Dynamic Macroeconomic Effects on the German Stock Market before and after the Financial Crisis*

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Abstract

Today we live in a post-truth and highly digitalized era characterized by the flow of (mis-)information around the world. Identifying the impact of this information on stock markets and, moreover, forecasting stock returns and volatilities has become a much more difficult, and perhaps an almost impossible, task purpose. This paper investigates the impact of macroeconomic factors on the German main stock index, the DAX30, for the time period from 1991 to 2016. There are no comparable investigations for the DAX regarding this time period and the GARCH approach in the literature. Using a dataset about 23 variables and over a timeframe of about 25 years, we find evidence that the growth rates of money supply M1 have a high impact on the stock returns. The results illustrate that in the post-crisis period more macroeconomic factors have a significant impact on the German stock market compared with the pre-crisis period. This implies that in the post-crisis period a macro-driven market is prevailing. In the post-crisis period, however, increasing saving rates, M2 and M3 lead to shrinking stocks values due to higher risk aversion.

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1 Introduction

For as long as stock markets in Europe and the US have existed, traders have tried to investigate and forecast the stock price and the capital markets. Familiar to traders and other interested parties is the finding that macroeconomic factors do indeed influence the stock price, and also corporation figures, political situations and branch industry figures. Identifying the impact of this information on stock markets and, moreover, forecasting stock returns and volatilities plays a crucial role in the economic sciences, especially regarding the discussion about the efficient market hypothesis. Since we now live in a post-truth and highly digitalized era where a lot of information flows around the world, it gets more difficult to estimate the markets returns and risks regarding the huge amount of information available or possible factors.

We analyze over thirty papers which relate to the impact of macroeconomic factors on stocks written since 1976 until present day and clustered them in terms time and scope. In the years 1980-1990 most studies are for the USA. Beginning with the investigations of Chen, Roll & Ross (1986), a lot of articles tried to show an association between security returns and macroeconomic variables. Bodie (1976), Fama (1981), Pearce and Roley (1983) (1985) have documented that aggregate stock returns are negatively related to inflation and to money growth.

The papers written between 1990 and 2000 focused more on the impact of macroeconomic factors on stock volatility. Hamilton and Susmel (1994) investigate besides the equity returns also their volatilities. Ferson and Harvey (1991) identify five factors impacting equity prices: the growth rate of industrial production, expected inflation, unexpected inflation, the bond default risk premium and a term structured spread. Fama (1990) argued that if equity prices reflect expected future cash flows, equity price changes should predict future macro conditions. Errunza and Hogan (1998) investigate via a VAR-model whether money supply volatility and industrial production has an effect on stock market volatility.

Between the years 2000 and 2010, the most important paper written in the field was written by Flannery and Protopapadakis (2002). They show that stock market returns are significantly correlated with inflation and money growth. They estimate a GARCH model of daily equity returns, where realized returns and their conditional volatility depend on 17 macro series announcements. They find six candidates for priced factors: three nominal (CPI, PPI, and a Monetary Aggregate) and three real (Balance of Trade, Employment Report, and Housing Starts). Popular measures of overall economic activity, such as Industrial Production or GNP are not represented.
2 Data and Variables

We work with three separate datasets. The first dataset is comprised of eighteen macroeconomic factors for Germany from Deutsche Bundesbank, European Central Bank (ECB), the Federal Statistical Office (Statistisches Bundesamt), the Center for European Economic Research (ZEW), Thomson Reuters and the Institute for Economic Research (ifo) from 1991 to 2016. These are:

- GDP
- Exports
- Money supply (M1, M2, M3)
- CPI & PPI
- Effective exchange rates (real & nominal, indirect quotation)
- Unemployment rate
- Savings rate
- Financial account
- 10-year German government bond yields
- Stock levels
- Manufacturing orders
- Industrial production
- Ifo Business Climate Index
- Ifo Business Expectations Index
- ZEW Indicator of Economic Sentiment
- Consumer Confidence Indicator Germany
- Lending to enterprises and individuals in Germany
- Real earnings

The ZEW Index and the Consumer Confidence Index are stationary, whereby the quarterly differences of the 10-year German government bond yields are calculated for further analysis. For the other factors, the quarterly growth rates are calculated and checked for stationarity. If necessary, seasonal adjustments are made using the Census X-13 method.

The second and main dataset relates to the quarter-to-quarter DAX returns from 1991 to 2016, calculated with the DAX-Total-Return Index from Deutsche Börse AG.

The third dataset features data from Thomson Reuters also for the same time period and including the gold and oil prices.

3 Model Specification

Our motivation is to investigate the dynamic macroeconomic influences on the German DAX index for the time period from 1991 to 2016. To the best of our
knowledge, comparable investigations for the DAX, the time period in question and employing the GARCH model do not exist.

GARCH processes differ from homoskedastic models, which assume constant volatility and are used in basic ordinary least squares (OLS) analysis. OLS aims to minimize the deviations between data points and a regression line to fit those points. With asset returns, volatility seems to vary during certain periods of time and depends on past variance. By applying an OLS on these heteroskedastic time series, periods with high volatility have a greater impact on the estimation of the coefficients, leading to inefficient coefficients and biased test statistics.

GARCH models handle heteroskedastic time series by modeling simultaneously the returns (mean equation) and the time-dependent changes in volatility (variance equation). By doing so, changes in the volatility are absorbed by the variance equation, so that the coefficients of the mean equation are efficient and free of bias.

The macroeconomic factors are partly highly correlated. Therefore, a common GARCH model, which includes all macroeconomic factors, leads to problems of multicollinearity. In this case, the test statistics are biased and it is impossible to obtain the isolated effect of a factor, which is the aim of the research. To determine the dynamic impact of macroeconomic factor $MF$ on stock returns $r$ over several quarters, for each individual factor we run a separate GARCH(1,1) regression. In this way, the estimated coefficients and the test statistics are free of the multicollinearity issue. The mean and variance equations of our approach are as follows:

Mean equation: \[ r_t = \beta_0 + \beta_1 MF_{t-1} + \beta_2 MF_{t-2} + \cdots + \beta_k MF_{t-k} + \varepsilon_t, \quad (1) \]

with \[ \varepsilon_t \sim N(0, \sigma_t^2), \]

Variance equation: \[ \sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \sigma_{t-1}^2. \quad (2) \]

This means that the stock returns are modeled by the last $k$ periods of the macroeconomic factor, whereby the conditional variances of the stock returns $\sigma_t^2$ are modelled by the variance and the squared error terms of the prior period.

To measure the joint impact of the lagged macroeconomic factor, we perform the Wald test with the following null hypothesis:

\[ \beta_1 + \beta_2 + \cdots + \beta_k = 0. \quad (3) \]
The calculated test statistic, which follows a $\chi^2$-distribution, reveals not only the significance of the sum of the lagged factor, but also the way in which the macroeconomic factor affects stock returns.

An additional test for the joint significance is the likelihood-ratio test. The test statistic, which also follows asymptotically a $\chi^2$-distribution, is calculated by dividing the likelihood of the GARCH-model with the lagged factors by the likelihood without the lagged factors. A high resulting ratio is an indicator of a significant impact of the lagged factors on stock returns.

### 4 Discussion of the Results

#### 4.1 Results of the whole time period

First of all, we measure the lagged impact of macroeconomic factors on DAX returns for the whole sample, the results of which are shown in Figure 4.1. Both the Wald test and the likelihood ratio test show strong evidence for a significant impact of lagged quarterly growth rates of M1 on DAX stock returns. The number of lags included in the GARCH specification is four and, according to the Wald test, the cumulative impact of these lags is positive. This means that the past four quarters jointly have a positive effect on stock returns. An explanation for this finding can be the excess liquidity caused by expansionary monetary policy, for example open market operations, which leads to increasing bond prices and decreasing interest rates. Considering that stock prices are reflecting the value of discounted future cash flows, lower interest rates lead to higher stock valuations. Additionally, the excess liquidity could increase the demand for stocks, so that stock prices rise. Furthermore, companies benefit from a lower cost of capital and increase their investments, which could have a positive effect on future cash flows and thus on stock returns.

Also positive and with one lag, the quarterly growth rates of the real and nominal effective exchange rate (NEER, REER) affect stock returns. Regarding the implications on the goods market, these positive effects appear inconsistent. Since an increase of the REER reflects a relative inflation adjusted appreciation of the domestic currency, and thus a loss in trade competitiveness on the part of domestic firms, corporate sales and earnings decrease along with stock prices. The positive sign measured can be explained from the perspective of a portfolio balance model: a relatively good domestic economic environment (e.g. along with increasing interest rates) attracts inflows of foreign capital, which increases the demand for domestic currency and assets. The significant positive impacts of both REER and NEER corroborate the portfolio allocation
effect and shows that the nominal factor has the principal impact on stocks with a delay of one quarter.

An interesting result is the negative impact of the **Consumer Confidence Index on stocks**. This means, a positive mood of consumers leads to decreasing returns in the stock market, which is not consistent with the Keynesian view: higher consumption should lead to higher sales and thus to higher stocks. An explanation for this could be the composition of the DAX30 index with relatively less consumer companies. The negative relation can arise from the inverse relationship of consumer confidence and savings behavior. Lower consumption leads to higher savings and, as a result, to higher investments. Thus, the supply of capital in financial markets will increase, so that asset prices, including stock prices, tend to increase. Additionally, the higher supply of capital leads to shrinking interest rates, so that the valuations of stocks increase due to the lower discount rate for future cash flows. This finding is consistent with the results of Fisher & Statman (2003), who found for the USA that higher consumer confidence is followed by lower stock returns, and Jansen & Nahuis (2003), who found for Germany that there is a negative correlation between consumer confidence and stock markets.

According to both tests, the one quarter lagged quarterly growth rate of the Ifo Business Expectations Index shows a significant and positive correlation on stocks. This finding is not very surprising since this factor is a leading indicator for expected economic activity and business environment. The interesting thing here is rather the number of lags - with just one quarter - which means that the effect of business expectations on stocks is not very persistent.

The impact of quarterly **German 10y government yield** differences is according to the Wald test significant and negative with three lags, whereby the likelihood ratio test shows less significance. A reason for this finding could here also be the rising (long-term) interest rate, which shrinks the valuation of stocks due to higher discount rates for future cash flows.

A similar explanation pertains to the **Producer Price Index**, whose quarterly growth rates show at least a weak and negative impact on stocks regarding the Wald test: increasing inflation leads to higher nominal interest rates and thus to a devaluation of the present value of expected cash flows. Additionally, higher prices for firms lead to higher costs and lower company earnings. Especially in the case of an elastic demand, the ability of companies to pass these costs on to consumers is very limited.

With a lag up to two periods, the quarterly growth rates of the stock level shows, according to the Wald test, a significant and negative impact on stocks. The likelihood-ratio test cannot support the significant impact. Because rising stock
levels lead to production without sales, this phenomenon is an exposure for companies and could lead to shrinking stock returns. Moreover, a rising stock level indicates a business cycle downturn, so that company earnings are under stress. Ostensibly, the effect of the shrinking interest rate in the downturn cycle on stocks remains inapparent.

Although the likelihood-ratio test shows insignificance, the Wald test indicates a significant and positive impact of the quarterly growth rates of the unemployment rate. Remarkable is the relatively long persistence of this effect - spanning four quarters. This finding could be explained by an economic contraction, which leads to higher unemployment rates and lower interest rates and, as a result, to higher discounted cash flows.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of lags</th>
<th>Wald-Tests ($\chi^2$)</th>
<th>Direction of the impact</th>
<th>Likelihood ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money supply M1 (in % q-o-q)</td>
<td>4</td>
<td>16.44 *** (0.0001)</td>
<td>+</td>
<td>22.12 *** (0.0002)</td>
</tr>
<tr>
<td>Real effect. exch. rate (in % q-o-q)</td>
<td>1</td>
<td>8.83 *** (0.0038)</td>
<td>+</td>
<td>6.17 ** (0.0130)</td>
</tr>
<tr>
<td>Nominal effect. exch. rate (in % q-o-q)</td>
<td>1</td>
<td>9.21 *** (0.0024)</td>
<td>+</td>
<td>6.25 ** (0.0125)</td>
</tr>
<tr>
<td>Consumer Confidence Index</td>
<td>2</td>
<td>7.24 *** (0.0072)</td>
<td>-</td>
<td>7.16 ** (0.0279)</td>
</tr>
<tr>
<td>Ifo Business Expectations Index (in % q-o-q)</td>
<td>1</td>
<td>3.65 * (0.056)</td>
<td>+</td>
<td>3.98 ** (0.0461)</td>
</tr>
<tr>
<td>German 10-y gov. yield (q-o-q differences)</td>
<td>3</td>
<td>4.23 ** (0.0396)</td>
<td>-</td>
<td>6.19 (0.1029)</td>
</tr>
<tr>
<td>Producer Price Index (in % q-o-q)</td>
<td>2</td>
<td>3.46 * (0.0630)</td>
<td>-</td>
<td>4.47 (0.1072)</td>
</tr>
<tr>
<td>Stock level (in % q-o-q)</td>
<td>2</td>
<td>5.21 ** (0.0224)</td>
<td>-</td>
<td>4.00 (0.1352)</td>
</tr>
<tr>
<td>Unemployment rate (in % q-o-q)</td>
<td>4</td>
<td>6.18 ** (0.0149)</td>
<td>+</td>
<td>6.73 (0.1509)</td>
</tr>
</tbody>
</table>

Table 4.1: Results of the GARCH Estimations for the Whole Sample, showing significant macroeconomic factors, their lag structure, the Wald test - including the direction of the impact on stock returns - and the likelihood ratio test.

Note: *** = 1% significance level; ** = 5% significance level; * = 5% significance level
4.2 Results Before and After the Financial Crisis

As a next step, we cluster the sample into a pre-crisis period (Q1 1991 – Q2 2007) and a post-crisis period (Q3 2007 – Q2 2016). Table 4.2 contains the results of taking this approach. At first glance, the results illustrate that in the post-crisis period more macroeconomic factors have a significant impact on the German stock market compared with the pre-crisis period. This implies that in the post-crisis period a macro-driven market is prevailing.\(^1\)

The second interesting finding concerns the money supply variables: in the pre-crisis period, the money supply M2, which in addition to M1 also includes longer-term deposits, also has a positive impact on stocks as does M1. Particularly, the increase of longer-term deposits, like money-market or savings accounts, positively affects the market over a time lag of two quarters. However, in the post-crisis period the money supply M2 also becomes significant as does M3, whereby both money aggregates show negative signs.

So, after a time lag of one quarter, positive M3 and M2 growth rates lead to lower stocks. Regarding the positive impact of M1 on stocks in the post-crisis period, this result can only be explained with longer-term and less liquid assets, which are not included in M1 but are included in the broader monetary aggregates M2 and M3.

Table 4.3 shows further GARCH(1,1) estimations with the differences between M2 and M1 and between M3 and M2. The results show that in the pre-crisis period neither of the differences are significant. For the post crisis-period, the figures show that both differences have a significant and negative impact on stocks. In the period between Q3 2007 and Q4 2012, where the financial crisis and the European debt crisis caused turmoil in the capital markets, this impact become more intense and more clear.

Moreover, the adjusted R-squared figures indicate that the growth rate of M2 minus M1 has more effect on stocks than the growth rate of M3 minus M2. The results also make clear that the positive impact measured in the pre-crisis period arises from M1, because the difference of M3 and M2 has no significant effect on stocks in the pre-crisis period.

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\(^1\) Indeed, some explanatory variables such as the oil price and the Consumer Price Index could be correlated so that we double-count macroeconomic effects since we conduct a separate estimation for each factor. Nevertheless, even if the double-counting leads to an exaggeration, the results are proving the macro-driven statement.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Pre-crisis</th>
<th>Post-crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-Value of the Wald-Tests</td>
<td>Direction of the impact &amp; number of lags</td>
</tr>
<tr>
<td>Money supply M1</td>
<td>0.0008 ***</td>
<td>+ 4</td>
</tr>
<tr>
<td>Money supply M2</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Money supply M3</td>
<td>0.0020 ***</td>
<td>+ 2</td>
</tr>
<tr>
<td>Manufact. orders</td>
<td>0.0691 *</td>
<td>+ 1</td>
</tr>
<tr>
<td>Savings rate</td>
<td>0.0001 ***</td>
<td>+ 1</td>
</tr>
<tr>
<td>Stock level</td>
<td>0.0286 **</td>
<td>- 2</td>
</tr>
<tr>
<td>Producer Price Index</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Consumer Price Index</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Consumer Conf. Index</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>German 10-y gov. yield</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Ifo Business Exp. Index</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Wages Index</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Oil price</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>ZEW Econ. Sent. Index</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Real effect. exch. rate</td>
<td>0.0304 **</td>
<td>+ 1</td>
</tr>
<tr>
<td>Nominal effect. exch. rate</td>
<td>0.0345 **</td>
<td>+ 1</td>
</tr>
<tr>
<td>Real GDP</td>
<td>0.0001 ***</td>
<td>- 6</td>
</tr>
</tbody>
</table>

Table 4.2: Results of the GARCH Estimates for Pre- and Post-Crisis Period Containing the Wald Test with the Direction of the Impact and the Lag Structure.

Note: Except for the German 10-year government bond yields, where the quarterly differences are taken, the quarterly growth rates of all macroeconomic factors are used for the regressions.

Note: *** = 1% significance level; ** = 5% significance level; * = 5% significance level; ns= not significant
A possible explanation for this finding could be that market participants undertake a portfolio reallocation due to higher risk aversions: in times of insecurity and crisis, investors prefer safer and liquid assets, so that the demand for stocks shrinks and the demand for liquid and low-risk assets rises. These low risk-assets are, for example, deposits with a maturity of up to two years or deposits redeemable at a period of notice of up to three months (M2 component), and money market instruments or marketable instruments issued by monetary financial institutions (M3 component). Considering this, it is not very surprising, that the impact of M2 is higher than M3, since M2 has more liquid and low-risk deposits than M3.

A notable change of the sign is also measured regarding the impact of the savings rate. In the pre-crisis period, increasing savings rates lead to higher stocks, which seems, at first glance, very intuitive since more savings induce more investments. In the post-crisis period, however, increasing savings rates lead to shrinking stocks. An explanation for this finding could again be higher risk aversion among market participants in the period following the crisis, leading to falling demand for (riskier) stocks despite larger savings.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Sample</th>
<th>P-Value of the Wald-Tests</th>
<th>Direction of the impact &amp; number of lags</th>
<th>Adj. R squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2 - M1 (in % q-o-q)</td>
<td>2007 Q3 - 2016 Q2</td>
<td>0.0244 **</td>
<td>- 1</td>
<td>0.16</td>
</tr>
<tr>
<td>M3 - M2 (in % q-o-q)</td>
<td>2007 Q3 - 2016 Q2</td>
<td>0.0268 **</td>
<td>- 1</td>
<td>0.08</td>
</tr>
<tr>
<td>M2 - M1 (in % q-o-q)</td>
<td>1992 Q1 - 2007 Q2</td>
<td>0.8765 ns</td>
<td>ns ns</td>
<td>-</td>
</tr>
<tr>
<td>M3 - M2 (in % q-o-q)</td>
<td>1992 Q1 - 2007 Q2</td>
<td>0.8512 ns</td>
<td>ns ns</td>
<td>-</td>
</tr>
<tr>
<td>M2 - M1 (in % q-o-q)</td>
<td>2007 Q3 - 2012 Q4</td>
<td>0.0000 ***</td>
<td>- 1</td>
<td>0.21</td>
</tr>
<tr>
<td>M3 - M2 (in % q-o-q)</td>
<td>2007 Q3 - 2012 Q4</td>
<td>0.0037 ***</td>
<td>- 1</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

Table 4.3: Results of the GARCH Estimates Using Quarterly Growth Rates of the Differences Between M2 and M1 and Between M3 and M2 for Various Periods.

Note: *** = 1% significance level; ** = 5% significance level; * = 5% significance level; ns= not significant
5 Conclusions

The results for the whole period show a positive and highly significant impact of the money supply M1, the real exchange rate and the nominal effective exchange rate.

Also highly significant but negative is the impact of Consumer Confidence Index on the DAX index.

In most cases, the interest rate effect plays a major role in our findings, particularly regarding the direction of the impact due to our interpretation.

We demonstrate that in the post-crisis period both M2 and M3 have negative impacts on stocks. An explanation for this finding could be the portfolio reallocation of market participants due to higher risk aversions: in times of insecurity and crisis, investors prefer safer and liquid assets, so that the demand for stocks shrinks and the demand for liquid and low-risk assets rises.

A notable change of the sign is also measured regarding the impact of the savings rate. In the pre-crisis period, increasing savings rates lead to higher stocks which, at first glance, seems very intuitive since more savings induces more investments.

In the post-crisis period, however, an increasing saving rates leads to shrinking stocks. An explanation for this apparent paradox is that there is a higher risk aversion on the part of market participants in the period following the crisis, leading to falling demand for (riskier) stocks despite larger savings.

The results illustrate that in the post-crisis period more macroeconomic factors have a significant impact on the German stock market compared with the pre-crisis period. This implies that in the post-crisis period a macro-driven market is prevailing.

On the whole, the results show a significant if delayed impact of macroeconomic factors on German stocks. Since the information regarding changes in these factors is publicly available and their changes are priced with a time lag, the strong and the semi-strong market efficiency theory can be rejected from this standpoint.
6 Literature


