issue markets, other explanations must be found.

³ See, e.g., Allen and Faulhaber [2], Grinblatt and Hwang [10], and Welch [28] for signaling with underpricing.

⁴ See, e.g., Baron and Holmström [4] and Baron [5] for principal-agent explanations of IPO underpricing.

⁵ Also see Aggarwal and Rivoli [1] and Loughran, Ritter, and Rydqvist [17].

Following Jenkinson and Ljungqvist [14], factors like buoyant stock markets, deregulation, business cycles and macroeconomic upswings, changing type and quality of companies going public etc. might 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'.

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 induced a widespread economic optimism (*Gründerboom*) with a strong impact also on stock markets: the number of newly floated companies increased dramatically.

This period of abundance ended in a Europe-wide crisis in 1873, accompanied by a dramatic decline in stock prices on German exchanges. 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

Before 1870, the foundation of a corporation required a concession by the government after a close examination of the respective company. When stocks were issued, a buyer had reason to believe that he had purchased a relatively risk-free security. The *Gründerkrise* after 1873 and its dramatic consequences caused by certain speculative practices in the issuing business had left the impression that the lack of experience of investors had been taken advantage of. The fact that afterwards 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 competition among issuers. In order to generate sufficient demand for their shares, issuers had to increase 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 buyers⁶, thus permitting

⁶ According to Borchardt and Meyer-Stoll [6], and Riesser [19], legislation at that time constituted hardly any liability for issuers which lead to great losses on the part of investors and underwriting banks in the case of

an informed 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 state information dissemination duties for issuers was seen more by the local stock market authorities than by the government. For example, in 1888, the admission of shares for trading and their quotation were first officially regulated in Berlin. 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 securities.

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 substantive quality of an issue were never made.

Although a standardized regulation over all stock exchanges in the Deutsches Reich did not yet exist, the other German stock exchanges soon followed the example of Berlin. Therefore, a certain uniform practice can be assumed.

Since the 1870s, more and more corporations 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 long-term relationships. On the basis of the information provided by the issuer, they not only published the prospectus but also guaranteed quality and correctness of the information provided with their name.⁷

Shares were allocated either by *Subskription* or by *freihändige Begebung*. *Subskription* was chosen when a certain amount of capital had to be risen in a certain time or if a favorable market climate should 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 allotted 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*.

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 (part of the) shares to investors via direct

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 investors in the case of bankruptcy were first enforced.

⁷ For a more detailed description see, e.g., Kleiner [15], Borchardt and Meyer-Stoll [6], and Gömmel [9].

sales by banks. If admission for listing on the stock exchange was requested afterwards, (part 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 were already placed. Through these 'pre-offers', issuers tried to induce oversubscription, creating a favorable climate (including attractive prices) for the placement of further issues.⁸

Following Borchardt and Meyer-Stoll [6], even though this usage 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 days⁹. One may therefore conclude, that shares in our sample were issued as directly as possible. 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 also able to withhold part 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, 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 the price formation process. Price support was thus perfectly legal and an established fact, since it was seen as a way to protect investors against uncontrolled price movements.

⁸ Before 1896, new shares of companies already trading on the stock market were often issued without having published a prospectus. The shares were sold at a price lower than the subsequent issue price and before being officially admitted to stock market trading, see, e.g., Kleiner [15].

⁹ See section 5.1 and footnote 13 respectively.

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 it made sure that 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.¹⁰ For example, companies had to have a minimum nominal value of equity with a minimum face value per share. 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. 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 IPO would not be admitted by the Zulassungsstelle.

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 was to be reduced: companies had to prove their economic efficiency over a certain 'control period' and were thus prevented from choosing the simple strategy of issuing shares 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 meant higher investor protection. These rules lead to a competitive advantage for big banks on the market for new issues, since they could more easily face this higher risk. According to Wetzel [29], compared to the time before 1896, the Stock Exchange Act was able to reach its goal: The German capital market was

¹⁰ The request for listing as well as the required prospectus (apart from the requirements regarding the contents of the prospectus already mentioned) had to be published in certain number of domestic newspapers and were announced by a notice at the stock exchange itself.

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

4 Data and Methodology

The basis sample for this study is a sample of historical German stock prices for the period from 1870 to 1914. These data were compiled at the Center for Financial Studies in Frankfurt am Main, Germany. They contain monthly returns for almost 1,400 firms from six German stock exchanges. Returns are computed as changes in the natural log of the stock price and are adjusted for dividend payouts and capital changes, i.e. with S_{it} denoting the price of stock i in month t (adjusted for capital changes and dividends)

$$r_{it} = \ln\left(\frac{S_{it}}{S_{i,t-1}}\right).$$

The initial return IR_i for IPO i is computed as $IR_i = \ln(S_i^*/I_i)$ where I_i and S_i^* denote the issue price and the first price recorded on the secondary market, respectively.¹¹

As a benchmark for the measurement of the long-run performance of IPOs we use indices for industry sectors taken from Eube [8]. The long-run performance of an IPO is then computed 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 under consideration 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.

Ex ante price uncertainty has frequently been considered a factor responsible for the underpricing of IPOs. Since reliable data on proxy variables suggested in the literature (such as size, sales, or other accounting data) are hardly available for our sample period, ex post

¹¹ 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 apply a simple linearization to obtain artificial one-day returns. See section 5.1.

volatility is used as a proxy measure for ex ante price uncertainty.¹² This volatility is computed as the standard deviation of logarithmic monthly stock returns over holding periods from one to five years. In terms of data availability the same rule applied as in the case of the long-run performance, i.e. for at least 50 percent of the months a stock had to have non-missing return observations.

5 Empirical Results

5.1 Initial Returns

The IPOs in our sample were observed for 182 firms over the thirty-year period from September 1884 to May 1914. Of course, a lot more IPOs took place over this period, but only for these 182 companies all the data necessary for the analyses presented below were available. The firms in this sample belong to twelve of thirteen industries represented in the basis sample (containing close to 1,400 companies). The distribution of these 182 IPOs over time is not uniform as can be seen from figure 1. Partly due to the fact that reliable data are hardly available for this period we observe only nine issues before 1894. A first peak then occurs in (the first half of) 1896 with 20 IPOs, and the most offerings per year are found for 1899 (26). Afterwards IPO activity is decreasing again, and after 1906 with 16 issues there is no other year with at least ten IPOs until 1914.

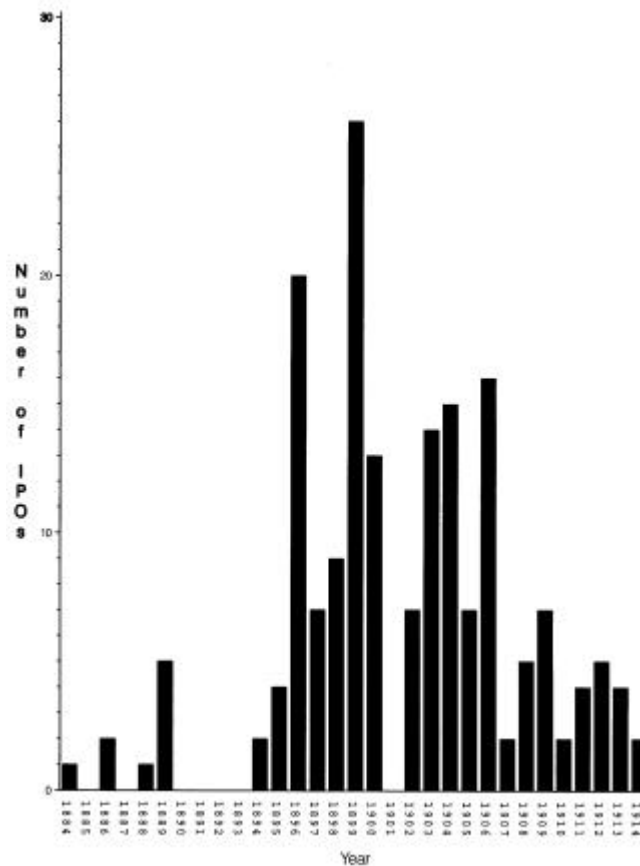
The first question that has to be investigated is if there is indeed significant underpricing. Descriptive statistics for initial returns are shown in table 1. The range of initial returns is considerable, with a minimum of -8 percent and a maximum of 24 percent. However, even just 'by inspection' we find evidence in favor of underpricing with an average initial return of 4.8 percent. The standard deviation is 0.0532 which yields a standard error of the mean of 0.0039. Besides the standard *t*-test (with a resulting statistic larger than 12) 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 168 out of the 182 IPOs in our sample exhibit positive initial returns.

¹² We also investigated if the age of a company at the time of the issue could serve as an explanatory variable for the amount of underpricing, but found no significant correlation between the two variables.

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, however, indicates that the data are not normally distributed.

Figure 1:

IPO Activity Between 1884 and 1914



Although not central to our analysis it is interesting to take a look at the cross-sectional distribution of initial returns across industries. We find the highest average underpricing for IPOs in the chemical sector (7.9 percent on average), the metal industry (6.3 percent), and for mechanical engineering companies (6.3 percent). The lowest average initial return is observed for banks with 1.2 percent and the leather and textile industry with 2.7 percent. Thus, underpricing is observed in all sectors of the economy.

Table 1:
Descriptive Statistics for Initial Returns

Number of Observations	182
Number of Observations > 0	168
Mean	0.0480
Standard Deviation	0.0532
<i>t</i> -value for zero mean	12.1848
Median	0.0295
Minimum	- 0.0843
Maximum	0.2495
Skewness	1.2391
Excess Kurtosis	1.9022
<i>p</i> -value Shapiro-Wilk test for normality	< 0.001

Since initial returns in our sample are not always one-day returns in calendar time, we also 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

$$IR_i^a = \frac{IR_i}{N_i} \quad i = 1, \dots, N \quad (1)$$

with IR_i (IR_i^a) as the (adjusted) initial return of IPO i ($i = 1, \dots, N$) 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 (1) we normalize all the returns as if they had been computed over a one day period. A more common adjustment might be to subtract the performance of a market index or an industry index from the initial return when it is computed over a period significantly longer than one day. Since daily index prices are not available to us, we used the adjustment in (1) to eliminate (at least partly) the effect of a longer return horizon. The lack of correcting for a general market trend would be a problem if the statistical properties of the data changed significantly. The statistical analysis, however, shows that all the main characteristics of the original initial returns remain unchanged, i.e. we

observe a highly significantly positive mean and also rejections of the normality hypothesis for a variety of tests.¹³

Another issue that is frequently discussed in the literature is the question if there is any true underpricing at all or if underwriting banks engage in activities to stabilize prices on the secondary market to avoid negative returns for IPOs so that observed distributions tend to have artificially large positive means.

This idea has first been put forward by Ruud [23]. According to the majority of theories, one reason for positive initial returns may be that underwriters deliberately underprice new issues in order to maximize the probability of placing all the shares. In contrast to such approaches, Ruud [23] argues that new issues are initially correctly priced, and that the often observed positive price jumps in the after-market are due to underwriters' price support. 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 reduce downward price fluctuations. Hence, returns are not drawn from a common distribution but from a mixture of price-stabilized and underpriced issues.

In contrast to other underpricing theories, the idea of price support seems to be consistent with both underpricing and long-run underperformance. As long as the price supporting activities continue, secondary market prices tend to be above equilibrium values, so that when the support is finally withdrawn prices will adjust downwards towards market equilibrium. The performance of IPOs will thus deteriorate when measured over longer periods.

Asquith et al. [3] take Ruud's [23] approach one step further and try to actually decompose the distribution for initial returns f into one for stabilized issues and a second one for underpriced issues. To do so they use a mixture of two normals with a mixing parameter \mathbf{a} , i.e. they assume $f = \mathbf{a}f_1 + (1 - \mathbf{a})f_2$ with f_j as a normal distribution with mean \mathbf{m}_j and standard deviation \mathbf{s}_j ($j = 1, 2$). The parameter vector $\Theta = (\mathbf{m}_1, \mathbf{m}_2, \mathbf{s}_1, \mathbf{s}_2, \mathbf{a})^T$ is then 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

¹³ The median number of days between the issue and the first recorded price on a stock exchange is six.

$$\begin{aligned} \ln L &= \sum_{i=1}^N \ln[f(\text{IR}_i)] \\ &= \sum_{i=1}^N \ln[\mathbf{a} f_1(\text{IR}_i) + (1 - \mathbf{a}) f_2(\text{IR}_i)] \end{aligned}$$

is maximized subject to the constraint $0 \leq \mathbf{a} \leq 1$. 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 underpriced issues).

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

$$\begin{aligned} \hat{Q} &= (\hat{\mathbf{m}}_1, \hat{\mathbf{m}}_2, \hat{\mathbf{S}}_1, \hat{\mathbf{S}}_2, \hat{\mathbf{a}}) \\ &= (0.0093, 0.0733, 0.0071, 0.0548, 0.3956) \end{aligned}$$

and the likelihood ratio test indicates a significant improvement of this model over the assumption of a simple normal distribution.¹⁴

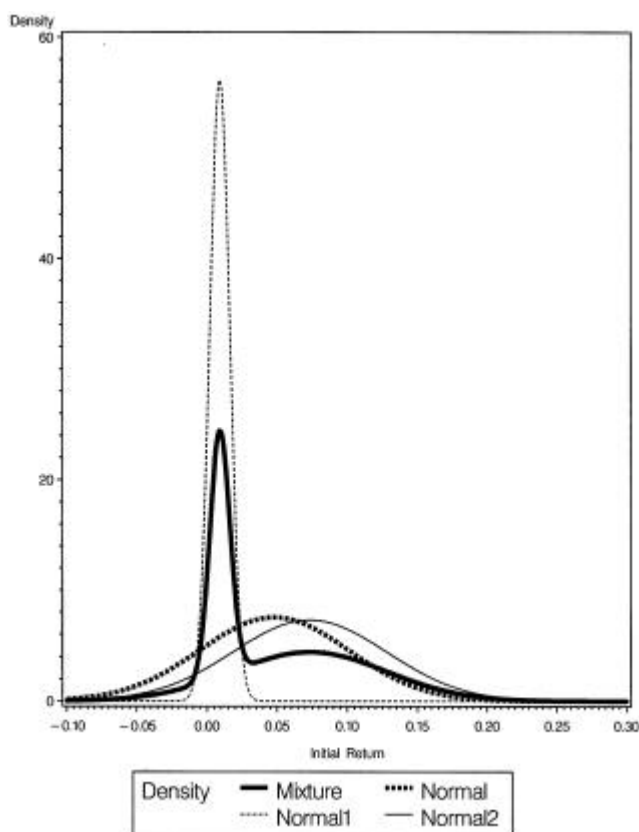
Figure 2 shows the fitted single normal distribution (denoted by 'Normal') as well as the two mixing normals ('Normal1' and 'Normal2') and the resulting 'Mixture'. The result is perfectly compatible with the findings of Asquith et al. [3]. One distribution is centered near zero ($\hat{\mathbf{m}}_1 = 0.0093$) with a low standard deviation ($\hat{\mathbf{S}}_1 = 0.0071$), whereas the second normal distribution has a much larger positive mean ($\hat{\mathbf{m}}_2 = 0.0733$) plus a much larger standard deviation ($\hat{\mathbf{S}}_2 = 0.0548$). The resulting mixture of distributions exhibits only little probability mass below zero and a fat right tail which is exactly what we would expect in the presence of price support.

Since we do not always observe our initial returns over one calendar day we have to make sure that this fact is not a latent factor that could be responsible for the results found above. The maximum likelihood estimation of the parameter vector for the adjusted returns defined in (1) 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. So,

¹⁴ 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 $\hat{\mathbf{m}} = 0.0480$ and $\hat{\mathbf{S}} = 0.0532$.

independent of which return variable we use, strong evidence in favor of price stabilization can be found.

Figure 2:
Mixture of Distributions for Initial Returns of IPOs



This is even confirmed further by looking at the fit of normal and mixed normal distributions for one-year returns of IPOs in figure 3. 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 the maximum likelihood estimation for a mixture of normals, we obtain

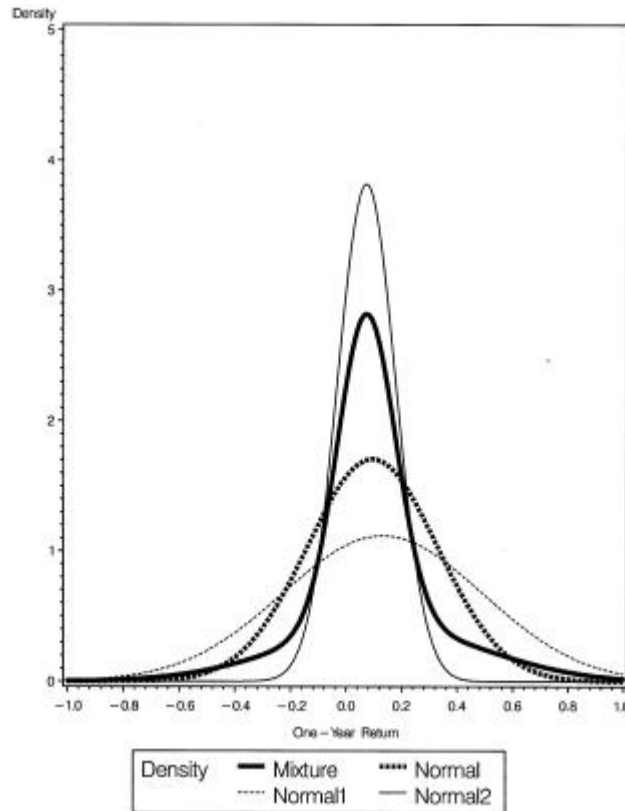
$$\hat{Q} = (\hat{\boldsymbol{\mu}}_1, \hat{\boldsymbol{\mu}}_2, \hat{\boldsymbol{s}}_1, \hat{\boldsymbol{s}}_2, \hat{\boldsymbol{a}})$$

$$= (0.0741, 0.1324, 0.1045, 0.3575, 0.6313)$$

This mixture of normals is statistically superior to the simple normal distribution as indicated by a likelihood ratio test. However, we do not 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 3:
Mixture of Distributions for One-Year Returns of IPOs



5.2 Long-Run Performance

As explained above we consider the industry index as the benchmark investment to which we compare the performance of an IPO. Existing empirical literature indicates that the length of the holding period is an important determinant for the long-run performance of IPOs. 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 descriptive statistics for the long-run performance of IPOs.

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	171	Primary	68	0.0040	3.09
		Secondary	82	< 0.0001	0.01
2 years	172	Primary	75	0.0023	2.65
		Secondary	88	0.0002	0.12
3 years	169	Primary	82	0.0001	0.16
		Secondary	96	- 0.0013	- 1.74
4 years	169	Primary	89	- 0.0003	- 0.58
		Secondary	94	- 0.0014	- 2.46
5 years	163	Primary	81	- 0.0004	- 0.81
		Secondary	91	- 0.0013	- 2.54

Table 2 shows the number of IPOs in the respective subsamples for various holding periods. 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.

In general, long-run return differences (compared to the benchmark, i.e. the industry index) 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 to all IPOs earned significantly higher returns than the industry average for holding periods up to two years as indicated by the *t*-statistics shown in table 2 (3.09 for one year, 2.65 for two years). The significance of this return advantage disappears in the third year, although the difference to the industry index still remains positive on average. From a holding period of four years on, however, even the relative advantage of the underpricing does not prevent these stocks from performing worse than the benchmark, although the difference is not statistically significant with *t*-values of -0.58 and -0.80, respectively. Overall, a participation in every possible IPO achieved better investment results than the respective industry as a whole if the shares were sold during the first two years. On the other hand, investors who had bought their shares on the first day of trading earned significantly negative returns relative to the

benchmark when the shares were held for more than three years. This is indicated by the t -statistics for the four and five year holding periods (-2.45 and -2.54) which are both significant at the 5 percent level. Thus, like in numerous other studies, there is evidence in favor of a long-run underperformance of IPO stocks.¹⁵

As suggested in the literature we try to assess the robustness of these long-run performance measures by forming calendar portfolios as suggested by, e.g., Mitchell and Stafford [19]. In each given month of the sample period, we collect the stocks that had an IPO at most n years ago, 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. The results are shown in table 3 for the case 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	Mean	t -value
1 year	0.0007	0.39
2 years	0.0003	0.19
3 years	-0.0010	-0.74
4 years	-0.0009	-0.59
5 years	-0.0011	-0.84

We obtain the typical result also found in other studies that long-run underperformance tends to disappear when measured on this basis. For all the five different calendar-time portfolios the mean returns are not statistically different from zero, a result that is also supported by various non-parametric tests.

5.3 Ex Ante Price Uncertainty

Finally, we want to investigate if there is a significant relationship between the amount of underpricing of an IPO and the subsequent return volatility of the stock. As described in

¹⁵ The results of such an analysis of long-run performance could be significantly biased downwards when a large number of companies goes bankrupt. In our case, all the firms survived the complete sampling period from 1884 to 1914.

section 4, the idea here is to use (realized ex post) return volatility as an instrument for the unobservable ex ante price uncertainty.¹⁶ We then measure the non-parametric Spearman rank correlation between underpricing and ex post return volatility. This measure seems preferable to the standard Pearson correlation measure here, since we do not want to assume a priori that the relationship between the two variables is linear. Furthermore, to avoid a spurious result by looking at just one fixed return horizon we compute this correlation for periods from one to five years. The results are shown in table 4.

Table 4:
Underpricing and Ex Post Return Volatility

Years	Rank Correlation	<i>p</i> -value
1	0.1526	0.05
2	0.2123	0.01
3	0.2429	< 0.01
4	0.2455	< 0.01
5	0.2191	< 0.01

The rank correlations are very stable around 0.2, and the *p*-value for the test of the null hypothesis of zero correlation is always below 0.05 so that we find significant evidence in favor of a positive relationship between ex ante price uncertainty and underpricing.

5.4 Impact of Regulatory Changes

As described in section 3, a major change in German stock market regulation took place in 1896/97. If underpricing is at least partly the consequence of the perception of uncertainty by investors, and if a tighter regulation of financial markets helped to reduce this structural uncertainty in German stock markets, we should observe a tendency for the amount of underpricing to decrease over time. On the other hand, the increased legal liability of underwriting banks could lead to just the opposite result, namely an increase in the amount of underpricing by which the banks could try to avoid being made responsible for unsatisfactory performance of the issue. Thus, the direction and size of the overall effect remains a purely empirical issue.

¹⁶ These returns are calculated from secondary market prices only.

A simple test of the hypothesis that underpricing declined in general over time would be to regress the underpricing (e.g. an average for the IPOs of each year in the sample) on time. A significantly negative coefficient would indicate that underpricing becomes smaller as time advances. This simple regression of initial returns on time (represented by the calendar year of the respective issue) yields a negative slope coefficient of -0.0019 with a *t*-statistic of -2.922 which is significant at conventional levels. Thus, underpricing tends to decline over time.

However, a more direct test of the hypotheses that institutional factors may be important for the occurrence of underpricing is to compare average underpricing before and after the legal reform in 1896. Here we perform a simple event study. Significantly smaller underpricing for the second period (i.e. after the reform) would favor the hypothesis that tighter regulation reduces underpricing on average.

Since the contents of the exchange reform act were discussed in parliament and in various commissions before the law was passed, market participants knew from early 1896 on that the institutional environment could change considerably in the near future. Although it does not represent a strictly scientific proof of the conjecture that underpricing is less likely in markets with tighter regulation, it is nonetheless striking to note that all of the 20 IPOs in 1896¹⁷ occurred before the law was passed officially, i.e. there are no IPOs in the second half of the year.

Splitting the sample of IPOs into two subsamples containing issues before and after the reform act, respectively¹⁸, and comparing the mean underpricing for the two groups via a Wilcoxon test yields a highly significant test statistic, which might lead to the conclusion that the institutional changes were indeed responsible for the observed reduction in underpricing. However, performing a sensitivity analysis by introducing artificial breakpoints in 1895, 1897, 1898 and 1899 and repeating the test for the two resulting subgroups shows that we always obtain significantly lower underpricing in the second half of the sample. Thus, there is no direct statistical evidence that it was just the introduction of the new law which caused the decrease in average initial returns.¹⁹

¹⁷ That is, all of the IPOs for which we have complete data in our sample.

¹⁸ We excluded the period from July 1896 to June 1898 so that the first subsample contains issues up to June 1896 whereas the second is made up of issues from July 1898 on.

¹⁹ There is no evidence for an impact of regulatory changes on long-run performance of IPOs. Issues before and after the Securities Exchange Act showed no statistically significant differences with respect to this variable.

One possible reason for this may be that the changes brought about by the new regulation had been in effect on the majority of stock exchanges even before the law had actually been passed. Thus, the Exchange Reform Act might represent to a large extent the codification of rules which had not been legally binding before, but which had been considered as 'good market practice'.

6 Summary

This paper investigates IPOs on the German capital market before World War I. Since there is no previous work in the empirical literature using this sample period we are able to provide a test of the robustness of the results obtained by earlier studies.

The first central result is that we also find significant underpricing. More than 90 percent of the IPOs in our sample exhibit positive initial returns. Furthermore, we also find evidence for price stabilization. Initial returns are not drawn from a single normal distribution, but rather from a mixture of two normals. Looking at long-run performance the evidence for our sample is again supporting previous evidence, since IPOs perform worse than the benchmark when the shares were bought on the secondary market and held for more than three years. Also the fact that underperformance tends to be weaker when calendar time portfolios are considered is consistent with previous studies.

Overall, the results of this paper show that existence of underpricing and long-run underperformance (at least when measured the usual way) is not specific to recent sampling periods for 'modern' capital markets. Given that general economic conditions have certainly changed between 1890 and 1970 we can conclude that there has to be a set of common factors for the two periods which cause IPOs to be underpriced and to underperform over longer holding periods. An important next step is now to investigate seasoned equity offerings (SEOs). There is a large body of empirical literature and theories on the performance of SEOs, and the analysis of our data could help to discriminate between various explanations for the empirical results.

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