

# An Examination of Relative Volatility in the German Debt and Equity Markets

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## Abstract

The present study examines relative volatility in the German debt and equity markets. Because of the significant impact that volatility in the bond markets has been shown to have on yield spreads and security values, it is important for investors in the global marketplace to be aware of the volatility patterns in these markets as well as the relative volatility of the bond market to the stock market. While previous research has found that volatility in the U.S. bond market has increased relative to the stock market, we observe the opposite in Germany – volatility in the bond market has decreased vis-à-vis the stock market. In addition, the negative trend in both the ratio of bond-stock standard deviations and the correlations between returns in the bond and stock markets indicate that the effectiveness of bonds as diversification vehicles in Germany has increased over time. This finding has important implications for global asset allocation. The results of this study confirm that a common trend in relative volatility does not exist among the developed securities markets.

JEL-Classification: G15

Keywords: bond market volatility, stock market volatility, correlation, asset allocation

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# An Examination of Relative Volatility in the German Debt and Equity Markets

## 1 Introduction

Does stock market and bond market volatility in Germany change over time as it does in other developed markets? What is the relation between bond market volatility and stock market volatility in Germany and has relative volatility changed over time?

In the U.S., many stock market investors and financial journalists believe that stock market volatility has increased in the second half of the twentieth century although the preponderance of evidence indicates that it has not. Siegel (1998) finds that the U.S. stock market has become more volatile *within the trading day* (largely as a result of instantaneous communications and futures markets arbitrage), but finds little evidence that the market has become more volatile as measured by monthly or even daily fluctuations. Campbell/Lettau/Malkiel/Xu (2001) find that U.S. firm-specific (idiosyncratic) volatility rose steadily from 1962 to 1997, even though market and industry volatility did not. One point that researchers and market participants alike agree on, however, is that aggregate U.S. stock market volatility is not constant, but changes over time. With respect to European markets, Johnson/Young (2002) and Young/Johnson (2004) report that volatility during the last three decades of the twentieth century in the UK and Swiss stock markets, respectively, is comparable to that of the U.S. stock market.

While U.S. bond market volatility has not been studied to the extent that has U.S. stock market volatility, researchers have shown that bond return volatility in the U.S. increased significantly in the early 1980s [e.g., Coleman/Fisher/Ibbotson (1993); Reilly/Wright/Chan (2000)]. In addition, changes in U.S. bond market volatility are reported to be a major risk factor for bond investors [Longstaff/Schwartz (1993)], and have a major impact on bond yield spreads [Dialynas/Edington (1992)] and the value of debt securities with embedded options [Dunetz/Mahoney (1988); Fabozzi/Pitts/Dattatreya (1997)]. Johnson/Young (2002) find that when compared to volatility in the U.S. bond market as reported by Reilly/Wright/Chan (2000), UK bond market volatility surged earlier (beginning in 1972 versus 1980 for the U.S. market), rose to higher levels, and persisted at higher levels longer. With respect to the Swiss bond market, Young/Johnson (2004) find that bond market volatility was comparable to that of the U.S. bond market,

except that volatility rebounded in Switzerland beginning in 1988 while volatility in the U.S. bond market remained at relatively low levels. In summary, bond market volatility affects many types of investments, is not globally universal, and is a topic worthy of further study.

While many previous studies have analyzed the volatility of stock and bond market rates of return in the U.S., the pattern of volatility exhibited in non-U.S. markets has not been as extensively studied. Schwert (1998) reports that UK stock market volatility exhibited a similar pattern to the U.S. market and that volatility returned to normal levels quickly after the 1987 crash. In addition, Schwert (1998) finds that the 1973–1975 OPEC crisis had a much larger affect on the volatility of UK stocks than on U.S. stocks.

The present study examines relative market volatility in the German debt and equity markets. Because of the significant impact that bond market volatility has been shown to have on yield spreads and security values, it is important for investors in the global marketplace to be informed of the volatility patterns in the German markets as well as the relative volatility of the German bond market to the stock market. We find that the bond and stock market volatility trends exhibited by the German markets are unlike those found in either the U.S. or UK markets. This finding has important implications for portfolio asset allocation decisions for global investors.

## **2 Data**

All data used in this study are drawn from the Ibbotson Database. The International Monetary Fund (IMF) Germany Long-Term Government Bond Total Return Series contains monthly returns over the period February 1957 to August 2003. Ibbotson computes long-term bond returns using yields from the IMF assuming a single bond with 20 years to maturity is bought at par at the beginning of each period. The bond is “held” during the period and assumed “sold” at the end of the period at a price calculated based on the coupon, remaining time-to-maturity, and the then-prevailing market yield. The return in excess of yield (capital appreciation) is then derived as the change in price over the period, divided by the beginning-of-period price. The yield is converted to an income return by (dividing it by 12) lagging it one period. Total return is equal to the income return plus the return in excess of yield. [Ibbotson Associates (2000)]

The Morgan Stanley Capital International (MSCI) Germany Total Return Series contains monthly returns over the period from January 1970 to October 2003. MSCI indices are market-weighted and are designed to reflect the performance of the entire range of stocks available to investors in a market. MSCI's total return index is based on a monthly total return dividend reinvestment methodology. The amount of the announced dividend is re-invested on the day the security is quoted ex-dividend and provides an estimate of the total return that would be achieved by reinvesting one-twelfth of the annual yield at every month-end. [Ibbotson Associates (2000)]

### **3 Methodology**

To examine bond market volatility, we compute 1) the moving standard deviation of monthly rates of return for 12-month calendar periods, 2) the standard deviation for discrete, non-overlapping 12-month calendar-year time periods, and 3) the variance for discrete, non-overlapping 60-month time periods. These measures are used 1) to examine how bond market volatility has changed over the 46-year period, and 2) to test for changes in bond market volatility over selected time periods.

To examine relative volatility in the bond and stock markets, we compute 1) the ratio of moving standard deviations of monthly rates of return for 12-month calendar periods for bonds to stocks, 2) the ratio of standard deviations for discrete, non-overlapping 12-month calendar-year time periods for bonds to stocks, 3) a moving measure of systematic risk (beta) for long-term German government bond returns relative to returns for the MSCI Germany total return series, and 4) the correlation coefficient between the returns on long-term German government bonds and the MSCI Germany total return series for moving 36-month calendar periods. These measures are used to examine trends and test for changes in bond market volatility relative to stock market volatility during the period of study. Because the bond market return series predates the stock market return series by nearly 13 years (February 1957 vs. January 1970), comparisons between bond market and stock market volatility are based on the 30-year overlapping time period from January 1973 through December 2002. In the following discussion of volatilities in the German bond and stock markets, comparisons are made to the research results from the U.S.

markets reported by Reilly/Wright/Chan (2000), the UK markets reported by Johnson/Young (2002), and the Swiss markets reported by Young/Johnson (2004).

## **4 Results**

### *4.1 Bond market volatility*

*Figure 1* shows the plot of the moving standard deviations of monthly rates of return for the IMF Germany long-term government bond series. This provides a dynamic view of bond market volatility in Germany over the 45-year study period. Beginning in 1966, the bond market became increasingly volatile until it peaked in 1981. Following the 1981 peak, bond market volatility declined for about four years and then remained relatively stable at about twice the level of the pre-1966 period. The 45-year trend in bond market volatility is positive and significant at the one percent level ( $t=10.29$ ). When compared to U.S. bond market volatility, both the level and patterns are very similar in the German market. When compared to bond market volatility in the UK, bond market volatility peaked later in Germany and then quickly retreated to lower levels while bond market volatility in the UK remained at higher levels for over a decade. Although bond market volatility in both Germany and Switzerland peaked in the early 1980s, Swiss bond market volatility experienced another upward trend beginning in 1988 reaching a peak in 1993 higher even than in the early 1980s while German bond market volatility remained relatively stable over the same period. Monthly standard deviations of total returns after 1995 in Germany were in the 1.0–2.0 percent range compared to the 1.0–2.0, 1.5–2.0, and 1.0–3.0 percent ranges for Switzerland, the U.S., and the UK, respectively.

### *4.2 Stock market volatility*

*Figure 2* shows the plot of the moving standard deviations of monthly rates of return for the MSCI Germany total return series. Unlike the bond market, the stock market did not experience a large increase in volatility in the mid 1970s during the OPEC crisis. In fact, stock market volatility declined by about 70 percent from 1975 to 1978, then began a steady increase with a peak in 1988 that coincided with the U.S. stock market crash. This illustrates the impact of U.S. market activity on world securities markets. The 1988 peak was followed by a quick retreat to levels of ten years earlier and a rebound culminating in

another peak in 1990. By 1992, stock market volatility had again retreated to 1970s levels, but began an upward trend in 1996 ascending in 2003 to the highest levels in the study period. Similar to the bond market, volatility in the German stock market exhibits a positive and significant trend over the study period ( $t=10.10$ ). The pattern of volatility in the German stock market is generally comparable to that exhibited by the U.S., UK, and Swiss stock markets, although the market reaction to the oil crisis in 1973 was much more muted for the German market. Also, while all four stock markets experienced an increase in volatility in 1998, German stock market volatility continued a climb to record levels in 2002-2003.

*Table 1* summarizes the discrete 12-month (calendar year) standard deviations for both the German bond market series and the German stock market series for the period January 1973 through December 2002. *Panel A* lists the high volatility years for both markets in terms of descending volatility. The data confirm our earlier observations that stock market volatility in Germany followed a pattern similar to those of the U.S., UK, and Switzerland, but bond market volatility did not. *Panel B* lists the low volatility years in terms of ascending volatility. We note that the peak volatility in both the bond and stock markets in the UK was approximately twice the peak levels of the bond and stock markets, respectively, of Germany, Switzerland, or the U.S. Over the 30-year period, the 1990s experienced the lowest volatility in the German bond market.

#### 4.3 *Relative volatility in the bond and stock markets*

*Figure 3* graphs the ratio of moving 12-month standard deviations of rates of return (standard deviation of bond returns divided by standard deviation of stock returns) over the period January 1970 through December 2002. The graph clearly shows that the relation between the measures of volatility in the German markets is not stable. While volatility is consistently lower in the bond market (the ratio rarely exceeds unity), there were several periods between 1977 and 1982 when bond market volatility approached stock market volatility (denoted by a ratio over 0.7). However, bond market volatility in many periods was but a small fraction of stock market volatility. In addition, the trend in relative volatility in the bond and stock markets is negative and significant at the one percent level ( $t=-6.88$ ). This finding contrasts the “significant positive trend in the ratio of volatility”

found for the U.S. markets [Reilly/Wright/Chan (2000, 86)]. Prior studies found no significant trend in the relationship between bond market volatility and stock market volatility in the UK and Swiss markets.

*Table 2* contains a summary of the relative volatility in the German bond and stock markets. *Panel A* shows the ratios of bond market volatility to stock market volatility for the calendar years with the highest and lowest ratios. The ratio of standard deviations ranges from a low of about 0.12 (bond volatility was little more than a tenth of stock volatility in 2002) to a high of almost 0.94 (bond volatility was nearly as great as stock volatility in 1980). The mean of the annual ratios of bond market standard deviation to stock market standard deviation is 0.3400, indicating that on average the bond market in Germany exhibits about one-third the volatility of the stock market. These results are similar to those reported for the U.S., UK, and Switzerland.

*Table 3* summarizes the discrete 60-month variances of bond returns and stock returns over the study period and also shows the ratio of stock market variance to bond market variance for each interval. In every time interval, the ratio is significant at the five percent level indicating that in Germany, stock market volatility is significantly greater than bond market volatility. This result is consistent with those reported for the U.S., UK, and Swiss markets.

*Table 4* contains *F*-ratios comparing bond market volatility over discrete 60-month intervals during the period of 1968–2002. For example, comparing the bond market volatility between the 60-month period 1973–1977 to the period 1968–1972 results in an *F*-ratio of 1.559. (Each ratio is calculated as the variance of the later interval divided by the variance of the earlier interval.) This indicates bond market volatility increased from the 1968–1972 period to the 1973–1977 period (the ratio is greater than unity), and the increase was significant at the five percent level. Comparing the 1983–1987 period to the 1978–1982 period results in an *F*-ratio of 0.429, indicating a decrease in volatility beginning in 1983 significant at the one percent level. This result is consistent with our earlier observation (based on *Figure 1*) that volatility in the German long-term bond market declined in the 1980s. A comparison of consecutive time periods (diagonal entries immediately under the 1.000 in each column) shows that of the six comparisons, three represent significant changes. Significant increases in bond market volatility occurred

between the periods centered on 1970 and 1975, and between the periods centered on 1975 and 1980. A significant decrease occurred between the periods centered on 1980 and 1985. Of the 21 possible comparisons between 60-month intervals, eight exhibited changes in volatility significant at the five percent level – four increases and four decreases.

### 3.4 Bond Market Betas Relative to Stocks

*Figure 4* shows the graph of regression coefficients (betas) relating German bond market returns to stock market returns for moving 36-month intervals covering the period 1970–2002. Whereas *Figure 3* shows the ratio of the moving 12-month standard deviations of the two series, the plot in *Figure 4* (moving betas) represents a measure of the covariance between the two series. Although both graphs illustrate relative volatility in the German bond and stock markets, they differ with respect to time interval and the influence of covariance. *Figure 4* confirms the instability in the relation between bond market returns and stock market returns over the study period. In the late 1970s and early 1980s (and to a lesser extent in the early to mid 1990s), the relationship is much stronger than in the balance of the study period. The 30-year trend for the beta coefficient illustrated in *Figure 4* is negative and significant at the one percent level ( $t=-9.06$ ). This contrasts to Reilly/Wright/Chan's (2000) finding of a significant upward sloping ( $t=24.79$ ) trend in the beta coefficients for the U.S. bond and stock markets. However, we must agree with their assertion that “the systematic risk relationship between these asset classes clearly was not stable over time, as shown by the significant changes in the beta over time.”

[Reilly/Wright/Chan (2000, 87)] In fact, several of the calculated betas for the German markets in 2000–2002 were negative, indicating that returns on bonds were moving counter to returns on stocks. The highest and lowest 36-month betas are displayed in *Panel B* of *Table 2*. These overlapping betas are calculated at the end of each year in the study period from 1972 to 2002.

### 4.5 Bond market-stock market correlation

*Figure 5* graphs the 36-month moving correlation coefficients between the returns on the German bond and stock markets. Because of the close relationship between beta and correlation (beta is easily converted to correlation by multiplying beta by the standard

deviation of the independent variable/standard deviation of the dependent variable), the plot of correlation coefficients very closely resembles that of the beta coefficients. The main difference is that the variability of the dependent variable is represented in the denominator of the correlation coefficient. The graph of monthly correlation coefficients, like the graph of the beta coefficients, shows considerable volatility (compare *Figure 5* with *Figure 4*), and the overall trend in correlations is negative and significant ( $t$ -statistic for the slope coefficient is  $-8.81$ ). This finding is consistent with that for the Swiss market, but contrasts with the results for the U.S. market (a positive and significant trend in the correlations) and the UK market (a negative but insignificant trend in correlations). Reilly/Wright/Chan's (2000) conclusion that U.S. stocks have become more interest rate sensitive, implying an increase in their empirical duration, is not consistent with evidence from the German market. In addition, Bernstein's (1992) contention that stocks are becoming more interest rate sensitive (as evidenced by higher correlations) and thus more bond-like is not supported by recent observations in the German market.

## **5 Summary**

We have reported the changes in Germany's bond market and stock market return volatilities over the period from 1958 to 2003 as represented by the IMF Germany Long-Term Government Bond Total Return Series and the MSCI Germany Equity Total Return Series. Although German bond market volatility has recently moderated, bond market volatility during the 45-year study period has trended upward and swings in bond market volatility became more pronounced. German stock market volatility spiked in 1988 and 1990, moderated until late 1997, and then climbed to record levels in 2003. Like the bond market, the stock market exhibited a positive and significant trend in volatility. During the 30-year comparison of bond market and stock market volatilities, Germany's stock market volatility averaged nearly three times that for the bond market. This compares favorably with the results of Schwert (1989, 1990) and Reilly/Wright/Chan (2000) who find that for the U.S. market, the average volatility for stocks is about three times that for bonds, but contrasts with the findings of Johnson/Young (2002) who find that stock market volatility in the UK is only about twice that of the bond market.

The long-term trend in relative volatility in the German bond and stock markets is negative. We observe instances when bond market volatility approaches stock market volatility, but in most periods volatility in the bond market was but a small fraction of that in the stock market. It is obvious, however, that the relation between bond market volatility and stock market volatility is unstable. This result is confirmed by the wide swings in the beta coefficients and correlation coefficients relating bond market returns to stock market returns. In 2000–2002, the beta and correlation coefficients are negative indicating an inverse relationship (negative covariance) between bond returns and stock returns.

Reilly/Wright/Chan (2000) reported that for the U.S. market, a combination of higher relative total risk (a higher ratio of bond-stock standard deviations) and a higher correlation between stocks and bonds reduced the diversification benefits of bonds vis-à-vis stocks. They argued that, as a result, a smaller allocation to bonds in a portfolio asset allocation decision was warranted. An important conclusion of this study is that the same recommendation is not appropriate for the German markets. The negative trend in both the ratio of bond-stock standard deviations and the correlations between bond and stock market returns indicate that the effectiveness of bonds as diversification vehicles in Germany has not declined, but rather has increased over time.

This study is an important addition to the body of knowledge regarding bond and stock market volatilities because it provides additional evidence contrary to popular beliefs about market volatility changes. The proliferation of cable television, the Internet, and other forms of low-cost and instantaneous financial market information has caused market participants to focus more on market volatility today than in the past. There is a general perception of rapidly increasing market volatility that is not supported by an empirical examination of market returns. While previous researchers have found that in the U.S. bond market volatility is increasing relative to stock market volatility, we find that the same is not true for Germany's markets. The results of this study, like those reported in earlier studies of bond and stock markets in Switzerland and the UK, indicate that it is inappropriate to assume that trends in the U.S. market are representative of those in other developed markets.

## References

- Bernstein, Peter L. (1992), From Forecast to Portfolio Construction, in Katrina F. Sherrerd (ed.), *Improving the Investment Decision Process – Better Use of Economic Inputs in Security Analysis and Portfolio Management*, Charlottesville, VA: Association for Investment Management and Research.
- Campbell, John Y., Martin Lettau, Burton G. Malkiel, and Yexiao Xu (2001), Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk, *The Journal of Finance* 56, 1–43.
- Coleman, Thomas S., Lawrence Fisher, and Roger G. Ibbotson (1993), A Note on Interest Rate Volatility, *The Journal of Fixed Income* 3, 97–101.
- Dialynas, Chris P., and David H. Edington (1992), Bond Yield Spreads: A Postmodern View, *The Journal of Portfolio Management* 19, 68–75.
- Dunetz, Mark L., and James M. Mahoney (1988), Using Duration and Convexity in the Analysis of Callable Bonds, *Financial Analysts Journal* 44, 53–73.
- Fabozzi, Frank J., Mark Pitts, and Ravi E. Dattatreya (1997), Price Volatility Characteristics of Fixed-Income Securities, in: Frank J. Fabozzi (ed.), *The Handbook of Fixed-Income Securities*, 5<sup>th</sup> edition, Chicago, IL: Irwin Professional Publishing.
- Gujarati, Damador N. (2003) *Econometrics*, New York, NY: McGraw-Hill.
- Johnson, Robert R., and Philip J. Young (2002), Bond Market Volatility vs. Stock Market Volatility: Evidence from the UK, *The Journal of Asset Management* 3, 101–111.
- Longstaff, Francis A., and Eduardo S. Schwartz (1993), Interest Rate Volatility and Bond Prices, *Financial Analysts Journal* 49, 70–74.
- Reilly, Frank K., David J. Wright, and Kam C. Chan (2000), Bond Market Volatility Compared to Stock Market Volatility, *The Journal of Portfolio Management* 27, 82–92.
- Schwert, G. William (1989), Why Does Stock Price Volatility Change Over Time?, *Journal of Finance* 44, 1115–1153.
- Schwert, G. William (1990), Stock Market Volatility, *Financial Analysts Journal* 46, 23–34.
- Schwert, G. William (1998), Stock Market Volatility: Ten Years After the Crash, *Brookings-Wharton Papers on Financial Services* 1, 65–114.
- Siegel, Jeremy J. (1998), *Stocks for the Long-Run*, New York, NY: McGraw-Hill.
- Young, Philip J., and Robert R. Johnson (2004), Bond Market Volatility vs. Stock Market Volatility: The Swiss Experience, *Financial Markets and Portfolio Management* 18, 8–23.

Figure 1: Moving 12-month Standard Deviation of Total Returns - IMF German L-T Bond

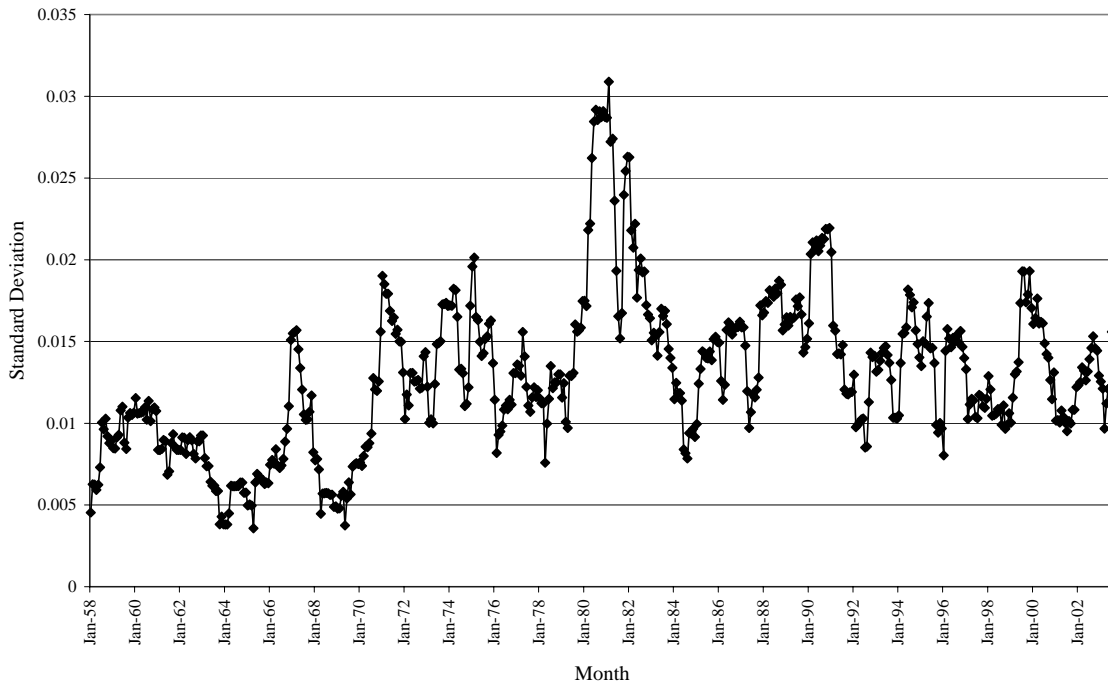
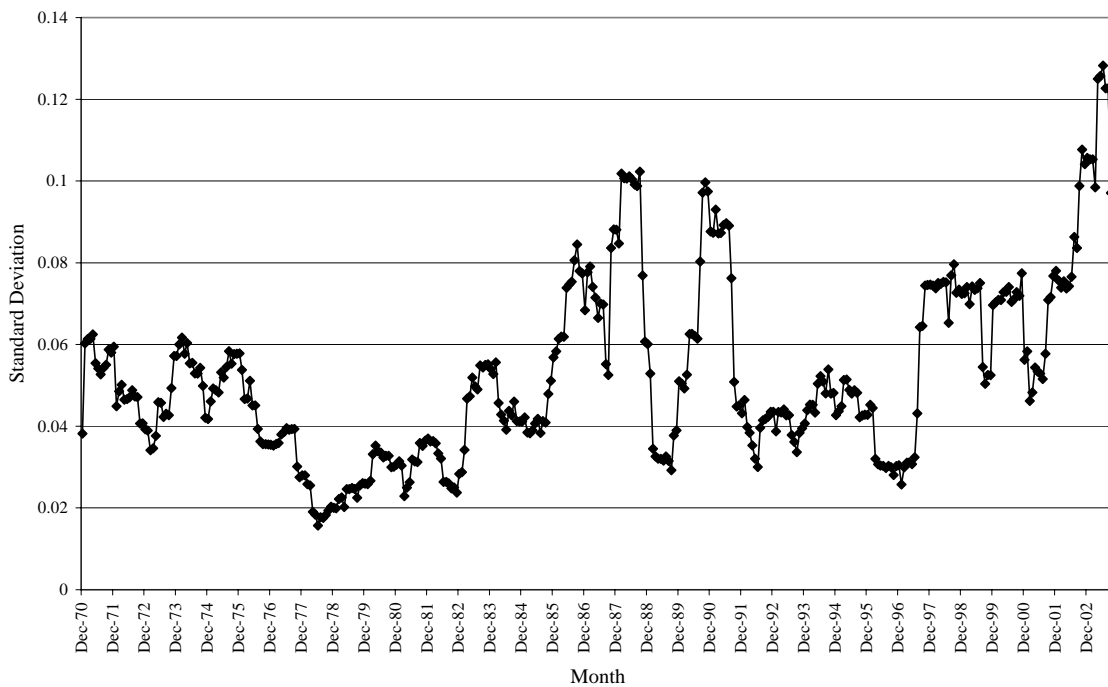


Figure 2: Moving 12-month Standard Deviation of Total Returns - MSCI Germany



*Table 1: Summary Statistics for German Bond and Stock Market Indexes:  
Annual Standard Deviations of Monthly Returns: 1973–2002*

*Panel A: High Volatility Years*

<u>Bond Market</u>		<u>Stock Market</u>	
1980	2.872%	2002	10.563%
1981	2.630%	1987	8.807%
1990	2.195%	1990	8.763%
1979	1.746%	2001	7.802%
1974	1.719%	1997	7.466%
1973	1.718%	1998	7.241%
1999	1.705%	1999	6.963%
1987	1.660%	1986	6.835%
1982	1.642%	1988	6.007%
1986	1.621%	1975	5.781%

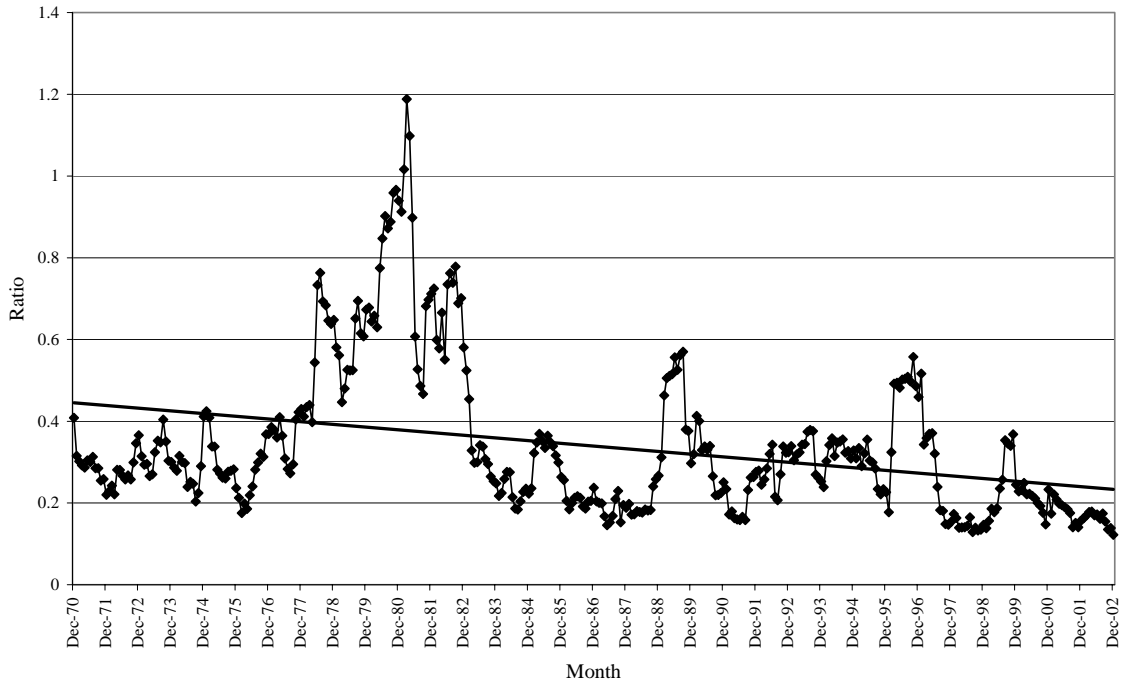
*Panel B: Low Volatility Years*

<u>Bond Market</u>		<u>Stock Market</u>	
1984	0.917%	1978	2.005%
1995	0.968%	1979	2.595%
1993	1.027%	1977	2.796%
1998	1.062%	1982	2.830%
1997	1.151%	1996	3.043%
1991	1.191%	1980	3.057%
1977	1.202%	1976	3.545%
2001	1.221%	1981	3.696%
2002	1.291%	1993	4.064%
1978	1.299%	1984	4.113%

*Panel C: Statistics for Entire Period: 1973–2002*

<u>Bond Market</u>	<u>Stock Market</u>
Mean of Annual Standard Deviations (N=30)	
1.500%	5.230%
Standard Deviation of All Monthly Returns (N=360)	
1.628%	5.773%

Figure 3: Ratio of Moving 12-month Standard Deviation of Returns for L-T Gov't. Bonds to MSCI Germany



*Table 2: Summary Statistics Comparing Volatility of German Bond Returns to Volatility of German Stock Returns: 1973–2002*

*Panel A: Ratio of Discrete Annual Standard Deviations for Bond Market to Standard Deviations for Stock Market*

<u>High Ratio Years</u>		<u>Low Ratio Years</u>	
1980	0.9395	2002	0.1223
1981	0.7116	1998	0.1466
1979	0.6731	1997	0.1542
1978	0.6481	2001	0.1565
1982	0.5804	1987	0.1885
1996	0.4594	1984	0.2229
1977	0.4300	1995	0.2265
1974	0.4115	2000	0.2331
1976	0.3686	1975	0.2366
1994	0.3283	1986	0.2372

Mean of annual bond StdDev to stock StdDev ratios = 0.3400

Ratio of bond StdDev to stock StdDev for all monthly returns = 0.2820

*Panel B. Beta coefficient for Bond Returns as a Function of Stock Returns*

<u>High 36-month Betas</u>		<u>Low 36-month Betas</u>	
1980	0.3798	2002	-0.0505
1981	0.3130	2000	-0.0111
1979	0.2861	2001	-0.0062
1982	0.2555	1989	0.0132
1994	0.1555	1998	0.0235
1995	0.1471	1999	0.0261
1996	0.1409	1987	0.0344
1978	0.1361	1988	0.0380
1976	0.1205	1985	0.0505
1977	0.1192	1984	0.0662

Mean of year-end 36-month beta coefficients = 0.1061

Beta coefficient of monthly returns for total period = 0.0556

*Table 3: Monthly Return Variances of German Bonds and German Stocks for 60-Month Time Periods: 1973–2002*

<u>Time Period</u>	<u>5-year Return Variance Bond Returns</u>	<u>5-year Return Variance Stock Returns</u>	<u>Ratio of Stock Variance to Bond Variance</u>
1973–1977	0.000228	0.002184	9.567**
1978–1982	0.000471	0.000827	1.755*
1983–1987	0.000202	0.004677	23.117**
1988–1992	0.000283	0.003580	12.664**
1993–1997	0.000200	0.002427	12.125**
1998–2002	0.000200	0.006323	31.612**

\*F-ratio is significant at the 5% level

\*\*F-ratio is significant at the 1% level

*Table 4: Ratios of Variance of IMF German Long-term Bond Returns for 5-year Time Periods: 1968–2002*

	1968–1972	1973–1977	1978–1982	1983–1987	1988–1992	1993–1997	1998–2002
1968–1972	1.000						
1973–1977	1.559*	1.000					
1978–1982	3.219**	2.065**	1.000				
1983–1987	1.382	0.886	0.429**	1.000			
1988–1992	1.931**	1.238	0.600*	1.397	1.000		
1993–1997	1.367	0.877	0.425**	0.989	0.708	1.000	
1998–2002	1.366	0.876	0.424**	0.989	0.708	0.999	1.000

\*F-ratio significant at the 5% level (8 out of 21 pairs)

\*\*F-ratio significant at the 1% level (6 out of 21 pairs)

Figure 4: Moving 36-month Regression Coefficient for IMF German L-T Gov't. Bond Returns =  $f(\text{MSCI Germany Returns})$

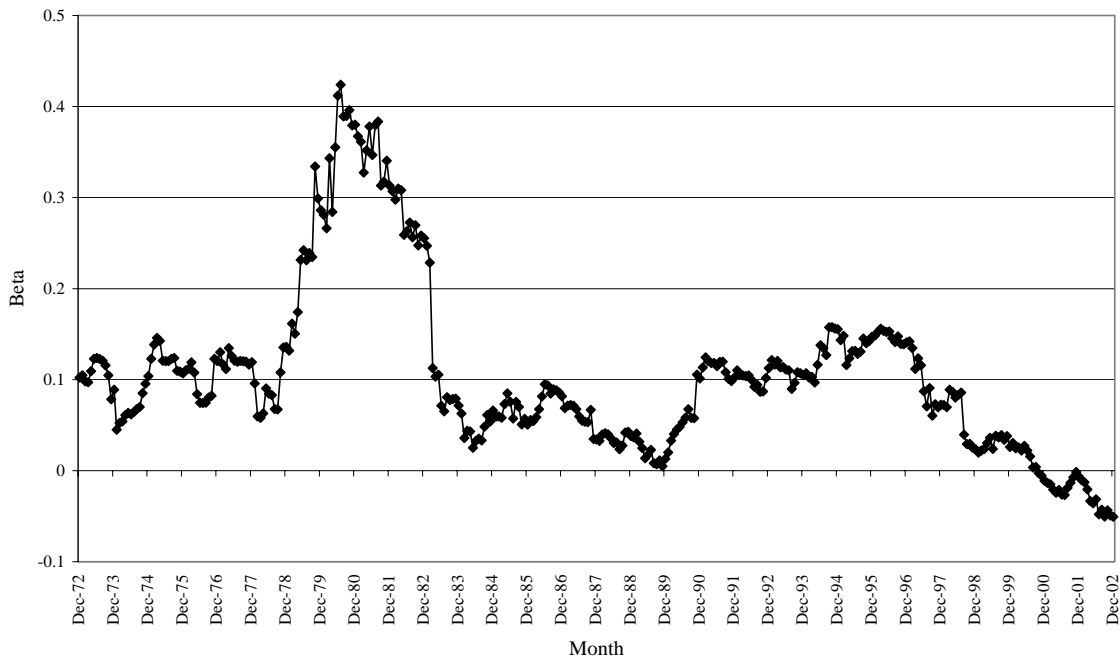


Figure 5: Moving 36-month Correlation of IMF German L-T Gov't. Bond Returns with MSCI Germany Returns

