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Abhandlungen

Returns on German Stocks 1954 to 2013

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Abstract

Existing time series of the returns on German stocks are either short or have weaknesses. We discuss the problems of creating such a time series and then report our monthly series based on all stocks in the top segment of the Frankfurt Stock Exchange. We compare our return series with the returns implied by major German stock market indices. In each of the four sub-periods we look at, which together cover the full 60 years, our time series is fully in line with at least one of the indices. In addition to looking at nominal rates of return we look at real returns and at excess returns with respect to the one-month money market interest rate. We show that the riskiness of a 20-year investment in German stocks, measured by the frequency of negative excess returns, has not increased but rather decreased since the middle of the 1960s.

Renditen deutscher Aktien 1954 bis 2013

Zusammenfassung

Existierende Zeitreihen der Renditen deutscher Aktien sind entweder kurz oder haben Schwächen. Wir erörtern zuerst die Probleme der Erstellung solcher Reihen, dann präsentieren wir unsere eigene monatliche Zeitreihe, die auf allen Aktien des obersten Segments der Frankfurter Börse basiert. Wir vergleichen unsere Zeitreihe mit den Renditen, welche die wichtigsten deutschen Aktienindizes implizieren. In jeder der vier untersuchten Unterperioden, die zusammen die gesamten 60 Jahre umfassen, steht unsere Reihe voll im Einklang mit zumindest einem in der Unterperiode existierenden Vergleichsindex. Wir betrachten zusätzlich zu den nominalen Renditen auch die realen Renditen und die Überrenditen im Vergleich zum Geldmarktzins für einmonatige Anlagen. Wir zeigen, dass das Risiko von 20-jährigen Anlagen in deutsche Aktien, gemessen mit der Häufigkeit von negativen Überrenditen, sich seit Mitte der sechziger Jahre nicht erhöhte, sondern eher verringerte.

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I. Introduction and Summary

Data on the historical (rates of) return on German stocks has been used extensively in academic studies during the last 30 years. Non-academic interest in this data came mostly from private and institutional investors and their advisors, particularly in the context of asset allocation decisions,[1] and from firms, in efforts to estimate their cost of equity capital. Since the beginning of this century, the historical risk premium on German stocks has played an important and well documented role in several areas subject to laws and their implementation, including the determination of fair returns for regulated industries[2] and freeze-outs of minority shareholders[3]. In these areas, long and accurate time series of the historical returns on German stocks are needed, which include dividends, have been constructed on the basis of stable rules over time, are well documented and are free of biases. The international interest in such data also has increased considerably in recent years.[4]

Existing time series of the (total) returns on 'all' German stocks typically do not meet all of these requirements. The time series of *Stehle/Hartmond*, which in 1991 was published in this journal, filled this gap but has not been updated since then. By including the years 1989 to 2013, we present a much longer series, which has the same coverage (all stocks listed in Frankfurt's top segment) and uses the same weighting throughout.

We refer to the updated time series as the *Stehle* et al.[5] total return time series for the top segment of the Frankfurt Stock Exchange, more

[1] *Kachel/Kuhn/Prugovecki* (2004) summarizes a number of publications, which were written in this context.

[2] Data of the return on the market portfolio has been used in the regulation of the German telecommunication, gas, and electric power networks for more than ten years, see *Stehle* (2010).

[3] Freeze-outs of minority shareholders in Germany were regulated by the "Wertpapiererwerbs- und Übernahmegesetz" in 2002. The Higher Regional Court (Oberlandesgericht) Stuttgart discussed the problems associated with the rate of return on the market portfolio extensively in its decision dated May 4, 2011 (20 W 11/08).

[4] In a series of publications *Dimson/Marsh/Staunton* have provided estimates for the annual returns on the equity, bond, and bill markets for several countries, which go back more than 100 years, see e.g. *Dimson/Marsh/Staunton* (2014). In recent years, their estimates were updated and improved annually.

briefly as Frankfurt Top Segment Series or FTS-Series. Like the DAX index family, our return calculations include regular and 'bonus' dividends, stock dividends (Kapitalerhöhungen aus Gesellschaftsmitteln), the value of rights issues (Bezugsrechte), and the effects of stock splits (Nennwertumstellungen). As in the calculation of the return on the 'market portfolio', returns on individual stocks are weighted by their total market capitalization (value-weighting). Our series is created with only one objective: to serve as a basis for stock market research. We therefore improve the whole time series whenever we find important errors or weaknesses. Most providers of modern indices do not change the historical time series when the index calculation procedure changes or when inconsistencies in the underlying data are discovered.[6]

We compare our total return FTS-Series with other total return series on 'all' German stocks, and with important total return indices (in German: Performanceindizes), which include all or most German stocks. Such a comparison is possible because the rate of change of a Laspeyres index, if properly calculated, is equal to the value-weight return on the portfolio of the included stocks (see Section V.1.). Included in our comparison are:

– The CDAX (Composite DAX), currently the most prominent proxy for the German market portfolio, for which two historical performance time series exist. Both cover the time period from 1970 to the official index start in 1993.
– The DAFOX, on which most academic studies on the German stock market are based, covers the years from 1960 to 2004.
– The total return time series of *Bimberg* (1991) and *Gielen* (1994). These are based on the data of the Federal Statistical Office (Statistisches

[5] Et al. refers to the former research assistants and doctoral students Anette Hartmond, Christian Wulff, Stefan Daske, Anja Schulz, Roman Brückner, Patrick Lehmann, and Martin H. Schmidt. Without their help, a time series that covers such a broad universe of stocks for such a long time period could not have been created. Over the years, this effort was financially supported by DFG research grants and research contracts with the Deutsche Börse AG, the Institut der Wirtschaftsprüfer in Deutschland e.V. (IDW), Metzler Bank, and Union Investment. Additional financial support came from the Landeszentralbank Berlin, University of Augsburg, and Humboldt University. Free access to data provided by Hoppenstedt-Verlag and by Thomson Reuters Datastream (through the RDC of SFB 649) facilitated our efforts.

[6] An exception to the rule is the Federal Statistical Office. When they changed their calculation procedure in 1984, they recalculated the years starting in 1976 and compared the old and the new series (*Lützel/Jung* (1984)).

Bundesamt) and cannot be updated since the Federal Office stopped providing the input data in 1995.

– The MSCI Germany (starting in 1970) and the Datastream-Germany Market series (going back to 1973). Both are used in many studies covering several countries.

Typically index calculations are not verified by an external auditor and the providers do not guarantee that their indices are always calculated free of errors.[7] Thus having a number of different indices, which imply similar results, increases our confidence in their quality. Since other total return series cover shorter time periods and have changes in their calculation procedure, we divide the 60 years in four sub-periods and compare at least two total return series for each period. Our comparison also includes a number of price indices (in German: Kursindizes) such as the Commerzbank-Index (covering the years from 1953 to 1998) and the still existing F.A.Z.-Index, which played an important role before the introduction of the DAX.

Several academics have calculated time series for the return on the market portfolio of all German stocks as a part of Fama-French factor data sets and have made them available on the Internet. These series are typically based on commercial databases. The longest one starts in 1984. We do not discuss them because *Brückner/Lehmann/Schmidt/Stehle* (2015) compare them in detail with some of the series we look at for the years 1996 to 2011. They report that some of these series deviate considerably from the series we discuss here.

Between 1977 and 2000, German stockholders received, on top of their cash dividend, a corporate income tax credit (Körperschaftsteuergutschrift). From their perspective, this was nearly as valuable as cash dividends. *Bimberg* (1991) and *Gielen* (1994) include the tax credit, whereas the DAX index family does not. We strongly feel that this additional financial benefit of holding stocks (about 1.4 %-points per year) should be included in return calculations whose objective is to serve as a basis for research. We offer two time series, one with and one without the tax credit. We use our FTS-Series without the tax credit only in comparisons with other indices or time series that do not include it. For all other purposes we use the FTS-Series with the tax credit.

In a final step we look at real returns, at excess returns with respect to the one-month money market interest rate, and at the returns for an in-

[7] See, e.g., Deutsche Börse AG (2014), p. 2.

vestment horizon of twenty years. Over the full 60 years, we estimate a mean real excess return of 5.92 %. In the last two non-overlapping 20-year periods the annual real excess returns are 5.43 and 5.34 %. The historic 20-year sub-periods have very different levels of inflation and short-term interest rates. Thus looking at real returns or excess returns is much more appropriate than comparing nominal rates. We also show that the riskiness of a 20-year investment in German stocks, measured by the frequency of negative excess returns, has not increased but rather decreased since the middle of the 1960s.

When we discuss the characteristics of the return time series we focus on the compound return (geometric mean) over long time periods. The geometric mean is emphasized in our discussions because it is the proper mean for an investor. The arithmetic mean of return time series plays an important role in the context of the valuation of firms (*Stehle* (2004)). In the regulation of network industries, the average of the geometric and the arithmetic mean is often recommended (*Stehle* (2010)).

When we compare the return on stocks to the return on fixed income instruments we use the short-term interest rate. This comparison is the traditional approach in finance textbooks. For some applications, including the valuation of firms and long-term investment projects, and the determination of fair returns in regulated industries, the return on stocks is typically compared to the return on long-term government bonds (*Stehle* (2004, 2010)).

Private and even institutional investors may have a hard time to replicate the geometric mean return on stocks (before taxes) presented here. The administrative cost of running a passive investment strategy is at least ½ % per year. For most mutual funds available to the German public, these costs are higher than 1 %. In addition, mutual fund investors, implicitly or explicitly, have to pay for sales and marketing costs (*Stehle/Lehmann* (2009)).

The paper proceeds as follows. We first discuss some relevant details of the German stock market, especially those different to the U.S. or the U.K. (Section II.). In Section III., we describe our database and calculation procedures. In Section IV., we report and analyze our return time series. In Section V., we compare our time series to existing time series. In Section VI., we look at the historic returns over 60 years (1954 to 2013) and three 20-year sub-periods, in nominal and real terms. In Section VII. we summarize our main results and also have the courage to present our return estimate for the next 20 years.

II. Relevant Details of the German Stock Market

Avoiding biases caused by sample construction, survivorship, hindsight, and backfilling is of crucial importance when constructing a historical return time series for a specific universe of stocks. The German tradition of having several stock exchanges, each with several segments, poses a number of problems in this respect. In Sections II.1., II.2. and II.3. we go more into the exchange and segment details than the 1991 paper, because these play a role in our index comparisons and because the Frankfurt Stock Exchange has changed its segment structure several times since 1991. Section II.4. focuses on penny stocks and delistings, II.5. on preferred stocks (Vorzugsaktien) and profit participation bonds (Genussscheine). Should they be classified as stocks and included in the calculation? Section II.6. describes some issues relating to the number of shares issued by a firm, II.7. explains the corporate income tax credit in more detail.

1. Stock Exchanges

In 1934 the Nazi government closed twelve of the existing 21 stock exchanges, which all were founded before 1870, when Germany consisted of independent kingdoms. Of the remaining nine, Breslau and Leipzig were closed in 1945, and Bremen was reopened. In the 1950s, when our time series start, eight stock exchanges existed in Germany. Düsseldorf, the center of the coal and steel industry, and Frankfurt, the center of the banking industry, had equally important exchanges in the 1950s. Munich and Hamburg also had important ones. The exchanges in Berlin, Bremen, Hannover, and Stuttgart were the smallest. In the 1950s and 60s, most stocks were traded simultaneously at more than one exchange. The successful firms increased their number of listings and possibly added listings at larger exchanges. However, only few were traded in the top segments of all eight exchanges (18 in 01/1958, source: Hoppenstedt Kurstabellen). Typically, the trading volume was the highest at the home exchange (Heimatbörse) or the two largest exchanges.

Guy (1977) estimates that in 1970, Düsseldorf was ahead of Frankfurt in the number of stocks that designated it as their home exchange.[8]

[8] *Guy* (1977) also looks at federal stock transfer tax statistics, volume data and the number of listed stocks.

Over time, Frankfurt's exchange became more and more important, but in 1995 still only 529 out of 812 (65 %) stocks were listed in Frankfurt (Deutsche Börse AG (1999)). In 2008, it was 1054 of 1178 (89 %).[9] Presently, Frankfurt is by far the most important German stock exchange; the other exchanges are often labeled as 'regional exchanges' (Regionalbörsen).

2. Market Segments

In addition to the 'horizontal' market segmentation, a 'vertical' one exists in Germany. During the time period covered by our study, three tiers called segments existed at most exchanges for most of the time. We typically only refer to the top, middle, and lowest segment since their names have changed over time.

The Official Market (Amtlicher Markt before July 1, 2002 Amtlicher Handel) was traditionally the highest ('top') market segment at all exchanges. This segment was regulated by a national law (Börsengesetz, stock exchange act) since 1896 and supervised by government agencies. The middle and also the lowest segments traditionally were 'only' subject to rules laid down by the local exchanges, which differed to some extent between the exchanges. Before 1987, the middle segment was named Geregelter Freiverkehr, after 1987 Geregelter Markt (Regulated Market). The lowest segment, at all exchanges, was named Ungeregelter Freiverkehr before 05/1988 and Freiverkehr (Regulated Unofficial Market) afterwards. The Frankfurt Stock Exchange changed its name to Open Market in 2005. The Open Market was for several years subdivided into three parts: (1) the Entry Standard (since 2006), (2) the First Quotation Board (from 2008 to 2012), and (3) the Second Quotation Board (it exists since 2008 and was renamed Quotation Board end of 2012).

On a given day, a specific stock may be listed in only one segment of a specific exchange. It may be listed in the same, in a higher or lower segment, at one or several other exchanges. A specific stock may move to a higher segment of an exchange at any time if it fulfills its listing requirements. In the long run, successful stocks of the lowest or middle segments of regional exchanges typically move upwards and are listed on

[9] Source: Deutsches Aktieninstitut e.V. (2011). The numbers include all segments existing at the time. *Brückner* et al. (2015) list more detailed annual numbers for several years, see their Table 2.

additional, often larger exchanges; unsuccessful ones move downwards and give up their listings at some exchanges.[10]

The amendment of the stock exchange law dated June 21, 2002 allowed the exchanges to create additional 'segments' within the three traditional segments. The Frankfurt Stock Exchange utilized this opportunity and in 2003 introduced two 'levels of transparency' that still exist: the General and Prime Standard.[11] In the Prime Standard, (issuers of) stocks have to maintain higher transparency standards subsequent to admission; i.e., quarterly reports have to be published, at least one analyst conference per year has to be held, and a public corporate calendar must exist and has to be updated continuously. These additional requirements and also the ad-hoc disclosures must be made in English and in German. Only stocks in the Prime Standard are eligible to be included in the 'selection' indices of Deutsche Börse AG (DAX, MDAX, SDAX, and TecDAX).

Between 1989 and 2003, the stock exchange law and the local rules of the Frankfurt Stock Exchange were changed a number of times, in the end the regulation of the top and the middle segment were nearly identical (*Brückner/Stehle* (2012)). In 10/2007 the two segments were combined and named Regulated Market (Regulierter Markt), which is a term used in the German version of the European Markets in Financial Instruments Directive (MiFID).[12] Thus, since 2007 only two segments have existed. However, because of the two transparency levels within the Regulated Market, the Frankfurt Stock Exchange is practically still partitioned into three 'segments'.

In the 1990s, additional 'segments' were introduced at some exchanges, most importantly the Neuer Markt in Frankfurt. It was opened on March 10, 1997, and designed to give young technology based companies access to capital. The Neuer Markt was not a segment in legal terms; it was only exchange regulated and the stocks typically had a formal listing in the middle segment. It may be compared to the NASDAQ in New York, the AIM in London, or the Nouveau Marché in Paris. The Neuer Markt attracted a large number of IPOs of young technology firms and was very

[10] *Brückner/Stehle* (2012) compare the top and middle segment of the Frankfurt Stock Exchange and analyze the migration between the two.

[11] http://deutsche-boerse.com/mda/dispatch/de/listcontent/gdb_navigation/mda/20_indices/10_news/30_Products/Content_Files/11_index_news/is_news_25112002.htm (June 2, 2014).

[12] It sometimes creates confusion that before 2007 the middle segment (Geregelter Market) was named in English Regulated Market, after 2007 the top segment.

successful in the beginning; see e.g. *Vitols* (2001) and *Kiss/Stehle* (2002). However, many irregularities and the disastrous performance from 2000 to 2002 (burst of the dot-com bubble) severely damaged its reputation. The composite index of the Neuer Markt, the NEMAX All Share reflects the initial success and the catastrophic end. Between 03/1997 and 03/2000, this index increased from 500 to 8559 points. From this peak, the index fell to its minimum of 358 points on March 12, 2003.[13] As a consequence, it was closed in 2003 and the stocks stayed with their formal listing. A few stocks made it, sooner or later, to the top segment, many ended up in the lowest segment.

Historically, the formal and informal admission requirements were higher in the top segment than in the middle segment. The regulation of the lowest segments was traditionally the weakest. Investor protection in this segment is still insufficient today; e.g., issuers are not required to publish a prospectus, firms are not obliged to publish ad-hoc announcements, insiders may trade secretly, annual reports can be based on the German accounting standard (instead on IFRS), and firms do not have to publish the names of large shareholders. A stock may be listed in the lowest segment without a formal application by the issuing firm, it suffices if a curb broker (Freimakler) believes that there is a demand for trading. Under European law (MiFID) the lowest segment is classified as a Multilateral Trading Facility (MTF) since November 2007. The German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin) has repeatedly warned investors about the special dangers associated with stocks listed in the lowest segment.[14] In addition, many reports by the press document market manipulations and other activities that may be labeled as criminal.

Criminal activity in the lowest segment has probably varied considerably over time. It has been very high in recent years. For instance, on April 14, 2012, the Deutsche Börse AG announced that the First Quotation Board, which was part of the lowest segment, would be closed on December 15, 2012, because of multiple cases of market manipulation.[15]

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[13] Great care must be taken in a standard risk/return analysis of this segment: from the beginning to the end of the segment, the arithmetic mean of the monthly returns was 1.07 %. The monthly geometric mean (compound return) was minus 0.31 %.

[14] E.g. in their annual reports 2008 (p. 156), 2009 (p. 174), 2010 (p. 46), 2011 (p. 197), 2012 (p. 176).

[15] The Frankfurter Allgemeine Zeitung of February 16, 2012 describes the enormous extent of the criminal activities in this market segment in more detail, see

As a result, 96 German stocks (and many more foreign stocks) lost their Frankfurt listing, which possibly was their only one. Sixteen stocks were already suspended one year earlier (see Hoppenstedt Aktienführer 2014). Taken together, the number of German stocks traded in the lowest segment in Frankfurt was reduced by more than 50 %.

3. Relative Importance of Frankfurt's Stock Market Segments

To give an overview of the economic importance of the Frankfurt stock market segments, we show in Figure 1 the number of stocks listed (bottom) and their relative market capitalization (top). We do not include the lowest segment in the figure but mention a few numbers relating to it in the text (source: Deutsche Börse Factbooks). Note that we only include listings of German stocks.

Before the change of the segment structure in May 1987, 276 stocks were listed at the Frankfurt Stock Exchange. Only 26 stocks were listed in the middle segment, which were not listed in the top segment of another exchange, 250 were listed in the top segment (*Brückner/Stehle* (2012)).

About nine years later, in 12/1996, 355 stocks were listed in the top segment, and 80 in the middle segment, giving a total of 435 (see Figure 1). About 66 stocks were listed in the lowest segment. All large, most mid-size and many small companies were listed in the top segment. In the middle segment some mid-size but mostly small companies were listed, in the lowest segment typically very small companies.[16] As a consequence, even during the years in which the middle segment contributed more than 20 % to the number of stocks, its economic significance, measured by the total market capitalization, was small (less than 3 %). The economic significance of the lowest segment was probably less than ½ %.

In 12/1998, 382 stocks were listed in the top, 85 in the middle segment, and 54 in the new 'segment' Neuer Markt totaling 521. The economic importance of the latter two segments combined was still less than 5 % (see Figure 1, top graph). In addition about 88 stocks were listed in the lowest segment.

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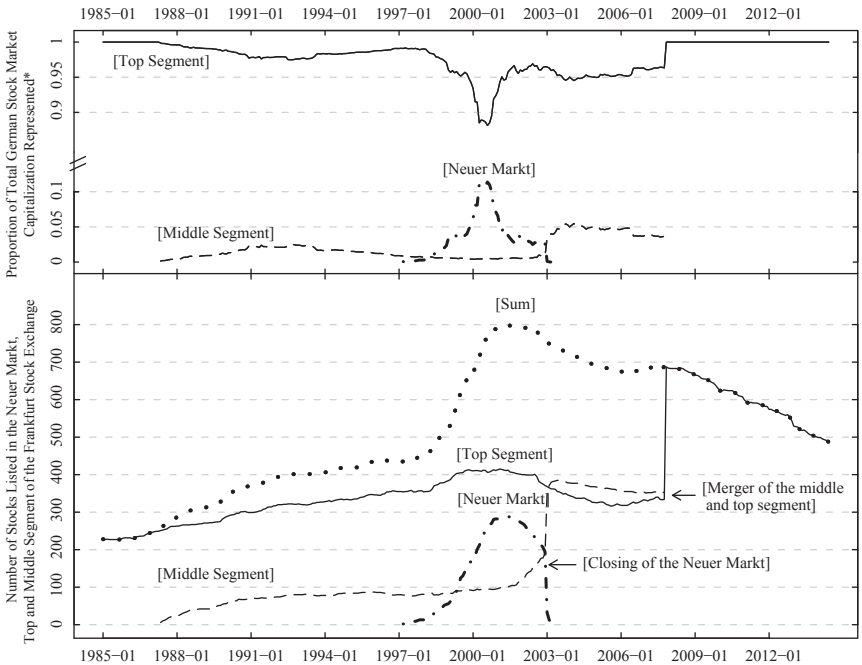
http://www.faz.net/aktuell/finanzen/aktien/first-quotation-board-boerse-schliesst-marktsegment-11640303.html (June 3, 2014).

[16] *Brückner* et al. (2012) describe the market capitalizations of the firms in the top segment in more detail, see their Table 1. *Brückner/Stehle* (2012) describe it for firms in the middle segment, see their Table 2.



Notes: This figure is based on our own data. * "Total German Stock Market Capitalization" does not include other German stock exchanges and the lowest segment of the Frankfurt Stock Exchange.

Figure 1: Statistics about the Major Stock Market Segments of the Frankfurt Stock Exchange

Another two years later, in 12/2000, the number of German firms listed in the top segment had increased to 411 (an increase of 8 % since 12/1998). The middle segment had increased to 95 (+12 %), the Neuer Markt to 282 (+422 %). As a consequence of the increase in the number of listed stocks and the high stock returns in the Neuer Markt (the NEMAX All Share increase by more than 1,500 %), its economic importance increased, representing more than 10 % of the total market capitalization. About 160 stocks were listed in the lowest segment – an increase of 81 % since 12/1998.

When the Neuer Market was closed after its crash, the number of stocks in the middle segment increased drastically to 385 in 06/2003, because the Neuer Markt stocks had a formal listing in the middle segment. The middle segment then had the same number of listed stocks as the top segment (see Figure 1, bottom graph). But 95 % of the total market capi-

talization was still represented by the top segment and only 5 % was represented by the middle segment. Between 12/2000 and 6/2003, the number of stocks in the lowest segment changed only minimally.

From 06/2003 to 10/2007, the number of stocks decreased to 334 (top) and 354 (middle). The number of German stocks in the lowest segment increased by 150 % to around 400. Since 10/2007, when the top and the middle segment were combined to the new top segment, the number of stocks has decreased to only 487 (06/2014). The number of stocks in the lowest segment also decreased.

4. Penny Stocks and Delistings

Some stock exchanges, e.g. the NASDAQ, delist penny stocks, that is, stocks with a share price of less than one.[17] In contrast, German stocks are not delisted according to such rules. In fact, in Germany's top and middle segments, until recently, it was very difficult to delist a stock, both for the company and for the exchange.[18] Companies in Germany are legally obliged to file for bankruptcy if their net worth turns negative (*Davyenko/Franks* (2008)). Bankrupt firm often remain stock exchange listed for a long time, mostly as penny stocks, if the bankruptcy trustee does not delists the stock.

We observe that most penny stocks are stocks of (nearly) bankrupt firms that no longer publish financial statements. The return on penny stocks typically has a much higher standard deviation than the return on stocks with higher prices because minor price changes might yield returns of 100 % or more. The BaFin regularly warns investors that price manipulations occur frequently in penny stocks (see e.g. BaFin (2013)).

The impact of penny stocks on the rate of change of an index based on market value weights is practically zero since they typically have a very low market capitalization. However, this is not always true. One example

[17] See NASDAQ Stock Market Rules, Rule 4000 Marketplace Rules, The Bid Price Requirement, http://cchwallstreet.com/nasdaq (July 21, 2014). The SEC refers to penny stocks as "a security issued by a very small company that trades at less than $5 per share", see http://www.sec.gov/answers/penny.htm (July 21, 2014).

[18] In 2001, the Deutsche Börse AG attempted to delist penny stocks from the Neuer Markt, but was not successful, see *Brückner/Stehle* (2012). Recently Germany's highest court (Bundesverfassungsgericht, decision 1 BvR 3142/07) allowed that stocks in the top segment are taken to a lower segment by the company.

is Infineon Technologies AG, whose stocks traded below 1.00 EUR from 12/2008 to early 2009, but in fact has been included in the DAX since 2000 (with only a short interruption in 2009). Hence, the classification of a stock as a penny should be based not only on the raw price but also on a second criterion like the market capitalization.

5. Common Stocks and Preferred Stocks

Many German firms issue two classes of stocks, Stammaktien (typically translated as common stocks) and Vorzugsaktien (typically translated as preferred stocks, we think a better translation is non-voting shares). The risk-return characteristics of Vorzugsaktien are very similar to those of common stocks, while U.S. preferred stocks are economically very similar to bonds.[19] Vorzugsaktien in fact are very similar to the U.S. common stock class of dual-class firms, which have inferior voting power. Vorzugsaktien typically have, by the corporate charter, a small dividend advantage compared to common stocks. Typically they also have a small minimum dividend, which is cumulative, that is, if not paid in a year it must be paid in the following year(s). Whenever a firm is behind schedule in paying the minimum dividend, common stockholders may not receive a dividend payment. There is no upper limit on the dividend on Vorzugsaktien, so in exchange for not having voting privileges their owners are always better off with respect to dividends than the owners of common stocks.

The fraction of firms in the top segment of the Frankfurt exchange that issues preferred stocks increases from 8 % in the late 1950s to 15 % around the end of the century, and then decreases to 8 % in 2007. Typically, both classes of stocks are traded on an exchange, preferred stocks typically with a discount (*Daske/Ehrhardt* (2002)). By law, only 50 % of the shares can be non-voting. Majority shareholders typically hold around 50 % of the common stocks.

6. The Number of Shares Issued by a Firm

For some firms the number of shares outstanding (according to the balance sheet) differs significantly from the number of exchange-tradable

[19] In the U.S., dividends on preferred stocks typically have a specified level and must be paid before common stockholders receive dividends.

shares (der zum Börsenhandel zugelassenen Aktien). The most prominent example is the Deutsche Telekom AG, which from 11/1996 to 04/1999 had approximately 2.993 billion shares outstanding of which only one billion were exchange-tradable. The federal and state governments held the rest. In addition, not all exchange-tradable shares are freely available to public investors because parts are typically held by strategic investors, family members, etc. In these cases, the free float number of shares, this is the number of shares available to public investors, can be significantly smaller and amount to less than 10 %. When calculating portfolio or index returns it has to be decided, which of the three numbers is used. Typically, modern indices apply free float weighting. *Deininger* (2005) discusses the problems associated with these weighting procedures.

Some databases, e.g. Datastream, supply shares outstanding as the standard number of shares. *Brückner* et al. (2015) argue that including the unlisted shares improves the firm size estimate. After World War II in many cases share ownership could not be determined. If a stockholder wanted to sell shares, the ownership had to be legally established (für handelbar erklärt). Stocks whose ownership could not be established were traditionally also not included in the indices.

7. Taxes

Prior to 1977, dividends were taxed at both, the corporate and the personal level. This double taxation of dividends was eliminated for German shareholders from 1977 to 2000. In addition to the 'cash dividend', local investors received a voucher from the tax authorities in the amount of the corporate income tax that was paid on their dividends (corporate income tax credit, Körperschaftsteuergutschrift). This voucher could be used to pay the personal income tax or to receive a tax refund (see *Stehle/Hartmond* (1991) or *Murphy/Schlag* (1999) for details). From 1977 to 1993, the value of these vouchers were 9/16 (56.25 %) of the cash dividend. As a consequence of the reduction of the corporate income tax rate to 30 % in 1994, it was 3/7 (approx. 42.86 %) of the cash dividend from 1994 to 2000. However, this imputation system ended in 2000 and investors received their last voucher with dividends paid in 2001 (for fiscal year 2000).

A return calculation that includes the corporate income tax credit assumes the perspective of a German investor with a marginal tax rate of 0 %. Thus it can be directly compared to the return on fixed income securities. If the tax credit is not included, the calculated return would be

equal to the after-tax return of a German investor with a marginal tax rate of 36 % (30 % after 1994). In a comparison with the return on fixed income securities, the interest rate would have to be adjusted by the tax rate. Over the full time period the tax credit was granted (1977 to 2000), we estimate an average benefit of 1.4 %-points per year. Foreign investors in German stocks officially were not entitled to a refund of the corporate income tax. We believe that by proper strategies (cum-ex arbitrage, dividend stripping) many received at least a partial refund.

III. Rate of Return Calculation and Data Quality

Our monthly (rate of) return calculations are based on German stocks listed in the top segment of the Frankfurt Stock Exchange. We classify a stock as 'German' if it is a domestic stock according to Hoppenstedt Kurstabellen. More recently, we require the prefix "DE" in a stock's ISIN. We start to include a specific stock at the end of the month in which the listing in the top segment occurred and exclude it when it is not listed there anymore. We focus on the top segment of the Frankfurt Stock Exchange for several reasons.

Brückner/Stehle (2012) analyze stocks listed in the middle segment of the Frankfurt exchange, but not in top segments of other exchanges for the years 1987 to 2007. They report that this segment was regulated nearly as strictly as the top segment, and its stocks had average returns comparable to those in the top segment. Their inclusion would increase the number of stocks in the 1990s by roughly 25 %. Because the market capitalization of these firms is very small compared to those in the top segment, their inclusion would have a small effect on value-weight returns (see Section II.3.). Nevertheless, with the focus on the top segment, the performance of German stock returns may be slightly biased. However, the main reason why we exclude the middle segment is that we do not have data for the years before 1987. The stocks in the lowest segment we would not include, even if we had the necessary data (for the reasons see Section II.2.). The stocks listed in the lowest segment are also not included in the other indices or time series we discuss. We also do not include the Neuer Markt during its existence.

Due to their similar risk-return characteristics we include both, common and preferred (non-voting) stocks, as long as they fulfill our requirement of being listed in the top segment of the Frankfurt Stock Exchange. But we do not include profit participation bonds (Genussscheine). These

securities, which in certain time periods have been very popular in Germany, are economically very similar to income bonds, bonds which only pay interest if earnings exist. We also do not include foreign stocks and exchange-traded mutual funds (ETFs). Some included firms focus on real estate transactions, a few of them belong to the group of the top 100 firms by market value. Among them may be German REITs (GREITs), but only a few very small ones and only in the last five years.

Undoubtedly, during the time period we look at, the tendency existed that successful firms, which were initially listed only at a small exchange, got additional listings at more and/or the larger exchanges, while their unsuccessful counterparts did not get additional listings. Therefore a sample that is based on the listing in Frankfurt should not include the stocks during prior periods in which they only were listed at regional exchanges. The ideal solution would be to include the stocks from all exchanges. Such an index or return time series has not been created yet. We focus on the stocks listed in Frankfurt, because including the other exchanges into our database would be very costly. Not including them may create a biased sample of the over-all German market, especially in the years before the 1990s.[20] We believe that in our market-value weighted time series the bias is small and that the results we report for the top segment in Frankfurt is a good estimate of the mean return on all stocks listed in the top segments of all German exchanges.

The data used to calculate stock returns is from a database, which was started in 1977 by Richard Stehle. Initially printed data from Amtliches Kursblatt der Frankfurter Wertpapierbörse, Hoppenstedt Kurstabellen, Hoppenstedt Aktienführer, Saling Aktienführer, and Handbücher der Deutschen Aktiengesellschaft (HBDA) were collected, cross-checked, and digitalized. Once digital data was made available to us by the Karlsruher Kapitalmarktdatenbank (KKMDB) around 1993, by the Börsen-Zeitung around 2000, and by Datastream around 2004, we used these sources more frequently. 1995 was the last year we hand-collected data. From 11/2007 onwards Datastream is our primary source.[21]

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[20] In the London Share Price Data Base for the UK, maintained at the London Business School, a different approach is used for the years 1955 to 1974: A random sample of all UK stocks is created, which by construction, is fully representative of the whole UK stock market.

[21] Richard Stehle is grateful to those who helped in this process over the years, mainly the creators of the FTS-Series plus Elke Hörnstein, Wolf Bay, Ralf Sattler, Jürgen Warfsmann, Norman Gehrke, Rainer Huber, Olaf Erhardt, Jürgen Maier, Ralf Koerstein, Yvette Richter, Olaf Grewe, Sascha Lehr, Sven Brüsewitz, Imre

Our database generally contains the following data types: the last price of each month, the number of shares outstanding and the number of exchange-tradable shares at the end of each month, dividends, information on pure and reverse stock splits, stock dividends, right issues, and other financial benefits. Including all cash and stock dividends, splits and rights issues is extremely important because stock prices usually remain fairly constant in the very long run. The shares of the Deutsche Bank were traded, e.g, for 250 Goldmark in 1910 and 1914. In 1958, 1974, and 1979 they were traded for 250 D-Mark. The Daimler-Motoren-Gesellschaft was quoted in 1916 for 600. The shares of Daimler Benz AG had the same price in 1958, 1965, 1983, 1992, and 1995. The stock price of the Harpener Bergbau AG was 180 in 1913, 1947, 1968, 1975 and 1981.

To ensure a very high data quality we compared our data on the 100 largest stocks for the years 1974 to 1995 with the data of the KKMDB, item by item. We found a large number of discrepancies, which we checked with other data sources. We then either corrected our database or notified Karlsruhe. We also checked all very large monthly returns. In addition, *Brückner* (2013) compared our data on the top segment with Datastream (1974 to 2007), also item by item. In case of a difference, he also went to other data sources, identified the correct data and corrected our data, if necessary. As a consequence of these and other checks we have made since starting the database in 1977, many returns on individual stocks and subsequently our FTS-Series has improved. The most drastic change is that we now report a return of 85.27 % for the year 1954, in 1991 we reported 75.8 %. Another large change relates to the year 1960. Originally we reported 45.9 %, now 35.78 %. However, the data improvements affected our estimations on the historic return on German stocks only minimally. For the 17 years from 1954 to 1970, we originally reported (*Stehle/Hartmond* (1991), p. 390) a geometric mean return of 13.9 % per year, now 13.95 %.

We do the same calculations as in *Stehle/Hartmond* (1991) and first estimate the monthly returns (simple, not log returns) on individual stocks (see their p. 381, formula 1). We do this for every common stock and every preferred stock listed in the top segment of the Frankfurt Stock Exchange, starting with the month after the first listing. We calculate monthly returns from the perspective of ordinary domestic investors. This means we adjust the returns for share reallocations from majority to

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minority shareholders[22] and dividends that are only distributed to minority or free shareholders.[23] For each stock, we estimate one series that contains the benefits from the corporate income tax credit (see Section II.7.), and one without.

In a next step we estimate the return on the market employing the same approach as described in *Stehle/Hartmond* (1991), formula two (p. 384). Thus, we calculate the market value of the equity as the product of the stock price and the number of exchange-tradable shares at of the end of the prior month. Penny stocks are not excluded because of their small impact when weighting returns by market capitalization (see Section II.4.).

IV. Monthly and Annual Returns on German Stocks

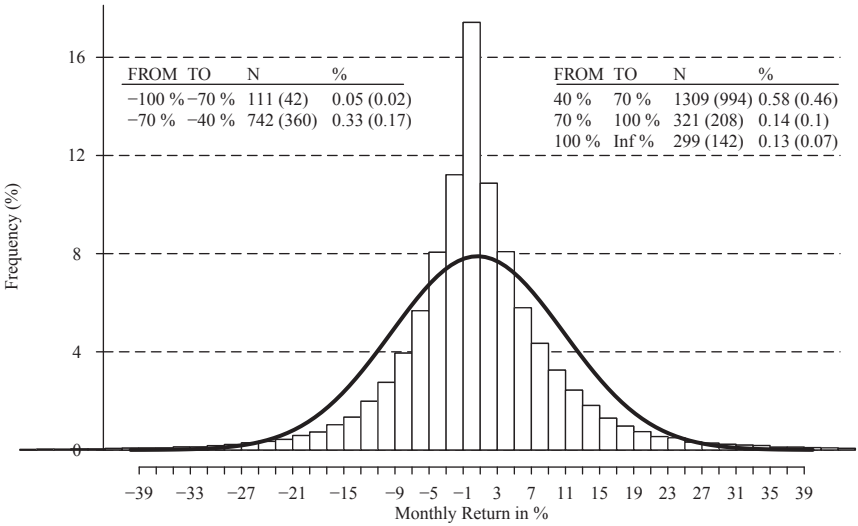
Figure 2 shows the distribution of all monthly returns of the individual stocks that are included in our analysis over the entire time period of 1954 to 2013. This figure is based on 223,896 stock-month observations. Each bar represents an interval of 2 %-points.

The plot is a good example of the well-known fact that returns on individual stocks typically exhibit leptokurtosis (more peaked and fatter tails than a normal distribution) and a minor skewness to the right.[24] Compared to a normal curve (mean 0.68 % and standard deviation 10.11 % of a winsorized sample at ±40 %), the number of returns between –3 % and +3 % is much higher. Many of the observations in the middle bar (–1 to 1 %) are related to stock prices that are identical at the beginning and the end of the month (35 %, 13,538 out of 38,909 stock-month observations in that bar). While it undoubtedly can happen that a stock changes its price during a month but has identical prices at the beginning and the end, we believe that most of these cases are extremely illiquid stocks, which are not traded at all during a month.

[22] E.g. in 11/1993 FAG Kugelfischer AG, the majority shareholder of Dürkopp Adler AG, distributed one for ten shares of Dürkopp Adler AG to all minority shareholders of that company.

[23] E.g. Audi AG and MAN Roland Druckmaschinen AG.

[24] Statisticians debate how those characteristics should be measured exactly, so we give only illustrations. *Schmid/Trede* (2003) argue, e.g., that excess kurtosis, based on the fourth moment of the distribution, is a joint measure of peakedness and fat tails, and that measuring these characteristics separately would be better. *Bai/Ng* (2005) argue that with serially correlated data "consistent estimates of three-dimensional long-run covariance matrices are needed" to test symmetry and kurtosis.

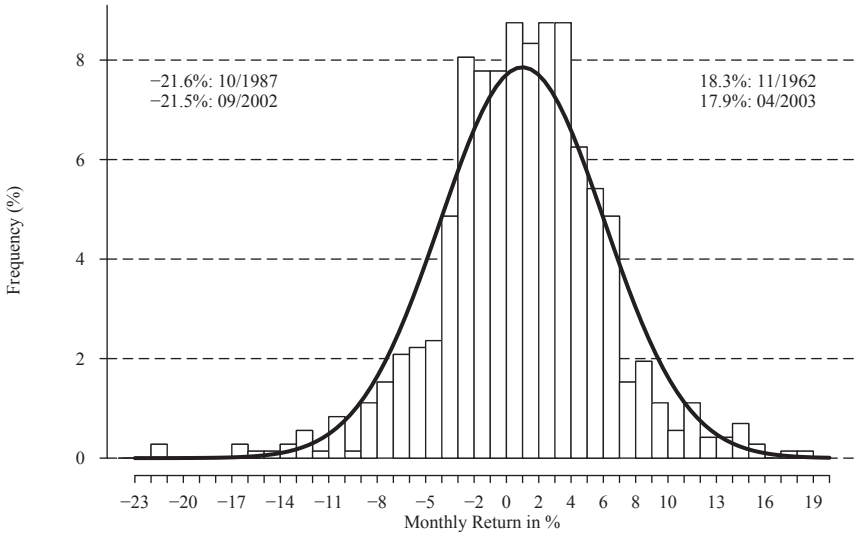


Notes: The frequency columns are based on return intervals of 2 %, e.g. –1 % to +1 %. The normal curve is based on the mean (0.6829 %) and standard deviation (10.108 %) of a winsorized sample at ±40 %. The two tables in the graph show the outliers in both tails (in brackets the outliers excluding penny stocks). We classify observations as penny stocks if the stock price is below 1.00 and the market capitalization is below €5.0 mio (see also Section II.4.). The total number of observations is 223,896. Returns contain the corporate income tax credit (1977 to 2000), see Section II.7.

Figure 2: Distribution of the Monthly Returns of the Individual Stocks Included in Our Analysis

The numbers at the top of the graph illustrate the fat tails and the skewness to the right. These show that monthly returns on individual stocks between –70 % and –100 % rarely occur. Monthly returns between +70 and +100, and above 100 %, occur more frequently. The Anderson-Darling test formally rejects normality (p-value < 0.0001). Most of these extreme returns are related to penny stocks and other stocks with a very low market capitalization. However, even the largest stocks can have very high positive or negative returns. For example, Volkswagen AG's common stock had the largest market capitalization of all German stocks at the end of 09/2008, with a weight of 8.4 % in our FTS-Series. In 10/2008 it had a return of 70.5 %, which increased its weight to 16.2 %. In 11/2008 it had a return of –40.9 %, in 08/2009 of –46.3 %. Siemens AG had a negative return of –28.4 % in 10/2008 (weight 6.3 %). In the same month Daimler AG (–24.5 %), BASF SE (–22.4 %) and E.ON SE (–15.6 %) did not do well either.

Figure 3 shows the distribution of the monthly returns on the market portfolio, our FTS-Series, containing 720 monthly observations (60 years).



Notes: The frequency columns are based on return intervals of 1 %, e.g. 0 % to +1 %. The normal curve is based on the mean (0.9874 %) and the standard deviation (5.078 %) of the whole sample of 720 observations. All are included in the figure. Returns contain the corporate income tax credit (1977 to 2000), see Section II.7.

Figure 3: Distribution of the Monthly Returns of the FTS-Series

The returns are market-value weighted and include the corporate income tax credit (1977 to 2000), see Section II.7. Each bar represents a return interval of 1 %. When comparing the portfolio returns to the distribution of individual stock returns in Figure 2, we find that the portfolio returns much better resemble a normal curve. Extreme outcomes are relatively rare but seem to occur with a higher likelihood than assumed by the normal curve. The two most negative observations are between –21 % and –22 %, out of 720 observations. The two largest monthly returns are around +18 %. So a minor skewness to the left seems to exist. The returns also cluster around the mean, but the distribution is less peaked. The assumption of normally distributed monthly portfolio returns is still not satisfied because of the combination of a minor peakedness, fat tails and skewness. The Anderson-Darling test formally rejects normality (p-value < 0.0001). Overall, 428 out of 720 (59.4 %) monthly returns are positive.

Table 1 (see next page) provides the 720 monthly nominal returns of Figure 3 plus the annual returns[25] (last column). The *annual* returns show that extreme outcomes of lower than –30 % occurred only three times in 60 years: 1987, 2002, and 2008. All have taken place in the last 30 years. So for short-term investors the stock market seems to have become more risky. Although Figure 4 in Section VI. shows that the increase was small. On the other hand, years with stock market returns larger than 30 % occurred more frequently (14 times: 1954, 1958, 1959, 1960, 1967, 1975, 1983, 1985, 1988, 1989, 1993, 1997, 1999 and 2003). The chances offered by the stock market seem to have been stable over the last 60 years. To give a visual impression of the frequency of very negative *monthly* returns we have highlighted the monthly returns below –10 % in black. Returns above +10 % are tinted in grey. Again it seems that for short-term investors the risk has increased a bit over time.[26]

Fig. 1, Fig. 2 and Table 1 are very similar to their counterparts in *Stehle/Hartmond* (1991). An exception relates to the means of the different calendar months, which we report at the bottom of Table 1. These differ considerably from each other. For instance, we report for all July-returns a mean of 1.81 % (median 2.58 %), which makes it the month with the highest mean return, and for September a mean of *minus* 1.10 % (median –0.59 %). September is not only the most negative month in Germany, it is also a bad month for the U.S. stock market (–0.37 %, 1954 to 2013).[27] This may reflect stock return seasonality (see e.g. *Rozeff/Kinney* (1976), *Keim* (1983), *Heston/Sadka* (2008)). Note however, that in the 1991 table, October was the month with the lowest mean (–0.5 %, September was only –0.1 %). Thus negative returns in September have become more frequent since 1989. August was the month with the highest mean return in the 1991 table (2.6 %). Now it has become a month with a much smaller mean return (0.64 %). Stock market volatility, measured by the standard deviation, has increased in eight out of twelve months compared to the 1991 paper. For April and September it has increased considerably, whereas in May and June it decreased considerably. Thus the monthly return patterns are not stable over time.

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[25] The annual returns are calculated for each year n over months t as $R_n = \left[\prod_{t \in n} (1 + R_t) \right] - 1$ with $t = 1, \ldots, 12$.

[26] *Mella* (2013) lists (p. 35) and discusses (pp. 44–51) the ten most negative DAX changes after 1959. Only one was before 1987 (in 1962).

[27] Based on Kenneth French's data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

Table 1: **Monthly Total Returns (%) on German Stocks 1954–2013**

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Year**
1954	5.14	3.17	1.58	–0.27	3.27	8.93	6.58	5.13	4.96	9.69	1.50	14.47	85.27
1955	–2.52	3.33	8.02	10.22	–2.85	1.26	3.78	2.38	–2.02	–12.43	2.55	4.88	15.67
1956	–2.55	–0.97	1.80	0.64	–3.72	–0.91	–1.74	–2.20	5.54	–3.07	–1.12	3.20	–5.37
1957	–2.38	–0.28	2.63	0.61	–0.79	–2.94	8.50	2.36	1.21	–1.92	2.64	0.53	10.09
1958	6.56	–2.91	3.09	5.71	–0.35	6.56	3.71	8.77	9.39	5.56	0.56	3.78	62.76
1959	4.35	–0.60	4.40	5.42	11.98	11.82	12.14	10.49	–7.34	–2.98	4.58	7.18	78.47
1960	1.80	–1.59	0.26	3.80	12.36	14.85	0.26	15.56	–7.72	–3.17	–2.23	–0.28	35.78
1961	–1.75	0.46	–1.03	1.94	5.84	–2.99	–6.39	–8.77	0.08	5.51	3.24	–3.10	–7.77
1962	–2.53	–0.75	–1.35	–3.14	–13.75	–7.40	–3.91	4.97	–6.56	–2.08	18.27	–2.94	–21.78
1963	–4.01	–5.14	4.07	3.10	13.93	–2.49	2.54	4.66	0.17	–2.62	–2.39	2.97	14.20
1964	5.80	2.05	4.03	–2.75	–2.70	0.31	2.62	2.63	–1.42	–3.53	–1.36	1.44	6.86
1965	0.86	–3.03	–3.58	0.62	0.89	–5.56	3.95	1.09	0.02	–4.43	–3.16	–0.41	–12.41
1966	5.28	2.35	–3.68	–3.48	–2.15	–7.91	–4.56	5.21	3.52	–6.66	0.56	–1.63	–13.37
1967	6.48	3.26	3.13	–4.35	1.40	–1.39	7.32	11.53	2.93	3.90	3.99	3.84	49.90
1968	3.87	0.05	2.61	3.72	–0.73	6.90	0.18	1.06	–2.47	2.11	–1.69	–0.78	15.42
1969	5.36	–2.11	1.36	–0.04	7.28	–2.20	–2.71	6.58	–1.60	4.89	4.87	–5.14	16.73
1970	–5.63	–1.82	0.66	–4.60	–8.36	–3.42	6.65	1.23	–2.11	–1.52	–3.04	–2.52	–22.54
1971	13.17	3.61	1.26	–5.65	1.87	–0.91	4.40	–3.54	–3.70	–6.04	0.03	6.04	9.27
1972	4.68	7.75	4.32	–2.14	2.88	–1.15	6.44	–1.10	–3.20	–2.32	1.17	–1.23	16.47
1973	5.04	–1.66	5.60	–4.40	–9.29	–0.39	–6.18	1.26	–1.52	6.65	–10.14	–1.66	–16.91
1974	6.53	–6.10	0.46	3.96	–3.29	–2.54	0.05	0.83	–5.06	1.84	5.17	1.15	2.17
1975	8.38	10.49	0.92	2.73	–6.63	1.35	8.82	–4.31	–1.35	7.25	4.71	0.55	36.28

1976	0.93	0.30	2.79	–5.56	–0.62	1.31	–1.01	–0.66	0.96	–7.17	4.70	0.62	–3.93
1977	0.74	–2.14	2.98	6.72	–1.34	–1.41	2.05	2.24	0.92	2.41	0.78	–1.05	13.34
1978	1.24	0.94	–0.03	–2.58	2.59	3.91	4.06	1.75	2.52	–2.11	–1.09	0.08	11.59
1979	1.52	–2.61	–1.27	0.22	–4.00	–0.59	4.03	1.51	0.18	–4.42	0.75	–1.40	–6.21
1980	0.72	2.55	–7.18	3.07	3.38	4.16	3.81	–1.79	–0.08	–1.96	0.99	–2.11	5.06
1981	–1.74	0.23	3.23	4.13	–1.85	6.88	2.32	–1.98	–5.60	–0.78	2.80	–2.18	4.89
1982	2.04	2.35	2.55	–0.28	–0.82	–0.91	1.16	–0.66	5.23	–0.58	2.58	6.28	20.31
1983	–0.80	7.06	11.70	6.41	–4.65	5.07	3.68	–5.30	2.37	7.26	1.46	1.09	39.83
1984	3.92	–4.10	0.32	1.04	–2.79	3.27	–5.07	5.49	6.61	1.52	0.53	1.96	12.66
1985	4.19	1.24	1.66	3.62	8.89	6.86	–3.49	8.43	6.20	12.67	–1.83	11.51	77.23
1986	0.33	–1.79	8.74	5.30	–8.69	–0.98	–4.36	14.23	–5.28	0.98	3.26	–1.06	8.89
1987	–10.93	–5.33	3.47	0.35	–1.04	6.92	6.96	1.47	–2.53	–21.62	–12.78	–1.15	–33.78
1988	–6.52	14.84	0.19	–0.99	2.01	5.32	3.48	0.23	6.33	3.71	–2.93	4.41	32.61
1989	1.92	–1.98	2.06	3.91	2.29	6.19	4.98	3.71	0.92	–6.60	5.51	11.08	38.42
1990	2.52	–0.79	9.42	–6.67	2.01	3.24	4.20	–14.66	–16.65	8.37	0.63	–2.76	–14.04
1991	–0.36	8.82	–1.44	4.30	5.26	–3.28	–0.49	1.33	–2.85	–1.80	–1.36	–0.39	7.26
1992	5.67	3.57	–1.05	0.36	3.61	–3.10	–7.13	–5.18	–3.26	1.19	2.32	–0.16	–3.93
1993	2.09	6.65	1.67	–2.04	1.20	2.59	6.57	6.50	–1.40	8.24	–0.23	7.01	45.60
1994	–1.77	–3.05	1.58	4.86	–4.75	–2.79	4.13	2.47	–7.17	2.00	–1.64	2.27	–4.56
1995	–3.81	3.76	–7.66	4.53	3.96	1.03	5.09	0.62	–2.04	–2.24	1.94	2.03	6.57
1996	7.04	–0.27	–0.27	–0.17	2.74	2.49	–3.06	2.51	3.27	0.32	4.78	1.29	22.26
1997	5.64	6.85	5.44	–0.06	4.68	6.26	13.65	–10.78	5.92	–8.24	3.52	5.87	42.89
1998	4.42	6.47	7.57	0.92	8.25	3.93	1.76	–15.67	–7.94	2.31	9.20	–1.60	17.93

(Continue next page)

(Table 1: Continued)

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Year**
1999	1.39	–3.91	–0.49	8.62	–4.30	6.17	–3.43	2.81	–3.25	6.62	4.90	15.31	32.55
2000	–1.07	10.12	–0.29	–2.80	–2.10	–2.55	2.30	–0.86	–5.87	–0.47	–6.56	–0.68	–11.17
2001	4.89	–6.25	–3.70	6.51	–1.53	3.13	–2.63	–8.06	–13.59	4.64	7.34	2.53	–8.75
2002	0.37	–0.58	4.94	–3.99	–2.49	–7.38	–10.93	–0.47	–21.50	11.57	3.42	–10.26	–34.56
2003	–3.90	–6.15	–4.33	17.89	2.19	6.39	6.27	1.29	–5.02	9.92	1.75	4.36	31.97
2004	3.44	–0.44	–2.90	2.76	–1.13	3.19	–3.07	–2.29	2.04	1.47	4.16	2.61	9.89
2005	1.07	2.24	0.07	–2.99	5.98	3.00	6.04	–0.17	4.12	–2.86	4.53	3.92	27.33
2006	5.90	3.29	3.16	0.75	–5.14	–0.31	0.58	2.66	3.22	3.49	1.07	4.71	25.48
2007	2.99	–0.53	3.40	5.82	5.05	0.50	–3.51	–0.08	1.99	3.05	–2.97	1.17	17.71
2008	–12.66	–0.93	–2.31	5.19	2.12	–8.51	–0.47	–0.31	–8.65	–12.20	–10.39	2.36	–39.36
2009	–8.21	–11.07	5.73	14.32	3.47	–1.34	9.16	0.30	4.22	–4.82	3.43	4.73	18.50
2010	–4.51	–0.39	9.13	0.30	–2.69	0.35	3.01	–2.97	6.08	5.84	1.35	3.70	19.91
2011	1.88	2.11	–1.87	5.26	–1.79	0.85	–3.01	–16.36	–6.39	11.09	–1.61	–2.85	–14.19
2012	9.79	5.62	1.11	–1.23	–6.62	1.13	4.79	2.23	3.08	1.50	2.22	2.48	28.40
2013	3.05	0.18	0.19	1.08	4.95	–4.08	4.00	–0.94	5.05	5.27	3.62	1.50	26.11
Mean	1.42	0.77	1.65	1.68	0.39	1.11	1.81	0.64	–1.10	0.54	1.15	1.79	13.77
SD	4.80	4.61	3.80	4.67	5.31	4.72	4.93	6.13	5.78	6.30	4.60	4.41	26.32
Median	1.84	0.11	1.62	0.98	0.02	0.94	2.58	1.16	–0.59	1.08	1.40	1.37	13.55
# < –5	5	6	2	3	7	5	5	8	15	8	4	2	
# > 5	15	10	9	13	10	14	14	11	9	15	5	9	

Notes: Monthly returns below –10 % are highlighted in black. Returns above +10 % are tinted in grey. The last column (Year*) shows the annual return, see footnote 25. Returns contain the corporate income tax credit (1977 to 2000), see Section II.7.

V. Comparisons with Popular Indices for the German Stock Market

We first (Section V.1.) briefly describe the basic construction procedures of stock market indices. In a second step (Section V.2.) we describe the characteristics of the indices we include in our comparisons. Section V.3. presents the results of our comparisons.

1. Stock Market Index Construction: A Brief Overview

Most stock market indices are based on the Laspeyres formula, which uses weights from a base period. Until the middle of the 1960s, all German stock indices based on the Laspeyres formula used the total nominal value of the shares (Grundkapital, number of shares times the nominal or par value per share) according to the firm's balance sheet as weights (*Mella* (1988) p. 5). *Bleymüller* (1966, Chapter 5) discusses alternative weighting procedures in detail and this is the one he recommends. Actually it was the only weighting procedure that made economic sense at the time, since stock prices were quoted in % of the nominal values (Nennwerte) of the stocks. As a consequence, the rate of change of a Laspeyres index is equal to the rate of return on the market portfolio of the included stocks (*Stehle/Hartmond* (1991), p. 393), the most important portfolio in the theory of finance. This equality is the basis of our comparisons in Section V.3.

Since at least 1995, the DAX family description states (see e.g. Arbeitskreis Aktienindizes der Deutsche Börse AG (1995), p. 10) that stock prices are weighted with the number of shares. This is a common procedure today, since today share prices are quoted as price per share (Stücknotiz). Again, the rate of change of a Laspeyres index is equal to the rate of return on the market portfolio of the included stocks (*Stehle/Hartmond* (1991), p. 393), and we also have a solid basis for the comparisons in Section V.3.

The way in which share prices are quoted did not change for all shares at the same time. Beginning in 1967, individual companies switched from the %-quotation to the per share quotation at a time of their choice. We assume that index calculators had a good understanding of what they were doing and after 1967, in the numerator of the Laspeyres formula, multiplied the prices per share with the number of shares for the individual companies that had changed their quotation procedure. In the denominator, they made a similar adjustment. Our comparisons for the relevant years in Section V.3. may be interpreted as a test of this assumption.

Calculated properly, a Laspeyres index replicates a feasible investment strategy (*Stehle/Hartmond* (1991) pp. 374–379 and 393–395). Only the Index of the Frankfurter Allgemeine Zeitung (F.A.Z.-Index) was continually based on the Paasche formula (weights from the end of the observation interval). Thus the F.A.Z.-Index does not replicate a feasible investment strategy. The Index of the Federal Statistical Office was a Laspeyres index until 1976, after that a modified Laspeyres procedure (Portfolio-Index) was used (*Angele* (1996)).

An important index characteristic is the frequency of the weight adjustment. The weights in indices created before the 1980s were typically only adjusted every three to twelve years. This implies that newly listed stocks were not included until the next weight adjustment. In the DAFOX calculation the weights are adjusted annually, we adjust them monthly. Modern Laspeyres indices often feature daily weight adjustments.

Initially all stock market indices were price indices. The first German total return index was the predecessor of the DAX, the BZ-Index calculated daily by the Börsen-Zeitung, starting in 1981. When the DAX was launched in 1988 and the CDAX in 1993, both a price index and a total return index were provided. Some price indices were supplemented at later points in time by dividend data to create total return indices. Most indices only include one class of stocks, typically the larger one. The MSCI Germany includes common and preferred stocks.

2. Relevant Characteristics of Individual Indices

From the end of the 1950s to the introduction of the CDAX in 1993, a number of broad stock market indices for Germany existed and competed for the attention of market observers.[28] In this section we only discuss the aspects, which we feel are important in our context. The indices are described in more detail in a large number of publications.[29]

In Table 2, we provide a list of the indices, which we include in the comparison with our FTS-Series. The table contains, among other information, the index provider and our data source, which is typically Datastream. It also contains the time period for which the index is provided

[28] *Mella* (2013, p. 10) vividly describes this competition.

[29] E.g. in *Bleymüller* (1966), *Schulze/Spieker* (1994), *Kleeberg* (1991), *Janßen/Rudolph* (1992).

Table 2: **German Stock Market Indices Included in Our Comparisons**

Commonly Used Index Name	*Index Provider/ Primary Source*	*Index Type*	*Our Source(s)/Code(s)*	*Available From*	*Available To*	*Interval*
CDAX Performanceindex	Deutsche Börse AG	Total Return	Datastream: CDAXGEN(RI)	02.01.1970	today	Daily
			Deutsche Bundesbank[A]: BBK01.WU018A	06/1994	today	Monthly
CDAX Kursindex	Deutsche Börse AG	Price	Datastream[B]: CDAXGNI(PI)	02.01.1970	today	Daily
			Deutsche Bundesbank[A]: BBK01.WU001A	06/1994	today	Monthly
Commerzbank-Index (Cobk.-Index)	Commerzbank AG	Price	Datastream[B]: BDCBIDX(PI)	01.01.1969	30.12.1998	Daily
Deutscher Aktien-forschungsindex (DAFOX)	KKMDB	Total Return	KKMDB	04.01.1960	30.12.2004	Daily
F.A.Z.-Index[C]	Frankfurter Allgemeine Zeitung	Price	Datastream[B]: FAZINDX(PI)	02.01.1969	today	Daily
Germany-Datastream Market	Datastream	Price	Datastream: TOTMKBD(PI)	01.01.1973	today	Daily
		Total Return	Datastream: TOTMKBD(RI)	01.01.1973	today	Daily
Index des Statistischen Bundesamtes	Federal Statistical Office *Gielen* (1994)	Price	Wirtschaft und Statistik	01/1954	06/1995	Monthly
		Total Return	*Gielen* (1994)	01/1954	12/1992	Monthly
MSCI Germany	MSCI	Price	Datastream: MSGERML(MSPI)	31.12.1969	today	Daily
		Total Return	Datastream: MSGERML(MSRI)	31.12.1969	today	Daily

Notes: [A]The time period 1970 to 1994 was online until 2014, see footnote 34. [B]Datastream also provides time series calculated from their own raw data: CDAX (price index) named "CDAX General Datastream-Calculated" (DAXGEZ(PI)), Cobk.-Index (total return index) named "Fkfurt Commerzbk 'Dead'" (BDCBIDX(DSRI)), and FAZ-Index (total return index) named "Faz General" (FAZINDX(DSRI)). [C]The F.A.Z.-Index as a total return index is available from May 30, 2000 onwards (Datastream code FAZINDX(RI)).

in our primary data source. In addition to the indices we include in our comparison, the predecessors of the DAX, the Hardy Index (1959 to 1981), the BZ-Index (1981 to 1987),[30] the West-LB Index, and the "Gesamtindex" of the Frankfurter Wertpapierbörse (FWB-Index) play an important role in Germany's stock index history.

The basic concept of the CDAX index is the same as that of the DAX, which is very good except that it does not include the corporate income tax credit (see Section II.7.). The CDAX initially only included the 320 stocks listed in the top segment of the Frankfurt Stock Exchange. After September 1998 the CDAX also includes the stocks listed in the middle segment (Geregelter Markt) and in the Neuer Markt of the Frankfurt Stock Exchange. As a consequence, the number of stocks nearly doubled between 1998 and 2000. From 1993 to June 2002, the (total) market capitalization was used for the weighting, since then a free-float weighting has been utilized.

Several CDAX time series already starting in 1970 are available. We describe the sources in detail since these time series are an important part of our index comparison. The Deutsche Börse AG, through its 'Datashop'[31], provides two daily CDAX time series, a total return and a price index, starting December 30, 1987. December 30, 1987 is the 'ultimo', the date for which the index level is set to 100. From 1970 to 1988, the 'official' CDAX predecessor is the Frankfurter Wertpapierbörse Index (FWB-Index), which had the same WKN as today's CDAX price index. It is also available in the Datashop. The FWB-Index, like most indices at the time, did not take dividends into account. The FWB-Index includes nearly all stocks traded in the top segment (95 % of the total market capitalization according to *Kleeberg* (1991), p. 16). Its ultimo is the year-end 1968 and the total nominal values of the stocks as of this date are used as weights. These remained unchanged until the beginning of the 1990s. All three time series, which are currently available in the Datashop, are well documented.[32]

Deutsche Börse AG (1993) and Deutsche Börse AG (2002) both describe and provide in printed form a monthly CDAX total return index starting

[30] *Stehle/Huber/Maier* (1996) discusses the DAX and its two predecessors in detail.

[31] http://datashop.deutsche-boerse.com.

[32] The CDAX calculation procedure is described in Deutsche Börse AG (2014). The FWB-Index is described in Frankfurter Wertpapierbörse (undated). This brochure contains a list of the included stocks as of June 30, 1988.

in January 1970.[33] Until 04/2014, a digital version of the time series published in 1993 was available on the website of the Deutsche Bundesbank, free of charge. Possibly such a version was also available until fall 2014 from Bloomberg and Reuters. It contains serious errors and is, at present, not available any more.[34] Because of the errors, we do not include it in our comparisons.

A daily version of the CDAX total return index published by Deutsche Börse AG in 2002 is available in digital form on Datastream, together with a CDAX price index (both starting in 1970). We include both CDAX time series (CDAXGNI(PI) and CDAXGEN(RI)) in our comparisons. These two time series are also available, free of charge, on the webpage[35] of the Deutsche Bundesbank, starting in 1994, see Table 2. Datastream in addition provides a CDAX price index based on their own raw data (code CDAXGEZ), which we do not include in our comparison.

Before the introduction of the Commerzbank-Index in 1953, the Composite Index of the Federal Statistical Office (Gesamtindex des Statistischen Bundesamtes) was the most important German stock market index. This index was first calculated in 1922, a time series going back to 1856 was created and published in 1934.[36] Originally it was calculated

[33] The printed version dated March 1993 only contains the composition on March 1, 1993. The printed version of May 2002 does not provide the index composition.

[34] The CDAX performance index time series published by the Deutsche Börse AG in March 1993 and Mai 2002 differ considerably between 1971 and 1992. According to the version of March 1993, the geometric mean for this time period was 6.99 %, which is 1.33 %-points lower than the version of May 2002 and the other estimates we report in Section V.3. (8.32 %). For several individual months the rate of change of Deutsche Börse AG's 1993 CDAX performance index was lower than the rate of change of Deutsche Börse AG's CDAX price index. This should not happen, since the only difference between both indices should result from a different treatment of dividends. The largest difference occurs for the year 1985, when the price index implies a rate of change of 71.98 % and the performance index of 56.95 %. All other time series we analyze imply that the latter number is 20 %-points too low. The May 2002 CDAX total return index and the price index are consistent in this respect. Thus, we do not recommend to use the 1993 version of the CDAX total return index of the Deutsche Börse AG.

[35] http://www.bundesbank.de/Navigation/DE/Statistiken/Zeitreihen_Datenbanken/Makrooekonomische_Zeitreihen/its_list_node.html?listId=www_s140_mb05 (May 15, 2014).

[36] *Angele* (1996) describes the history and the main characteristics of this index. His paper contains references to all important documents relating to the index, which were published before 1996. *Bimberg* (1993) and *Gielen* (1994) discuss it in detail.

for four days per month, daily index levels are available for the years 1982 onwards. The Index of the Federal Statistical Office included all shares until 1984, from then on only the tradable shares.[37] For budgetary reasons, the index calculation ended in 06/1995. A strength of the index is that it includes a large number of stocks (more than 300) from all exchanges. A weakness of this index is that the weights, and thus the included stocks, were constant from 1953 to 1965, from 1966 to 1972, and from 1973 to 1984. From then on they changed daily. Another weakness is that it was originally only a price index. For the years 1954 to 1992 the Federal Statistical Office also provides an annual dividend time series, so a total return index can be approximated. Noteworthy details of the data supplied by the Federal Statistical Office are:

– When the index calculation was adjusted, the new procedure was typically used to recalculate the index for a number of prior years.

– Two dividend time series are provided, one includes the corporate income tax credit, the other does not.

– It is based on the adjusted nominal capital, i.e., an adjustment for cross-holdings was made, and from 1984 onwards it was based on the tradable nominal capital.

– Vorzugsaktien are not included.

– Sub-indices for 41 industries and for six additional groups of stocks are provided.

Bimberg (1991), *Gielen* (1994) and *Morawietz* (1994) use the data supplied by the Federal Statistical Office to create monthly performance time series. The time series by *Gielen* and *Morawietz* start in 1870 and end in 1993.[38] *Bimberg's* time series covers the years 1954 to 1988. All three are based on the annual dividend yields supplied by the Federal Statistical Office, which include the corporate income tax credit. All three break the annual dividend yields down to monthly dividend yields and add them to the monthly rate of change of the price index. *Gielen* bases his return calculations on the average index levels during a month. *Bimberg's* and *Morawietz's* return calculations are based on the last day of a month for which an index level exists – we find this preferable.

[37] When the DAX was introduced in 1987, this procedure was adopted (Arbeitskreis Aktienindizes der Deutsche Börse AG (1995)).

[38] See also *Ehrhardt* (2012) who discusses these and additional time series for German stocks and bonds.

Morawietz does not provide a total return time series, only components and averages. Consequently we cannot include his results. In our index comparison, we mainly use the performance time series calculated by *Gielen* because *Bimberg's* series ends in 1988.

Many studies on the German capital market that focus on time periods between 1974 and 2004 are based on the Deutscher Aktienforschungsindex (DAFOX). The DAFOX was the first total return index covering the top segment of Frankfurt and is available from 1960 to 2004.[39] From 1960 to 1974, only a fraction of the stocks of this segment is included. After 1974 the DAFOX is calculated practically in an identical way as our FTS-Series.

Another proxy for the German market portfolio is the MSCI Germany. We also include it in our analyses since it is used in many studies that cover a large number of countries. This index was launched on March 31, 1986 and commences December 31, 1969. The index values between 1970 and 1986 are "back-tested data"; the exact procedure is not explained in detail. Since 2001 the index is based on 54 large and mid cap stocks, covering about 85 % of the German stock market capitalization (MSCI (2014)). Similarly to the CDAX, the calculation procedure switched to free float weighting in 2001 (MSCI (2000)).

We also include the Commerzbank-Index (Cobk.-Index) and the F.A.Z.-Aktienindex. The Cobk.-Index, when it was introduced in 1953, was the first major index that was calculated on a daily basis. It is based on 60 very large stocks that amount to 70 % of the total market capitalization of the Frankfurt Stock Exchange at the end of the 1980s (*Kleeberg* (1991), p. 16). Until 1976, the included stocks and their weights were constant, then changed and again constant until 1988. For the F.A.Z.-Aktienindex our time series starts in 1964. This index is based on 100 very large stocks, representing about 80 % of the market capitalization (*Kleeberg* (1991), p. 16).

The Aktienindex der Westdeutschen Landesbank (West-LB) is an index that is based on data of the Düsseldorf exchange. It played an important role in the 1970s and 80s, but since then has been of minor importance. The index was used in the study of *Guy* (1977). We do not include the

[39] The DAFOX is documented in *Göppl/Schütz* (1995) and available from the KKMDB. Among others, *Schlag/Wohlschieß* (1997), *Wallmeier* (2000), *Elsas/El-Shaer/Theissen* (2003), and *Artmann/Finter/Kempf/Koch/Theissen* (2012) use the DAFOX.

West-LB index in our comparison because only a version calculated by Datastream is available to us.

Datastream also provides a 'country index' for Germany, the Datastream-Germany Market, which is available as a total return and price index. Both start in 1973 and are included in our index comparisons. Today this index is based on approximately 250 "representative" stocks covering 75 to 80 % of the total German stock market capitalization. Since 1999, Datastream adjusts the index composition quarterly. The index composition before 1999 is not explained in detail in Thomson Reuters (2012). Before 1999, possibly only stocks are included for which data is available in 1999. This would introduce an ex-post selection bias.

3. FTS-Returns vs. Index Rates of Change

In this section we compare the available time series in order to identify their similarities and differences. This comparison also increases our confidence in the quality of our and/or other return time series for the German capital market. Our comparisons of annual returns focus on the following four sub-periods:

- *1954 to 1970*. We have three total return series available, our FTS-Series and those of *Bimberg* (1991) and *Gielen* (1994), which are both based on the data of the Federal Statistical Office. The Cobk.-Index (price index) also covers the full time period.
- *1971 to 1992*. Several total return time series are available to us. 1971 is the first full year of the CDAX, 1992 is the last year for which the Index of the Federal Statistical Office may be adjusted with their dividend data. Within this time period we take a short look at the years 1977 to 1992. For this period we include the Datastream-Germany Index and also examine the magnitude of the corporate income tax credit.
- *1993 to 2003*. In these eleven years our FTS-Series and the CDAX differ most, mainly due to the inclusion of the Neuer Markt. In this period we additionally include the DAFOX, the Datastream-Germany Market, and the MSCI Germany.
- *2004 to 2013*. In these years our time series differs from the CDAX mainly because of the latter's free float weighting.

For the time periods 1954 to 1970 and 1971 to 1992, we only look at the annual returns and their geometric means (see Table 3). Today these time

periods are mainly important for the calculation of the historic risk premium, thus the comparison of the means is the most important part of the analysis. In the time periods 1993 to 2003 and 2004 to 2011, we also look at monthly returns. In these more recent periods the time series are very important inputs in empirical studies in which financial markets are analyzed. In *Brückner* et al. (2015) we show, e.g., that alternative time series of the return on the market portfolio can lead to very different results in the evaluation of the performance of mutual funds. By discussing the alternative time series in great detail we hope to help other researchers in their choice of the proper proxy for the German market portfolio.

1954 to 1970. For these very good stock market years we compare three total return time series: our FTS-Series, the time series created by *Bimberg* (1991), and the one by *Gielen* (1994). Due to the differences in their calculation procedures, the returns supplied by *Bimberg* and *Gielen* differ considerably in individual years (e.g. in 1954: *Bimberg* 83.57, *Gielen* 73.42 %). In the long run, the differences evaporate. Table 3 only contains *Gielen's* time series.

In several years the annual returns estimated by us and by *Gielen* differ by close to 10 %-points or more (e.g. in 1958: FTS 62.76, *Gielen* 52.20 %). But the geometric means for the 17 years are very similar. *Gielen's* mean is 13.32, *Bimberg's* 13.41, ours is 13.95 %. The small difference between our series and the two series based on the Index of the Statistical Office may be due to the fact that the Federal index used constant weights before 1976. As a consequence new industries (e.g. automobiles) were underweighted in many years, declining industries (coal and steel) were overweighted. The price indices of the Federal Statistical Office and the Commerzbank differ by larger amounts in individual years, especially in the early years (1954: Federal Statistical Office 76.63 %, Cobk.-Index 97.30 %; 1958: 49.44 vs. 65.71; 1959: 83.95 vs. 69.74). The geometric means for the 17 years are 9.51 (Federal Statistical Office) and 11.37 % (Cobk.-Index).

1971 to 1992. For these 22 years we have complete data on seven total return series. Table 3 contains in addition to our FTS-Series and *Gielen's* series, the CDAX total return index published by Deutsche Börse AG in 2002, the DAFOX and the MSCI Germany.

Two of the series include the corporate income tax credit, our FTS series and *Gielen's* series. In some years their returns differ by nearly 10 %-points, e.g. in 1985 77.23 % (our estimate) vs. 68.17 % (*Gielen's* estimate). Note that *Bimberg's* estimate is 78.84 % and *Gielen's* low return

Table 3: **Annual (Rates of) Return According to Alternative Time Series (in %), 1954 to 1992**

Year	*Stehle* et al. Frankfurt Top Segment-Series (FTS-Series)		Index of the Federal Statistical Office/ *Gielen* (1994)		CDAX		Cobk.-Index	F.A.Z.-Index	DAFOX	MSCI Germany		Germany-Datastream Market	
	Total Return (with tax credit)	Total Return	Total Return (with tax credit)	Price	Total Return	Price	Price	Price	Total Return	Total Return	Price	Total Return	Price
1954	85.27	85.27	73.42	76.63			97.30						
1955	15.67	15.67	22.69	13.54			13.28						
1956	–5.37	–5.37	–4.03	–7.86			–7.56						
1957	10.09	10.09	10.42	4.71			5.03						
1958	62.76	62.76	52.20	49.44			65.71						
1959	78.47	78.47	73.68	69.74			83.95						
1960	35.78	35.78	37.91	32.78			33.44						
1961	–7.77	–7.77	–6.96	–10.01			–8.55		–4.56				
1962	–21.78	–21.78	–21.53	–24.28			–23.80		–22.28				
1963	14.20	14.20	12.05	10.28			11.09		16.37				
1964	6.86	6.86	9.51	4.99			3.37	3.74	7.57				
1965	–12.41	–12.41	–11.89	–15.43			–13.99	–14.58	–11.81				
1966	–13.37	–13.37	–13.64	–18.38			–18.37	–16.14	–14.85				
1967	49.90	49.90	37.92	37.06			43.90	43.48	49.92				
1968	15.42	15.42	15.99	11.40			12.26	13.65	17.88				
1969	16.73	16.73	19.15	13.84			8.21	11.69	17.99				
1970	–22.54	–22.54	–21.52	–24.05			–28.04	–26.23	–25.15	–23.84	–26.73		
1971	9.27	9.27	7.24	5.80	9.32	5.10	3.98	5.58	9.31	11.46	6.92		
1972	16.47	16.47	16.43	10.31	16.56	13.17	11.59	13.67	18.55	16.03	12.16		

1973	–16.91	–16.91	–15.12	–17.59	–16.89	–19.53	–22.74	–21.15	–16.36	–19.36	–22.37		
1974	2.17	2.17	2.42	–2.90	1.45	–2.66	0.79	0.36	–0.66	4.44	–0.34	–6.23	–10.44
1975	36.28	36.28	31.16	29.32	35.56	30.57	37.74	35.06	36.14	41.63	36.16	40.02	34.42
1976	–3.93	–3.93	–2.22	–6.53	–4.61	–7.84	–6.30	–7.70	–4.53	–3.91	–7.22	–3.02	–6.51
1977	13.34	13.28	16.02	8.94	13.06	8.89	8.28	8.36	13.85	12.22	7.99	15.47	11.07
1978	11.59	9.66	13.62	7.74	10.26	6.85	3.76	6.88	9.73	8.27	4.60	10.55	6.67
1979	–6.21	–7.99	–7.56	–11.73	–8.44	–11.41	–12.42	–11.57	–8.13	–9.23	–12.36	–8.15	–11.55
1980	5.06	2.78	5.65	–0.79	4.50	0.66	–4.49	–2.07	4.12	1.71	–2.30	2.53	–1.64
1981	4.89	2.75	4.80	–1.30	3.54	–0.04	–1.23	–0.67	1.82	2.74	–1.33	0.67	–3.15
1982	20.31	17.90	16.77	13.88	20.55	16.46	13.06	14.43	18.20	16.91	12.64	14.50	10.50
1983	39.83	37.92	40.68	35.85	39.34	36.05	36.46	39.09	39.16	42.00	38.31	36.20	32.71
1984	12.66	11.04	12.55	7.92	10.61	7.97	6.35	8.34	10.84	9.61	6.82	13.20	10.30
1985	77.23	75.10	68.17	72.75	75.62	71.98	76.14	71.58	75.32	84.81	80.90	73.59	69.66
1986	8.89	7.77	16.23	4.95	6.83	4.94	4.86	3.42	7.83	7.23	5.30	2.16	0.24
1987	–33.78	–34.54	–32.46	–35.31	–35.86	–37.19	–36.49	–37.14	–34.67	–38.41	–39.75	–32.00	–33.55
1988	32.61	30.72	29.43	28.50	31.89	29.17	27.10	29.32	31.16	36.30	32.82	32.94	29.48
1989	38.42	36.74	32.82	33.01	37.11	34.80	32.59	34.75	36.30	40.22	37.20	41.33	38.40
1990	–14.04	–15.03	–5.76	–16.92	–14.69	–16.72	–22.33	–18.61	–15.05	–19.26	–20.94	–15.10	–16.78
1991	7.26	5.87	2.49	4.08	4.74	2.18	6.07	6.18	6.58	10.38	7.87	6.09	3.69
1992	–3.93	–5.18	–4.31	–7.25	–6.39	–8.94	–5.55	–5.83	–5.67	–3.89	–6.13	–2.18	–4.52
Geometric Means for Selected Time Periods													
54–92	11.38	10.74	11.12	7.08			7.54						
54–70	13.95	13.95	13.32	9.51			11.37						
71–92	9.45	8.32	9.44	5.24	8.32	5.19	4.67	5.45	8.36	8.66	5.30		
77–92	10.78	9.23	10.90	6.46	9.34	6.44	5.47	6.45	9.35	9.37	6.30	9.49	6.39

seems to be caused by his use of average index levels in the calculation of returns. However, the long-term (geometric) means of the FTS and *Gielen's* (total) return series for the 22 years are nearly identical: 9.44 and 9.45 %. (Based on *Bimberg's* data the mean is 9.44 %.)

Four total return series do not include the corporate income tax credit, our FTS-Series (excluding the tax credit), the CDAX, the DAFOX, and the MSCI. The construction of the FTS, CDAX and DAFOX is nearly identical in this time period: all three include all stocks listed in the top segment of the Frankfurt Stock Exchange, and all three weigh returns with market capitalizations. The returns in Table 3 shows that the three series are indeed very similar. Differences larger than ±1.5 %-points are rare. The largest difference between our series and the CDAX is 2.65 %-points in 1982. The largest difference between our series and the DAFOX is 2.83 %-points. Again, the long-term (geometric) means of the three (total) return series for the 22 years are nearly identical: 8.32, 8.32, and 8.36 %.

The MSCI Germany is also constructed in a similar way but includes only 54 large and mid cap stocks. Due to this focus and the lower diversification, the returns in individual years differ more from the other three series. For example, in 1985 the MSCI Germany increased 85 %, while our FTS-Series, the CDAX, and the DAFOX only increased 75 %. Over the 22 years, the MSCI Germany's mean return is 8.66 % and thus slightly higher than the mean of the FTS-Series, CDAX, and DAFOX. This probably stems from the reverse size-effect that existed in Germany during some of the years, especially in the early 1980s (*Stehle* (1997) and *Brückner/Lehmann/Stehle* (2012)). The slightly higher mean of the MSCI Germany may also be caused by the calculation procedure for the years prior to 1986. The high similarity between our time series, the DAFOX and the CDAX is confirmed by a correlation analysis (results are not tabulated) based on monthly return data from February 1970 to December 1987: the three R^2 between these series are higher than 0.99.

For the sub-period of 1977 to 1992, the mean returns on our FTS-Series (excluding the tax credit), the CDAX, the DAFOX, the MSCI Germany and the Datastream-Germany Market index, are roughly identical: 9.23, 9.34, 9.35, 9.37 and 9.49 %. Throughout these years, the corporate income tax credit existed (it ended 2000, see Section II.7.) and significantly contributed to the total return. The mean return of *Gielen's* series, which includes the tax credit, is 10.90 %. Our time series that includes the tax credit (Table 3, column 2) results in a geometric mean of 10.78 %. This is 1.56 %-points higher than our time series without the tax benefit.

A rough estimate of the annual risk premium on stocks is 5 %, so the inclusion of the tax credit can make a large difference in many contexts. We strongly advocate that the corporate income tax credit is included in all applications.

Table 3 contains also annual returns implied by six price indices: the Federal Statistical Office, the CDAX, the Cobk.-Index, the F.A.Z.-Index, the MSCI Germany and the Datastream-Germany Market. The comparison of the means for the years 1977 to 1992 shows that they are roughly similar: 6.46, 6.44, 5.47, 6.45, 6.30 and 6.39 %. Four of them may be directly compared to the correspondent total return series: *Gielen's* series based on the Federal Statistical Office, CDAX, MSCI Germany and Datastream-Germany Market. For most years, the annual returns between an index pair differ by 3 to 4 %-points.

1993 to 2003. From 1993 to 2000, the annual FTS-Series and CDAX returns (see Table 4) are very similar. The largest difference is 1.81 %-points in 2000. The differences among the other pairs of return series are marginally larger. An exception is the DAFOX return of 32.96 % in 1998. In all other total return time series the 1998-return is much lower (CDAX 15.54 %, FTS-Series 16.75 %, MSCI Germany 20.32 %, Datastream-Germany Market 18.84 %). The DAFOX 1998-return thus differs by more than 12 %-points from all other returns. We believe that this difference is caused by calculation or data errors. In their analysis of the conditional performance of German equity mutual funds, *Bessler/Drobetz/Zimmermann* (2009) notice that a problem exists but do not look at it in more detail: "Again, we observe that the DAFOX index produces lower alphas than the other indexes […]".

To check, whether the similarity between the annual return series in the years 1993 to 2000 also exists at the monthly level, we look at the R^2 between pairs of return series (see Table 5, Panel A). This is important because in these more recent years the time series are used in empirical studies such as event studies and performance analyses.

Due to the DAFOX error in 1998, we restrict the comparison to the five years 1993 to 1997. We can report that:

– All pair-wise R^2's are higher than 0.96.
– Our FTS-Series and the CDAX are nearly perfectly correlated (R^2 = 0.9922).
– The R^2 between the FTS-Series and the other series is close to 0.98 or even 0.99.

Table 4

Annual (Rates of) Return According to Alternative Total Return Time Series (in %), 1993 to 2013

Year	FTS-Series			CDAX	DAFOX	MSCI Germany	Germany-Datastream Market
	With Tax Credit	Ex. Tax Credit	Ex. Tax Credit, Free Float Weighting				
1993	45.60	43.79		44.56	42.64	46.21	44.18
1994	–4.56	–5.37		–5.83	–5.51	–6.18	–5.76
1995	6.57	5.62		4.75	5.43	8.04	7.65
1996	22.26	21.24		22.14	19.30	22.87	21.58
1997	42.89	41.89		40.83	39.87	45.90	39.88
1998	17.93	16.75		15.54	32.96	20.32	18.84
1999	32.55	31.53		31.68	29.93	41.20	35.53
2000	–11.17	–11.72		–9.91	–9.24	–9.53	–8.99
2001	–8.75	–9.55		–17.91	–7.32	–17.75	–17.36
2002	*(–34.56)*	–34.56	–37.42*	–39.94	–33.86	–43.06	–36.86
2003	*(31.97)*	31.97	35.44	37.58	32.52	37.10	33.92
2004	*(9.89)*	9.89	9.23	8.47	8.55	8.26	8.22
2005	*(27.33)*	27.33	28.61	28.20		27.36	26.26
2006	*(25.48)*	25.48	24.63	24.09		22.36	24.41
2007	*(17.71)*	17.71	19.62	20.42		22.60	16.95
2008	*(–39.36)*	–39.36	–42.12	–42.58		–42.67	–39.20
2009	*(18.50)*	18.50	25.20	25.40		22.61	18.36
2010	*(19.91)*	19.91	18.58	18.46		16.91	19.01
2011	*(–14.19)*	–14.19	–14.76	–14.82		–14.69	–14.06
2012	*(28.40)*	28.40	28.14	29.26		30.07	28.26
2013	*(26.11)*	26.11	26.73	26.75		26.68	26.29
Geometric Means for Selected Time Periods							
93–13	9.71	9.31		8.59		9.13	8.94
93–03	9.92	9.14		7.78	10.57	9.16	8.88
04–13	*(9.48)*	9.48	9.56	9.48		9.10	9.01

Notes: * The free float between 01/1999 and 03/2002 is approximated by using the first available free float (on Datastream) for each stock, which in most cases is 04/2002.

Even though we exclude the year 1998, the pair-wise correlations are lowest for the DAFOX.

The similarity between our FTS-Series and the CDAX ends in 2000. In 2001, the market declined by 9.55 % according to our series and by 7.32 % according to the DAFOX. Based on the CDAX the market decline was 17.91 %. We attribute the difference to the crash of the Neuer Markt stocks (the NEMAX All Share went down by 59.86 % in 2001), which are included in the CDAX but not in our FTS-Series and the DAFOX.

In 2002, the market decline according to the CDAX (–39.94 %) was about 5 %-points higher than according to our FTS-Series and the DAFOX. Again, this difference seems to be caused mainly by the Neuer Markt, since the NEMAX All Share went down by 62.99 % in 2002. The CDAX free float weighting, introduced in 06/2002, may also have contributed to the difference.

In 2003, the CDAX declined 37.58 %, again 5 % more than our FTS-Series and the DAFOX. But this difference cannot be explained by the Neuer Markt, because this segment by the time had lost its economic significance (see Section II.2., Figure 1). We also calculate an FTS-Series based on Datastream's free float data, which is available starting in 04/2002. Its return in 2003 is 35.44 %. So free flow weighting can explain a large part of the difference. The remaining difference may be due to the inclusion of the middle segment, which had become more important after the closing of the Neuer Markt (see Section II. 2.).

The geometric mean return in the eleven years from 1993 to 2003 is 9.14 % according to our FTS-Series, 9.16 according to the MSCI, but only 7.78 % according to the CDAX.[40] The difference of 1.32 % may matter in many types of empirical studies. For example, it equals the average underperformance of German stock mutual funds. Therefore, mutual funds that abstained from investing in the Neuer Markt should not be compared to the CDAX. If they are compared to the CDAX, their performance will look considerably better than it actually was.

2004 to 2013. After three 'good' years (2004 to 2006) with respect to the magnitude of the annual return differences, the FTS-Series and the CDAX diverge again considerably in 2007 (17.71 vs. 20.42 %), 2008 (–39.36 vs. –42.58 %) and 2009 (18.50 vs. 25.40 %). When we compare our FTS-Se-

[40] The geometric mean of the DAFOX with an adjusted 1998-return (32.96 % replaced by 16.5 %) is 9.25 %, which is very similar to our geometric mean of 9.14 %.

Table 5

R^2 Between Pairs of Total Return Time Series

Panel A: 01/1993 to 12/1997 (60 Months)

Index	FTS-Series (ex. tax credit)	DAFOX	Germany-Datastream Market	MSCI Germany	CDAX
FTS-Series (ex. tax credit)	1.0000	0.9747	0.9854	0.9836	0.9922
DAFOX		1.0000	0.9688	0.9637	0.9656
Germany-Datastream Market			1.0000	0.9874	0.9882
MSCI Germany				1.0000	0.9824
CDAX					1.0000

Panel B: 01/2004 to 12/2013 (120 Months)

Index	FTS-Series (ex. tax credit)	FTS-Series (ex. tax credit, FFW*)	Germany-Datastream Market	MSCI Germany	CDAX
FTS-Series (ex. tax credit)	1.0000	0.9871	0.9891	0.9835	0.9824
FTS-Series (ex. tax credit, FFW*)		1.0000	0.9754	0.9940	0.9969
Germany-Datastream Market			1.0000	0.9734	0.9719
MSCI Germany				1.0000	0.9965
CDAX					1.0000

Notes: The R^2 are obtained from an OLS regression where the left hand variable is a time series of column one, and the right hand variable is a time series within that row.
* FFW=Free float weighting.

ries with free float weights (see Table 4) with the CDAX, the differences in individual years almost disappear. So the CDAX switch to free float weighting seems to explain the relatively large differences between our regular FTS-Series and the CDAX in the years 2007 to 2009. However, note that the (geometric) means for the ten years are not affected: 9.48 (FTS), 9.56 (FTS free float weights) and 9.48 % (CDAX).

Our analyses of R^2 between monthly return time series (see Table 5, Panel B) strongly supports our explanations based on annual returns. Our FTS-Series based on free float weights is most correlated with the CDAX (R^2 = 0.9969). In addition, the MSCI Germany, which switched to free float weighting in 2001, is highly correlated with both time series (0.9965 and 0.9940).

We also use Datastream's free float data to examine what effect the different weighting procedure has on the volatility (measured by the standard deviation of monthly returns in %). Our regular FTS-Series without the tax credit for the 120 months from 2004 to 2013 has a standard deviation of 4.75 %-points. If we weigh with free float, the standard deviation increases to 5.11 %-points. The standard deviation of the CDAX in the same period is 5.25. While these differences seem to be small and are statistically insignificant (F-test = 1.2198, *p*-value = 0.2799, CDAX vs. FTS), they may matter in certain contexts, e.g., in value-at-risk estimations. For a definite answer of the question, which weighting produces a more volatile time series, more data is needed.

VI. Nominal vs. Real Returns, Excess Returns

In Section IV. we concluded that for short-term investors the risks associated with stock investments may have increased over time. Large negative monthly or annual returns have occurred more frequently during the last 30 years than during the first 30 years.

In this section we look at risk and return with the perspective of a long-term investor. In the long-run, inflation may reduce the real value of an investment and as a consequence the real return considerably. Long-term investors should base their decisions on real returns only. We estimate real returns by dividing 1+the nominal return by 1+the inflation rate, see *Stehle/Hartmond* (1991), formula 9, p. 400. Inflation in Germany has typically been relatively low during the 60 years we look at, but still has a considerable impact on the purchasing power of the nominal returns over long investment horizons. Over the entire time period we look

at, the geometric mean inflation rate based on the data of the Federal Statistical Office is 2.625 % per year.[41]

To compare a risky investment in the German stock market portfolio with a 'risk-free' investment, we also report nominal and real returns on one-month money market contracts (Monatsgeld) reported by Frankfurt banks. This time series is a prominent proxy for the risk-free rate and is available on the webpage of the Deutsche Bundesbank (code BBK01. SU0104). The time-series starts in 12/1959 and ends in 06/2012, when the Deutsche Bundesbank stopped collecting this data. From then on we use the one-month EURIBOR (Einmonatsgeld) time series, which is also provided by the Deutsche Bundesbank (code BBK01.SU0310). Before 12/1959, we obtain the data from the monthly reports of the Bundesbank.[42] The one-month money market rate has typically been below 5 % (per annum), but from 07/1969 to 12/1971, 09/1972 to 03/1975, and in 12/1988 and 06/1994, it was consistently higher than 5 %, with a maximum of 13.33 % in 12/1973.

Table 6 reports the geometric means for the full time period of 60 years and three non-overlapping 20-year sub-periods. For the 60 years from 1954 to 2013, our estimate of the geometric mean *nominal* return on stocks is 10.8 %, our estimate of the geometric mean *real* return on stocks is 7.96 %. Over the same time period, the geometric mean of the risk-free rate amounts to nominal 4.72 % or real 2.04 %. The excess returns are calculated as the differences between the geometric mean of stocks and the mean risk-free rate, in nominal terms 6.08 % and in real terms 5.92 %.

The geometric means of the nominal returns on the market portfolio of stocks in the first two 20-year time periods, 1954 to 1973 and 1974 to 1993, are nearly identical: 12.05 % and 12.22 %. Over the last 20 years the return is only 8.17 %, which is roughly 4 %-points less. When taking in-

[41] A long time series for the inflation is available at https://www.destatis.de/DE/Publikationen/Thematisch/Preise/Verbraucherpreise/VerbraucherpreisindexLangeReihen.html. We use the time series "Preisindex" until 1999, which represents a household of four persons with middle class income until 1961, and an "on average household" afterwards. From 2000 onwards we use the "Verbraucherpreis index". The time series includes until 1994 only West-Germany (up to 1959 also excluding Saarland and up to 1961 without West-Berlin), afterwards Germany in total.

[42] Reports are available at http://www.bundesbank.de/Navigation/EN/Publications/Monthly_report_articles/monthly_report_articles.html. See e.g. report 03/1960, p. 64, Table 4, "Money Market Rates", column "One-month loans". We calculate the mid-point between the highest and lowest rate quoted.

Table 6

Geometric Means of Annual Nominal and Real Returns (%)

Time Period (Years)	Inflation	FTS-Series		Risk-Free		Excess Returns	
		Nominal	Real	Nominal	Real	Nominal	Real
1954–2013 (60)	2.62	10.80	7.96	4.72	2.04	6.08	5.92
1954–1973 (20)	2.91	12.05	8.89	4.84	1.88	7.21	7.01
1955–1973 (19)	*2.97*	*9.12*	*5.98*	*4.91*	*1.89*	*4.21*	*4.09*
1974–1993 (20)	3.39	12.22	8.54	6.60	3.11	5.62	5.43
1994–2013 (20)	1.59	8.17	6.48	2.75	1.14	5.42	5.34

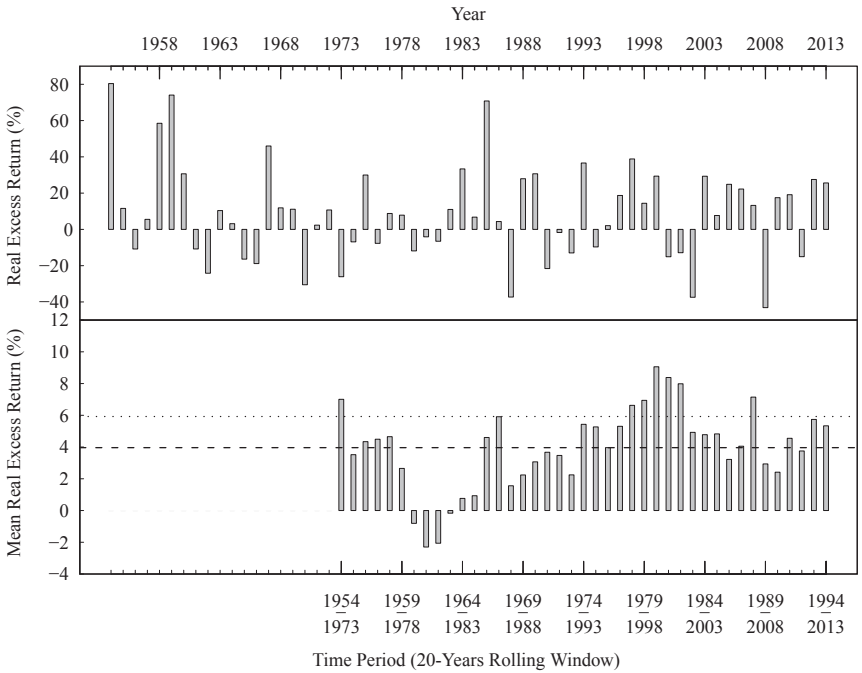
Notes: The FTS-Series contains the corporate income tax credit (1977 to 2000), see Section II.7. Real returns are calculated as in *Stehle/Hartmond* (1991), formula nine (p. 400). The nominal (real) excess return is the nominal (real) return according to the FTS-Series minus the nominal (real) risk-free rate.

flation into account, the difference between the last and the first two sub-periods shrinks to roughly 2 % as a consequence of the much lower rate of inflation in the last 20 years.

In many contexts, a comparison of the excess returns (rate of return on stocks – risk-free rate) is appropriate. Due to the low returns on a risk-free investment during the last 20-year sub-period (2.75 % in nominal terms), the mean excess returns of the last two sub-periods are very similar. They are roughly 5.5 %, in nominal terms and in real terms slightly less. The excess return for the first 20-year sub-period is considerably higher: 7 %. To a large extent this is related to 1954, which was an unusually good year (+85 %) for stock investors. A large part of this increase, and of the other high returns on German stocks between 1949 and 1953, may be related to the reduced uncertainty about the economic future of Germany, its stock market, and the financial burdens which could be imposed on stock ownership as a consequence of World War II.[43] When we omit 1954 and only look at the years 1955 to 1973, the mean return on stocks in excess of the one-month risk-free rate is roughly 4 % in real terms.

In our analysis of long-run returns we so far have focused on three non-overlapping sub-periods, which are 20 years long. In the bottom part of Figure 4 we show the real excess returns for all time periods having a

[43] *Stehle/Wulff/Richter* (2006) discuss the years 1948 to 1954 and present estimates for the return on blue chip stocks during these years. *Ronge* (2002) looks at the years 1870 to 1959.



Notes: The graph at the bottom plots rolling geometric means of real excess returns. Each point in this graph is based on the prior 20 years, starting in 1973 (it includes the time period from 1954 to 1973). The upper dotted line at 5.92 % is the mean real excess return from 1954 to 2013 (60 years), shown in Table 6. The middle dashed line at 3.96 % is the mean of the rolling geometric means of real excess returns.

Figure 4: Yearly and Means of Real Excess Returns

length of 20 years, starting with 7.01 % (1954 to 1973) and ending with 5.34 % (1994 to 2013). The most negative 20-year real excess return (–2.3 % per year) was for investments starting at the beginning of 1961. Investors who held a well-diversified portfolio of German stocks lost 14.1 % in real terms during the next 20 years, investors who had invested at the risk-free rate of interest gained 35.7 % in real terms. So after 20 years, the value of the stock market investment was 50 %-points less than the value of the risk-free investment. For investors starting in 1962 the situation was similar. Stock investors with an investment horizon of 20 years who started in 1960 and 1963 did slightly worse than investors favoring a risk-free investment. Since then investments in German stocks with a length of 20 years always resulted in positive mean real excess returns. So the riskiness of a 20-year investment in German stocks, measured by the frequency of negative excess returns, has not increased but rather decreased since the middle of the 1960s.

The upper dotted line (5.92 %) shows the geometric mean of the 60 annual real excess returns, 1954 to 2013. The middle dashed line (3.96 %) shows the geometric mean of the 41 rolling 20-year geometric means. The difference between these means is nearly 2 %. It illustrates that the mean of the 41 rolling 20-year means gives a biased picture of what happened in the 60 years. The bias results from the fact that the individual years are taken into account differently in the mean of the 41 observations, depending on when they occur. The highest annual return, which occurs in 1954, is only taken into account in the mean for the years 1954 to 1973. The returns for the years 1973 to 1994 all enter twenty rolling means. This implies that for estimating the 20-year mean excess return we have only three independent observations in our data covering 60 years.

VII. Summary

The *Stehle* et al. FTS-Series provided in this paper has the same coverage (all stocks listed in Frankfurt's top segment), is well documented, and uses the same weighting procedure and other construction details throughout. It is available on a monthly basis for 60 years starting in 1954. Other total return series available for the German market only cover shorter time periods or have weaknesses.

We compare the annual returns of our FTS-Series (without the corporate income tax credit) with other total return time series in four sub-periods. The four sub-periods, taken together, cover the full 60 years for which the FTS-Series is calculated. They were chosen on the basis of the availability of other total return series:

- 1954 to 1970: *Bimberg* (1991) and *Gielen* (1994), based on the index of the FSO.
- 1971 to 1992: in addition the DAFOX, the CDAX total return index published by Deutsche Börse AG in 2002, and the MSCI Germany.
- 1993 to 2003: DAFOX, CDAX (official), MSCI Germany, and Datastream-Germany Market.
- 2004 to 2013: CDAX (official), MSCI Germany, Datastream-Germany Market, and a free float version of our FTS-Series.

In each of the four sub-periods analyzed, our FTS-Series is nearly fully in line with at least one other total return time series. None of the other total return series does as well in pair-wise comparisons. Close to our FTS-Series is the DAFOX, which is mainly used by academics. However,

its 1998 return deviates by more than 12 %-points from all other series. We attribute this to a calculation or data error.

The CDAX is fully in line with our FTS-Series for the years 1971 to 2000. Due to the crash of the Neuer Markt, the CDAX return in 2001 is more than 8 %-points lower than the FTS-Series, and more than 5 %-points in 2002. In the years after 2002, the CDAX deviates several times significantly from the FTS-Series. These differences we attribute to the CDAX's free float weighting. We find that free float weighting leads to a more volatile (although statistically insignificant) time series, but the geometric mean is not affected. It may, however, affect the results of specific types of empirical studies, especially performance and event studies. Our advice to academic users is to use both market proxies alternatively.

During most of the 60 years, Frankfurt's top segment (Amtlicher Markt) was the only segment in which a very prudent investor would have invested. Many institutional investors were restricted to this segment by law or by their own charter. We strongly believe that our FTS-Series is the best choice to analyze the risk and return characteristics of German stocks. In any case, it is easy to combine the various time series to get a time series tailored to one's preferences that is going back to 1954. Long-term investors should look at the risk premium in real terms, since inflation and interest rates have decreased systematically in recent years. To an investor who is ready to invest his/her money for 20 years in a broadly diversified portfolio of German high quality stocks, our series provides three independent observations. The latter two, 1974 to 1993 and 1994 to 2013 point to a real risk premium of 5.38 %. This is our prediction for a passive investment for the next twenty years. In 2014, the rate of return on the CDAX was 3.09 %, the risk-free rate 0.13 %, and the inflation rate 0.19 %. Including 2014 would change our results only little.

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