

Entorf, Horst; Jamin, Gösta

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## German stock returns: The dance with the dollar

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# **W. E. P.**

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## **Würzburg Economic Papers**

**Nr.19**

### **German Stock Returns: The Dance with the Dollar**

**Horst Entorf**

**Gösta Jamin**

**March 2000**

Universität Würzburg  
Professur für Ökonometrie  
Sanderring 2, D-97070 Würzburg  
[horst.entorf@mail.uni-wuerzburg.de](mailto:horst.entorf@mail.uni-wuerzburg.de)  
Tel.: +49/931/31-2935  
FAX: +49/931/888-7097

# German Stock Returns: The Dance with the Dollar

**Horst Entorf**

**Gösta Jamin**

**Universität Würzburg**

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*Abstract:* The purpose of this paper is to shed some light on the association between the stock returns of German DAX corporations and movements of the U.S. Dollar. The link turns out to be rather unstable, but it depends significantly on direction and magnitude of foreign trade, and on the existing level of the DM/ Dollar exchange rate. This conclusion is based on exchange-rate-exposure and APT-modelling, as well as on panel data on the performance of 28 German DAX corporations, inclusion of macroeconomic risk factors, data on export and import involvement, and on econometric panel, GLS, SUR and cointegration techniques.

Authors:

Horst Entorf  
Professor for Econometrics  
University of Würzburg  
Department of Economics  
Sanderring 2  
D-97070 Würzburg  
[horst.entorf@mail.uni-wuerzburg.de](mailto:horst.entorf@mail.uni-wuerzburg.de)  
Tel. 0931/ 31-2935

Gösta Jamin  
University of Würzburg  
Department of Economics  
Sanderring 2  
D-97070 Würzburg

## **1. Introduction**

Given that Germany is one of the nations most vulnerable to international trade (both exports and imports amount to one third of GDP), there is surprisingly little evidence on the relationship between exchange rate fluctuations and stock exchange movements in Germany. This contrasts sharply with numerous comments on the reaction of the domestic stock market to U.S. dollar changes in the popular business press. According to the interpretation of many journalists, there should be a positive correlation between the German stock prices and the DM/\$ rate, respectively a negative correlation between the German stock prices and the EURO/\$ exchange rate. A typical example looks as follows: “Steep rise of the EURO annoys stock markets”<sup>1</sup>. Analysts base such stories on the supposition that Germany is strongly export oriented, such that any appreciation of the German/European currency, for example, would mean “bad news” to German/European companies, because of the worsened competitiveness relative to Non-German/Non-European companies. The worsened situation results from the anticipation of lower market shares which might arise due to the need to invoice higher prices in destination countries. This reasoning applied a fortiori by the time of the legal force of the DM, i.e., before introduction of the EURO.

However, these arguments are questionable for at least three reasons. First, Germany’s share of imported goods and services in GDP is almost of the same size as the corresponding share of exported goods and services in GDP.<sup>2</sup> Hence, any appreciation might imply good news as well, such that the conjectured correlation between DM/\$ changes and German stock market returns would be negative. Secondly, if German companies fully hedge their currency risk by using derivative products and other exchange rate hedging instruments as, for instance, locating production in the United States<sup>3</sup>, then their stock price changes should not be correlated with any movement in the dollar at all. The final reason is related to third factors which have asymmetric influences on both stock returns and exchange rates. Prominent candidates are divergent monetary and fiscal policies, as well as asynchronous output movements (see Blanchard, 1981, Gavin, 1989).

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<sup>1</sup> “Starker Kursanstieg des EURO verstimmt Aktienbörsen”, Handelsblatt, July 26, 1999, p.1.

<sup>2</sup> In 1999, Germany’s exported goods and services amounted to DM 1132 billion, while Germany had to pay DM 1089 billion for imported goods and services. At the same time, German’s GDP was DM 3878 billion (Statistisches Bundesamt, 2000).

Our paper tries to take these points into consideration. It does so by first relating the stock returns of German companies comprising the DAX to movements of the Dollar, and by using exchange-rate exposure models in the tradition of Adler and Dumas (1980, 1984), Jorion (1990), Bodnar and Gentry (1993), Dominguez (1998), and others. In order to take account of the regime dependency given by the German trade structure, we propose to estimate time-variant Dollar exposures. They allow us to tackle the second question, i.e. the existence of hedging strategies of German corporations. It is interesting to see whether currency risk is decreasing over time, as hedging strategies are put into standard practise nowadays. Moreover, time-variant exchange rate exposures will be related to the prevailing trade structure, i.e. to concurrent exports and imports, such that the hypothesis of trade driven exchange rate exposures can be tested.

Surprisingly, the empirical literature on exchange rate exposure is rather silent on the third question, i.e. about the fact that other macroeconomic risks might distort the relationship between stock returns and exchange rate movements. In this paper, we estimate what we call a “conditional exchange rate exposure”. It is achieved using a rolling (time-variant) multi-factor model, based on APT-modelling, which includes exchange rates as a risk factor besides “classical” factors as, for instance, interest rates, inflation and output. The time-variant conditional exchange rate exposure will then be compared to the (unconditional) Dollar exposure, and it is also used to test its dependency on the exporting and importing situation of the German economy. Finally, in order to obtain a comprehensive view of the problem, a complete APT model is estimated for different time periods.

We base our analysis on performance indices from 28 German DAX corporations of the “Karlsruher Kapitalmarktdatenbank” of the time 1975-1995, we include macroeconomic risk factors, and we use data on export and import involvement. The econometric approach is grounded on econometric panel, GLS, SUR and cointegration techniques.

We find a rather unstable association between stock returns and DM/Dollar changes. The association strongly depends on the import-export structure and the existing DM/\$ level.

This paper is organised as follows. In Section 2, the correlation between stock returns and exchange rate movements is considered from both microeconomic and macroeconomic viewpoints. Section 3 presents our econometric approach. Section 4 informs about esti-

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<sup>3</sup> See, for instance, Dominguez (1998) for a discussion of hedging instruments.

mated exchange rate exposures, and in Section 5 results from the APT modelling are presented. Section 6 summarises our main findings.

## ***2. The correlation between stock returns and exchange rate movements: microeconomic and macroeconomic viewpoints***

Comments in the business press on the expected reaction of stock markets to dollar changes seem to be motivated by a relation as follows:

$$(1) \quad r_{it} = \begin{cases} \mathbf{a} + \mathbf{b}_1 d_t + \mathbf{e}_t & \text{if } X_i > 0 \\ \mathbf{a} - \mathbf{b}_2 d_t + \mathbf{e}_t & \text{if } X_i < 0 \end{cases}$$

where  $r_{it}$  represents the stock return of company  $i$  at time  $t$ ,  $d_t$  is the return of the DM/\$ exchange rate at time  $t$ , and  $X_i$  represents the foreign involvement of company  $i$ . Most comments are based on a strong positive foreign involvement of German firms, because they see rising dollars (i.e. a rising DM/\$, respectively a depreciation of the Euro) as driving force of good stock market prospects. This approach looks rather ad hoc, but in fact, Adler and Dumas (1980, 1984) have shown analytically that exposure to currency risk can be measured within a bivariate linear regression framework, in which the stock market return is regressed on a constant and the exchange rate. The exchange rate exposure boils down to the partial derivation with respect to the exchange rate, i.e. to the slope parameter of the bivariate regression.

This line of research was followed by an influential paper by Jorion (1990), who analysed the exposure to exchange rates of U.S. multinationals. Most applications are for U.S. financial markets, with important exceptions. Bodnar and Gentry (1993) provided evidence for Canada, Japan and the U.S., Bailey and Chung (1995) studied the effects of exposure to currency and political risks on equity returns in Mexico, and He and Ng (1998) as well as Dominguez (1998) investigated the exchange rate exposure of Japanese corporations. Publications on the relationship between exchange rates and German stock market returns are rare. Only recently, exceptions are provided by Glaum et al. (1998), Müller (1998), Entorf and Kabbalakes (1998), Entorf (2000), Jamin (1999), and Schieszl (2000).

Only few articles deal with determinants of currency exposure, though the link between exchange rate exposure and foreign involvement seems to be straightforward. Jorion (1990) finds that exposure varies systematically across the companies under consideration, depending on firm characteristics such as the percentage of foreign operations. Bodnar and Gentry (1993) compares industry-level exchange rate exposures for Canada, Ja-

pan and the USA. They find that between 20 and 35 per cent of industries have statistically significant exchange rate exposures that are larger for Canada and Japan than for the USA. He and Ng (1998) examine a sample of 171 Japanese multinational companies and find that higher exposure levels are related to higher export shares. Entorf (2000) takes a macroeconomic perspective by estimating time-variant (average) exposure of all German corporations using the returns of a broad German stock market index (DAFOX) and shows cointegration of aggregate exchange rate exposure with export and import shares.

Macroeconomic influences matter, as can be seen when the correlation between exchange rates and equity returns is looked at from the viewpoint of macroeconomic theory. However, there are only few articles that examine both financial markets simultaneously. Gavin (1989), extending Blanchard (1981), provides an exception. The models extends Blanchard (1981), who has shown how stock markets react to changes in interest rates, output, and, in particular, to anticipated and unanticipated changes of monetary and fiscal policy. Gavin (1989) analyses how both stock market prices and exchange rates interact. Table 1 illustrates channels of influence. Employing the European/German case, we see that monetary expansions (contractions) of the central bank would lead to both positive (negative) stock returns on the one hand, and positive (negative) DM/\$ movements on the other hand, because the Euro depreciates (appreciates). Thus, the correlation between both market returns would be positive. In case of a fiscal expansion, however, the correlation would be negative, when we start from the reasonable assumption that, in general, fiscal expansion is considered as „good news“ for short-run output fluctuations.

Table 1 shows that the existence of monetary, fiscal and output disturbances require a broader view of the problem. An extended way of approaching the economic impact of exchange rate fluctuations is the use of Arbitrage Pricing Theory (APT) models pioneered by Ross (1976). According to the APT, stock returns may be explained by a K-factor model of the form

$$(2) \quad r_N = \mathbf{m}_N + B_N f_K + \mathbf{e}_N$$

where  $r_N$  is the N-vector of returns of N securities,  $\mathbf{m}_N$  is the N-vector of expected returns of the N securities,  $f_K$  a K-vector of realisations of K factors,  $B_N$  a NxK matrix of factor sensitivities of the N securities to the K factors and  $\mathbf{e}_N$  the vector of error terms of the N securities. The N-vector of expected returns can be decomposed into

$$(3) \quad \mathbf{m}_N = \mathbf{I}_0 + B_N \mathbf{I}_K ,$$

where  $I_0$  is the risk-free rate,  $B_N$  is the same matrix of factor sensitivities as in equation (2), and  $I_K$  is the K-vector of risk premia for the K factors. Therefore, estimating APT-models allows for the joint estimation of risk premia and associated factor sensitivities. The theory does not specify the nature of the factors. We shall interpret them for our estimations as realisations of macroeconomic risk factors.

**Table 1: Monetary and fiscal policy changes, and their impact on the correlation between stock market returns and exchange-rate movements**

|                    | Stock prices   | Exchange rates  |
|--------------------|--|---|
| Monetary Expansion | Falling interest rates → lowering user costs of capital → <u>rising stock prices</u>   | (i) falling interest rates → increasing capital exports → <u>depreciation</u><br><br>(ii) increasing prices on the goods market → <u>depreciation</u> |
| Fiscal Expansion   | (i) Increasing output → rising profits → <u>rising stock prices</u> („good news“) *)<br><br>(ii) Increasing interest rates → higher user costs of capital → decreasing stock prices („bad news“) | Rise of interest rates → increasing capital imports → <u>appreciation</u>   |

\*) In general, fiscal expansion is considered as „good news“ for short-run output fluctuations.

Substituting equation (3) into equation (2), rearranging terms and adding a time index t results in

$$(4) \quad r_N(t) = I_0 + B_N (I_K + f_K(t)) + e_N(t).$$

Before estimating the model, macroeconomic risk factors have to be selected. To a certain extent, this selection is arbitrary. According to the Discounted Cash Flow Model, which assumes that prices of assets are determined through their expected discounted dividend payments, factors have to be selected that are potentially responsible for the determination of these payments. For our investigations (see below), we use the business climate, the inflation rate, the term structure, a residual market factor, and, in particular, the U.S.-



Dollar. These factors are similar to those proposed by Chen et al. (1986), who pioneered the macroeconomic variables approach for estimating the APT. The unexpected components of those macroeconomic time series which only can influence asset returns in efficient capital markets are determined using ARMA- and ARIMA-filtering techniques. To obtain the residual market factor we follow the procedure suggested by McElroy and Burmeister (1988). The market return has to be orthogonalized with respect to the macroeconomic variables in order to capture the market risk which is not explained by the other systematic risk factors. Therefore, the residual market factor is represented by the residuals of an OLS-regression of the market return on the macroeconomic variables.

Estimating APT models (see Jamin, 1999, for a recent application on German data) allows for the joint determination of factor sensitivities, i.e. the reaction of a single asset on exchange rate movements, and of risk premia, which reveal whether investors have to be compensated by a higher expected return because the exchange rate risk is not diversifiable. In this paper (see Section 4), we will make use of a rolling multi-factor model in order to estimate exchange rate exposures that remain after controlling for other macroeconomic risks. Complete APT models will be presented in Section 5.

### ***3. Exchange rate exposure and foreign involvement:Econometric issues***

In this section, we first characterise previous attempts to relate exchange rate exposure to foreign involvement. Next, modifications of this approach that use data in a more efficient way are discussed.

#### **Two-step versus one-step procedures**

Previous attempts to estimate exchange rate are dominated by the microeconomic point of view, i.e., returns of companies are regressed on exchange rates. The link to foreign involvement is performed using two-step and/or one-step procedures (see Jorion, 1990). In the first step, by running  $N$  time series regressions, the stock returns of a sample of  $N$  companies are regressed on the exchange rate (the Dollar). Step 2 consists of regressing the exchange rate (Dollar) exposure (i.e., the slope parameter of the first step) on indicators of foreign involvement. Jorion (1990), for instance, employs the ratio of foreign to total sales:

$$(5) \quad \begin{aligned} r_{it} &= \mathbf{a}_i + \mathbf{b}_i d_t + \mathbf{e}_{it}, \quad i=1, \dots, N, t=1, \dots, T \\ \mathbf{b}_i &= \mathbf{g}_0 + \mathbf{g}_1 X_i + \mathbf{u}_i, \quad i=1, \dots, N. \end{aligned}$$

Econometric problems arise, because estimated exposures are based on common samples, such that they are not i.i.d and  $\mathbf{u}_i$ 's are correlated. Jorion (1990) has proposed an alternative procedure that was also applied by Bodnar, Gentry (1993) in a similar fashion. Jorion suggests to insert the dollar exposure in the first equation :

$$(6) \quad r_{it} = \mathbf{a}_i + \mathbf{g}_{0i} d_t + \mathbf{g}_{1i} X_i d_t + \mathbf{e}_{it}$$

Expected signs look as follows:

$$(7) \quad \frac{\partial r}{\partial d} = \mathbf{g}_0 + \mathbf{g}_1 X \begin{cases} > 0, \text{ if } X > 0 \Rightarrow \mathbf{g}_0 > 0, & \mathbf{g}_1 > 0 \\ < 0, \text{ if } X < 0 \Rightarrow \mathbf{g}_0 < 0, & \mathbf{g}_1 < 0 \end{cases}$$

Thus, the advantage of the one-step procedure is its higher efficiency because time series and cross-sectional information can be used in a GLS framework. The disadvantage, however, lies in the fact that cross terms might suffer from the problem of both multicollinearity and difficult interpretation. Now the dollar exposure is no longer just the regression coefficient, but it depends on the level of foreign activities, and more than one estimated parameter is involved to calculate it, as can be seen from equation (7). This leads to potential ambiguities and misinterpretations, if, for instance, both  $X$  and  $\mathbf{g}_1$  are negative. These disadvantages have let us to prefer a two-step procedure, though in a modified and more efficient way (see below).

### Profile of wanted generalisation

Based on drawbacks of existing estimation techniques, some points need to be taken into account to design less ambiguous, more feasible, and more efficient estimation procedures.

First, it should be possible to include the panel information  $X_{it}$  instead of the cross-sectional information  $X_i$  (see equation 5).

Second, currency exposure strongly depends on beliefs of market participants. Beliefs and expectations, however, do not depend on the whole history of financial markets, but rather depend on limited information sets, as can be seen from numerous examples of unstable coefficient estimates in the literature on CAPM and APT modelling (see, for instance, De Santis and Gérard, 1998, for time varying currency risks in an international asset pricing

model). Thus, estimations should be time-variant, and they should give much more weight on recent observations.

Third, covariates from non-financial markets such as  $X_{it}$  are not available at the same high frequency level as financial variables are. High frequency data, however, should be used in a complete, non-averaged way, in order to avoid loss of information.

Fourth, simultaneity matters. This might not be the case when single companies are considered, since for them any Dollar movement is exogenous. However, in our paper exchange rate exposures are also estimated for the German economy as a whole. In such cases, macroeconomic theory has taught us that third factors might influence the correlation between exchange rates and equity returns. Thus, as a matter of fact, the direction of causation is unclear, such that it might be preferable to consider a correlated instead of a causal relationship.

### **A modified two-step procedure**

In order to take as many points into consideration as possible, we decided to proceed by performing a modified two-step procedure. In step I,  $\mathbf{b}_{it}, i=1, \dots, N$ , i.e. firm-specific and time-variant exchange rate exposures are estimated. We do so by running rolling regressions:

STEP I:

$$(8) \quad r_{ij} = \mathbf{a}_{it} + \mathbf{b}_{it} d_j + \mathbf{e}_{ij}, \quad i = 1, \dots, N$$

$$j = t - \mathbf{t} + 1, \quad t - \mathbf{t} + 2, \dots, t - 1, \quad t$$

$$t = \mathbf{t} + 1, \mathbf{t} + 2, \dots, T,$$

where  $\mathbf{t}$  represents the size of the rolling window, and  $T$  is the number of total time series observations. Based on the APT multi-factor model, the extended multivariate estimation of the exchange rate exposure looks as follows, where the exchange rate is measured by the unanticipated residual from ARIMA-modelling, and where  $f$  includes all (unanticipated) factors (incl. the residual market factor) except the exchange rate factor:

$$(8') \quad r_{ij} = \mathbf{a}_i + \mathbf{b}_{it} d_j^u + b'_{it} f_t + \mathbf{e}_{ij}$$

In order to achieve overall (macro) estimates of the currency exposure,  $\mathbf{b}_{it}$  can be restricted to be identical to  $\mathbf{b}_t$  for all  $i=1, \dots, N$  by using rolling-GLS (SUR) or rolling-panel estimation techniques:

$$(9) \quad r_{ij} = \mathbf{a}_i + \mathbf{b}_t d_j + \mathbf{e}_{ij}$$

A restricted rolling multi-factor version needs to be changed accordingly:

$$(9') \quad r_{ij} = \mathbf{a}_i + \mathbf{b}_t d_j^u + b'_t f_t + \mathbf{e}_{ij}.$$

In step 2, we analyse the relationship between exchange rate exposures and foreign involvement. The best possible way to identify exposure and its determinants would be via description of both firm-specific and time-specific situations. This can be done by estimation of seemingly unrelated regressions (SUR):

STEP II:

$$(10) \quad \mathbf{b}_{it} = \mathbf{g}_{0i} + \mathbf{g}_{1i} X_{it} + \mathbf{u}_{it}, \quad i = 1, \dots, N, \quad t = 1, \dots, T$$

$$\text{var}(\mathbf{u}) = (\mathbf{s}_{ij}) \otimes I_T$$

SUR is (asymptotically) efficient given known exchange rate exposures, as it allows to consider unanticipated shocks that hit all corporations simultaneously (general crashes, for instance).

Overall macroeconomic estimates can be achieved by restricted SUR or panel estimation:

$$(11) \quad \mathbf{b}_{it} = \mathbf{g}_{0i} + \mathbf{g}_1 X_{it} + \mathbf{e}_{it}$$

Applied estimation has to take account of data restrictions, because only limited information is available at the firm level, particularly when high frequency data would be needed. Nevertheless, we are still able to identify the impact from different regimes of foreign involvement by relating exchange rate exposures to aggregated trade activities, available from macroeconomic foreign trade statistics:

$$(12) \quad \mathbf{b}_{it} = \mathbf{g}_{0i} + \mathbf{g}_{1i} X_t + \mathbf{u}_{it}, \quad \text{or} \quad \mathbf{b}_{it} = \mathbf{g}_{0i} + \mathbf{g}_1 X_t + \mathbf{u}_{it}.$$

Does the modified two-step procedure meet the requirements described above? First, the approach is suitable to incorporate panel information, though information on  $X_{it}$  is not used in the present paper. Second, unstable relationships and limited information sets are taken into account by proposing a rolling regression procedure. Third, the potential of high fre-

quency data can be saved by using a two-step procedure. The estimation of exchange rate exposures in the tradition of Adler and Dumas (1980, 1984) is performed in a first step using *all* financial observations. According to the fourth requirement, macroeconomic influences are considered in STEP I, see equation (8') and (9'). Moreover, a complete APT model informing about both currency risk premium and the factor sensitivity of the Dollar will be estimated for several sub-periods in Section 5.

As regards correlation versus causal relationship, we provide additional evidence based on t-values of estimated Dollar exposures. Following Entorf (2000), mere estimates of exchange rate exposures may be not sufficient to inform about their statistical significance. A straightforward way is to weight them by estimated standard errors, such that exchange rate exposure boils down to the estimated conventional t-value on  $\mathbf{b}_{it}$ , i.e.  $\hat{\mathbf{b}} / (\hat{\mathbf{s}}_b)$ . This indicator has the advantage of providing information on both size and importance. In particular, in bivariate regressions of the kind we face in STEP I, t-values have the wanted effect of not depending on the choice of which variable is put on the left-hand side, i.e., the same t-value would arise if we take the Dollar as dependent variable, and the stock return as explanatory variable.

Proof:

Calculation of the rolling t-value from equation (8) gives:

$$t_t = \sqrt{\frac{R_t^2 (t-2)}{(1-R_t^2)}}, \quad R_t^2 = \frac{S_{rdt}^2}{S_{rrt} S_{ddt}}$$

where

$$S_{rdt} = \sum_{j=t-t+1}^t (r_j - \bar{r}_t) (d_j - \bar{d}_t), \quad \bar{d}_t = \frac{1}{t} \sum_{j=t-t+1}^t d_j, \quad \bar{r}_t = \frac{1}{t} \sum_{j=t-t+1}^t r_j$$

$$S_{rrt} = \sum_{j=t-t+1}^t (r_j - \bar{r}_t)^2, \quad S_{ddt} = \sum_{j=t-t+1}^t (d_j - \bar{d}_t)^2$$

## **4. Estimation of the Dollar exposure of German companies**

### **Data**

The sample of stocks includes 28 leading German corporations comprising the DAX (the leading index of the Frankfurt stock exchange) on the 31<sup>st</sup> of March 1995.<sup>4</sup> They represent about 70 % of total turnover in German stocks during the sample period.<sup>5</sup> Monthly returns for the period from April 1977 through March 1995 are adjusted for dividends and capital increases and splits according to the adjustment factors from the Karlsruher Kapitalmarktdatenbank (KKMDB) in order to obtain the total returns of the assets.<sup>6</sup> The US-dollar is the monthly change rate of the closing price of the US-dollar at Frankfurt foreign exchange market. Foreign involvement is measured by the ratio of exports to GDP, and by the ratio of imports to GDP (Source: Deutsche Bundesbank). Both imports and exports include goods and services, available on a quarterly basis.

As additional macroeconomic variables for the estimation of the multi-factor model and the complete APT model (Section 5) we use, in the spirit of Chen et al. (1986)

- Business climate: Monthly change rate of the ifo-Geschäftsklimaindex which measures the degree of confidence in the economic situation calculated by the ifo-Institut in Munich.
- Inflation: Monthly change rate of the Lebenshaltungskostenindex (consumer price index) calculated by the Statistisches Bundesamt in Wiesbaden.
- Term structure: Difference between the 10-year rate on German government bonds and the 1-month money market rate, both calculated by the Deutsche Bundesbank in Frankfurt.
- Residual market factor: For the estimation of the residual market factor we use as the dependent variable the monthly return of the DAFOX (Deutscher Aktienindex für Forschungszwecke) calculated by the KKMDB. The DAFOX is a Laspeyres performance index including all stocks traded at Frankfurt stock exchange. Therefore, it is the best substitute for the market portfolio available for the German stock.

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<sup>4</sup> VIAG and Henkel had to be excluded as their returns are not available for the whole estimation period.

<sup>5</sup> See Sauer, A. (1994), p. 102.

<sup>6</sup> The KKMDB is a data base collecting German stock prices. For further information see <http://finance.wiwi.uni-karlsruhe.de/Forschung/kkmdb.html>.

## Results, STEP I

The (unconditional) Adler-Dumas Dollar exposure is not constant over time, as can be seen from Table 2, which provides GLS (panel) estimates of equation (8) for different time periods. The estimate is significantly negative until 1985, and turns out to be significantly positive thereafter. For the total period, the Dollar exposure is positive and significant, but the estimate is only about 0.097, which is much lower than the estimated absolute values from the sub-samples.

**Table 2: Estimation of Dollar exposure using fixed-company effects**

|             | Dependent variable: $r_{it}$ , measured in: |                 |                 |                |                |
|-------------|---|-----------------|-----------------|----------------|----------------|
|             | 1974-1995                                   | 1974-1979       | 1980-1985       | 1986-1989      | 1991-1995      |
| $d_t$       | 0.097<br>(4.0)                              | -0.269<br>(6.2) | -0.257<br>(7.4) | 0.484<br>(8.1) | 0.358<br>(9.1) |
| $\bar{R}^2$ | 0.0001                                      | 0.0092          | 0.0197          | 0.0250         | 0.0330         |
| BFN-DW      | 1.92  | 1.97            | 2.09            | 1.84           | 2.12           |

*Notes:* Sample: Monthly observations from 28 DAX corporations of the period 1974:02 – 1995:03 (7112 observations). Estimates include company-specific constants and consider company-specific heteroskedasticity under the assumption that residuals are contemporaneously uncorrelated. Estimates are based on FGLS with variances estimated from a first-stage pooled OLS regression. In parentheses: t-values based on White's (1980) heteroskedasticity consistent covariance matrix. BFN-DW: Panel-DW statistic (Bhargava, Franzini and Narendranathan, 1982).

According to the procedure described in equation (8), the complete picture emerges from Figure 1, which shows the evolvement of the Dollar exposure of all 28 companies over time. The window size,  $t$  , is chosen to be 48 months. The estimated coefficient of each

rolling regression period is displayed at the time of the midterm period, more precisely at  $t - t/2$ . Two preliminary results seem to be straightforward: a) Dollar exposures are rather unstable over time, b) the majority of firm-specific exposures is rather low in the 80s and quite high in the 90s. Going deeper into details, we observe that for energy oriented corporations like VEBA and RWE rather strong negative exposures are estimated for the beginning of the eighties, i.e. at the time of the second oil crisis, when high invoices for imported oil had to be paid, whereas in case of the more export oriented car-producers exposures are quite high at the time of a low Dollar and high export shares, i.e. at the end of the 80s and the beginning of the 90s (see DAIMLER, for instance).

In Figure 2, these observations are confirmed by inspecting the results from rolling regressions, in which the Dollar exposure is restricted to be the same across all companies (B\_BIV, see equation (9)). The time series from these estimates is depicted in Figure 2. Figure 2 also displays results according to equation (9'), i.e. the (conditional) coefficient on the DM/\$ returns in a multivariate framework (B\_APT). As before, estimated  $b_{it}$  are displayed at time  $t - t/2$ . Movements are less pronounced than in the bivariate (unconditional) case, but general tendencies keep the same. In the aftermath of both oil price shocks 1975/76 and 1981/82, estimates of the Dollar exposure are negative, suggesting that a further increase of the DM/\$ was "bad news" to expected profits of German companies because of suspected rising input costs, in particular due to more expensive oil imports. These concerns were reinforced by the Dollar price level, which was high in the beginning of the 80's and still rising until 1985 (and quickly falling thereafter as a consequence of the Plaza agreement, see Figure 3).

These situations contrast sharply with the end of the 80's and the beginning of the 90's, when Germany's trade structure has become strongly export oriented, backed by a weak Dollar (see Figure 3). In situations like this, a rise of the DM/\$ is good news to the German economy, because the car industry and other export-oriented industries driving the German economy are expected to benefit from the more favourable terms of trade. In fact, the estimate of the Dollar exposure turns out to be positive since 1987. This result, by the way, confirms the popular view expressed in the business press (see Introduction).



Figure 1: Dollar exposure of DAX corporations

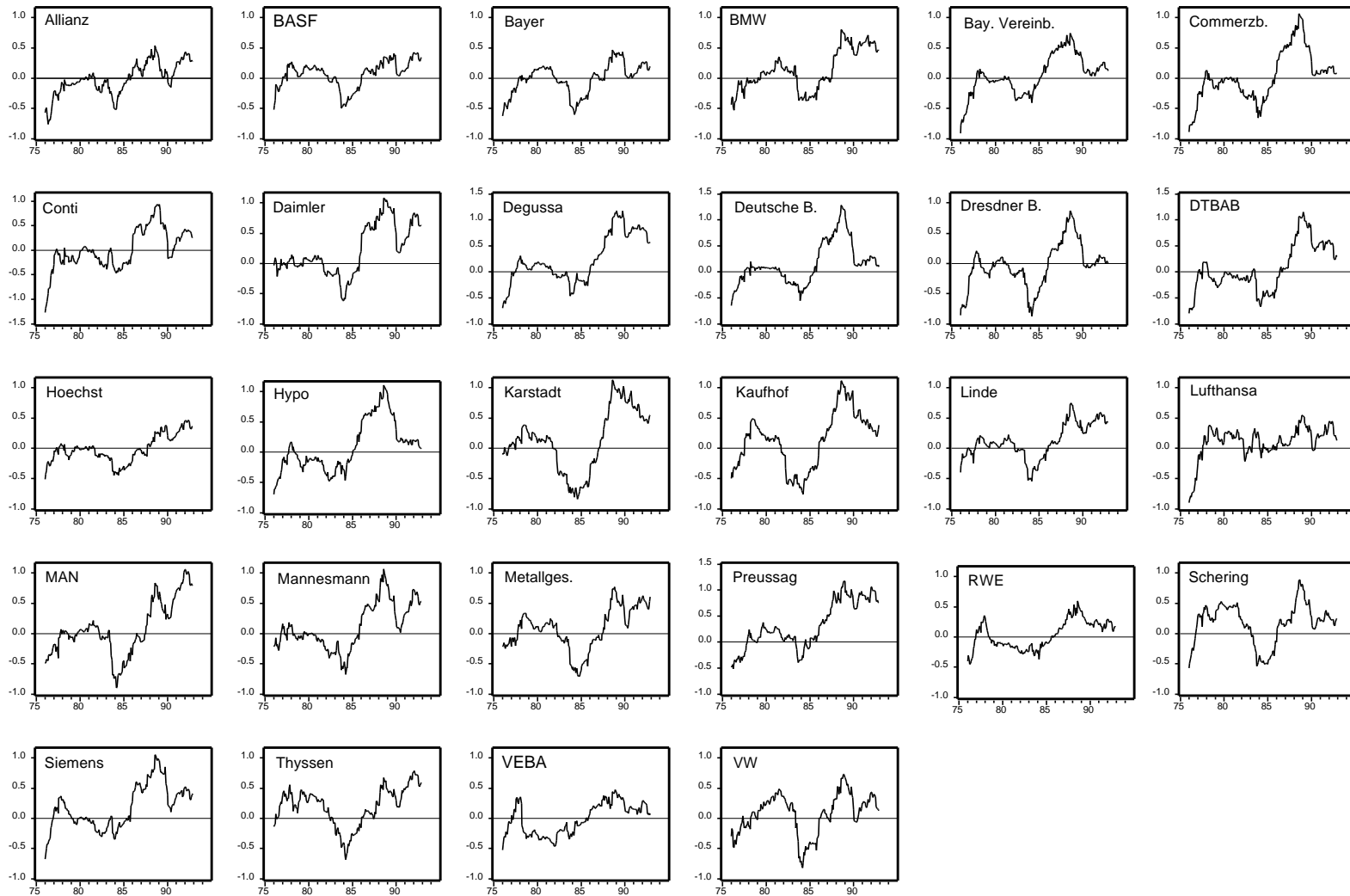
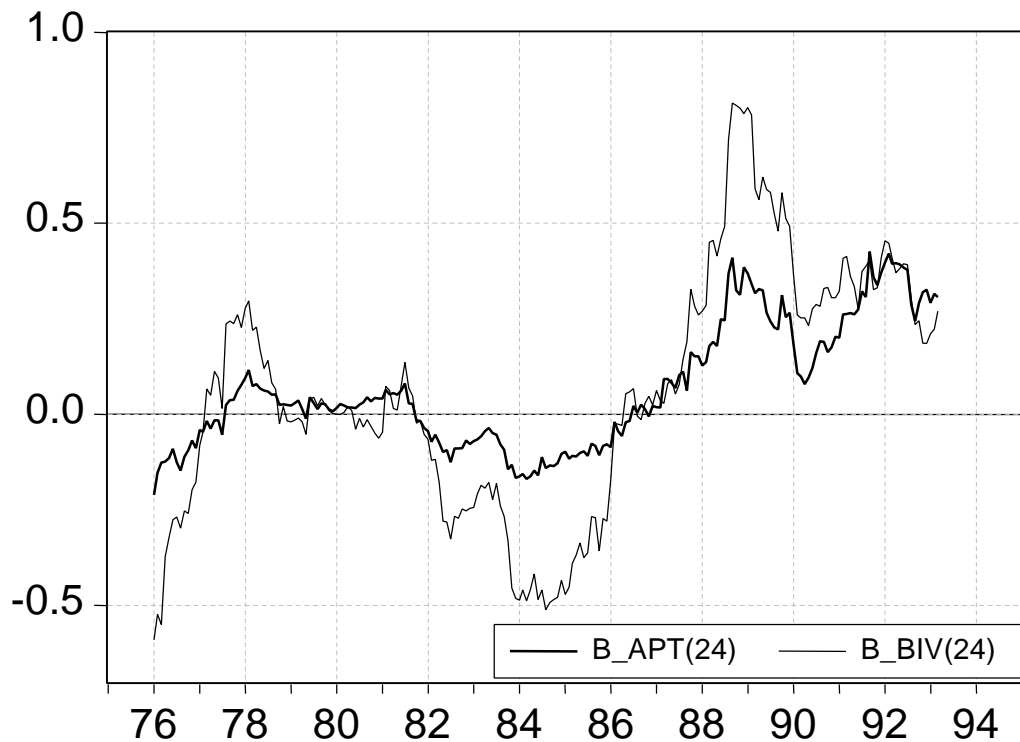
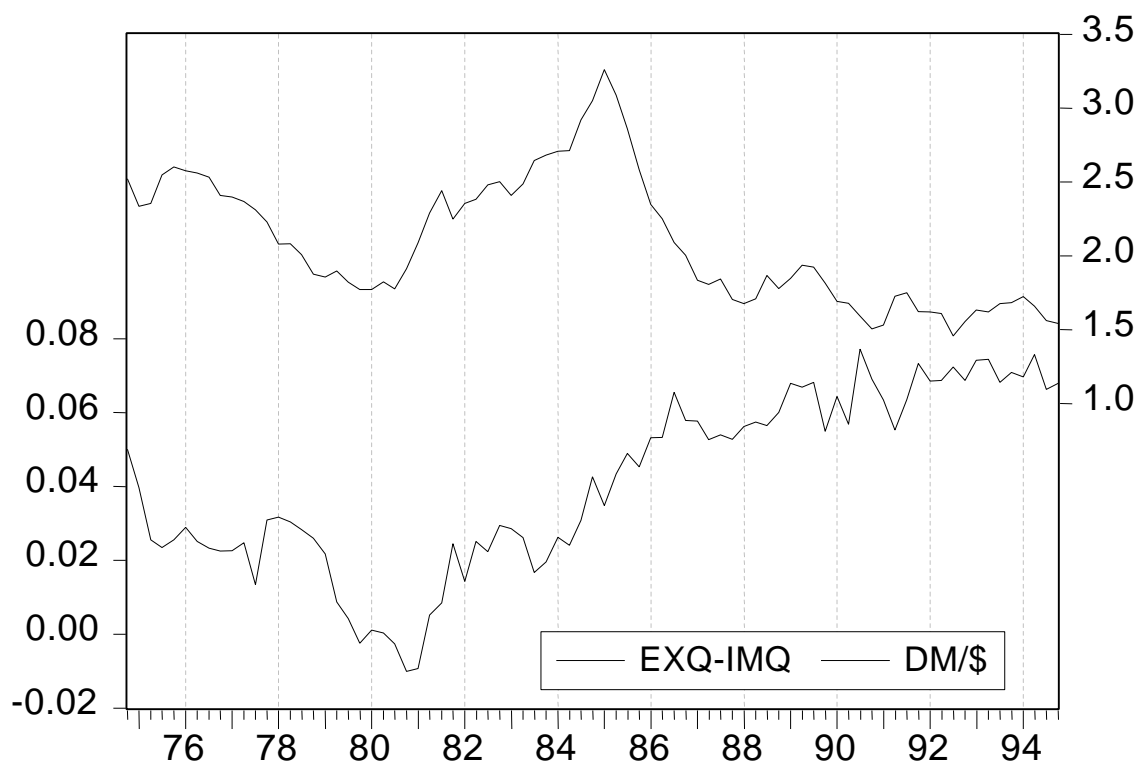


Figure 2: Conditional and unconditional Dollar exposure



Note: See the text for further details

Figure 3: The Dollar and the German net export ratio



Note: left scale: export share - import share, right scale: DM/\$

## Results, STEP II

Figures 1 and 2 suggest to run formal tests according to equation (12) which allow us to assess the influence of the trade structure as well as of the Dollar exchange rate on the Dollar exposure. Table 3, showing unrestricted results, confirms our suppositions: 1) the higher the DM/\$ level is, the lower is the Dollar exposure; 2) the higher the export ratio is, the higher is the Dollar exposure (24 out of 28 companies reveal a positive sign); 3) the higher the import share is, the lower is the Dollar exposure (21 out of 28 companies show a negative sign).

Restricted results (identical parameters for all firms) are presented in Table 4. They confirm in a more compact way what has been found in Table 3. As further checks of robustness, we have included the Dollar exposure expressed as a t-value (i.e. the t-value on the Dollar return), as well as the difference between the export share and import share, in order to dispel potential concerns about multicollinearity. All results confirm previous findings.

Table 5, finally, makes use of  $b_t$  (instead of  $b_{it}$ ) according to equation (9'). Since  $b_t$ , as well as explanatory variables could not be distinguished from nonstationary time series by consulting standard unit root tests, a test of cointegration has been performed. We use a test based on the ECM framework. Banerjee et al. (1998) have published critical values and have shown the relatively high statistical power of this test. Since trade variables have been available only at a quarterly basis, monthly data had to be transformed to a quarterly frequency. Table 5 presents results for "merging the last observation" and for "merging by averaging". Long-run parameters, which are the relevant parameters here, turn out to be robust, and confirm results already found in Table 3 and Table 4. The ECM parameter  $g$  is negative, and rejects the null of non-cointegration in 3 out of 4 cases.

**Table 3: Dollar exposure of 28 DAX corporations as a linear function of export ratio EXQ, import ratio IMQ, and DM/\$ exchange rate**

Dependent Variable:  $\beta_{it}$  (Dollar Exposure)

| Variable       | Coefficient | St. Error | t-Statistic | Prob.  |
|----------------|-------------|-----------|-------------|--------|
| <b>DM / \$</b> |             |           |             |        |
| ALLIANZ        | -0.303389   | 0.042125  | -7.280380   | 0.0000 |
| BASF           | -0.395013   | 0.021015  | -18.79683   | 0.0000 |
| BAYER          | -0.461295   | 0.027299  | -16.89783   | 0.0000 |
| BMW            | -0.553809   | 0.025527  | -21.69496   | 0.0000 |
| BV             | -0.242384   | 0.080298  | -3.018576   | 0.0026 |
| COBA           | -0.397923   | 0.113029  | -3.520542   | 0.0004 |
| CONTI          | -0.416870   | 0.090531  | -4.604743   | 0.0000 |
| DAIMLER        | -0.472433   | 0.060998  | -7.745005   | 0.0000 |
| DEGUSSA        | -0.667017   | 0.049657  | -13.43242   | 0.0000 |
| DEUTSCHE       | -0.348109   | 0.104047  | -3.345700   | 0.0008 |
| DREBA          | -0.456242   | 0.093798  | -4.864066   | 0.0000 |
| DTBAB          | -0.584091   | 0.069614  | -8.390406   | 0.0000 |
| HOECHST        | -0.395237   | 0.012624  | -31.30825   | 0.0000 |
| HYPO           | -0.177796   | 0.107070  | -1.660562   | 0.0970 |
| KARSTADT       | -0.889467   | 0.076368  | -11.64708   | 0.0000 |
| KAUFHOF        | -0.722494   | 0.092501  | -7.810700   | 0.0000 |
| LINDE          | -0.451771   | 0.024978  | -18.08669   | 0.0000 |
| LUFT           | -0.304516   | 0.052241  | -5.829002   | 0.0000 |
| MAN            | -0.771000   | 0.044312  | -17.39937   | 0.0000 |
| MANNES         | -0.392420   | 0.054419  | -7.211113   | 0.0000 |
| METALLGES      | -0.652721   | 0.042387  | -15.39903   | 0.0000 |
| PREUSSAG       | -0.620090   | 0.042051  | -14.74610   | 0.0000 |
| RWE            | -0.194094   | 0.024651  | -7.873796   | 0.0000 |
| SCHERING       | -0.601092   | 0.049351  | -12.17994   | 0.0000 |
| SIEMENS        | -0.273187   | 0.055510  | -4.921436   | 0.0000 |
| THYSSEN        | -0.602554   | 0.048022  | -12.54751   | 0.0000 |
| VEBA           | -0.047327   | 0.021188  | -2.233706   | 0.0256 |
| VW             | -0.592884   | 0.061210  | -9.686061   | 0.0000 |

Table 3 (continued), dependent Variable: $\beta_{it}$  (Dollar Exposure)

| Variable   | Coefficient | St. Error | t-Statistic | Prob.  |
|------------|-------------|-----------|-------------|--------|
| <b>EXQ</b> |             |           |             |        |
| ALLIANZ    | 4.098348    | 0.606319  | 6.759396    | 0.0000 |
| BASF       | 0.447808    | 0.301444  | 1.485542    | 0.1376 |
| BAYER      | -0.041444   | 0.490386  | -0.084514   | 0.9327 |
| BMW        | 3.347138    | 0.611419  | 5.474374    | 0.0000 |
| BV         | 6.541119    | 1.133888  | 5.768750    | 0.0000 |
| COBA       | 7.045653    | 1.825300  | 3.859997    | 0.0001 |
| CONTI      | 6.842161    | 1.625474  | 4.209333    | 0.0000 |
| DAIMLER    | 9.203264    | 1.250041  | 7.362368    | 0.0000 |
| DEGUSSA    | 8.284638    | 0.943664  | 8.779220    | 0.0000 |
| DEUTSCHE   | 7.260203    | 1.923881  | 3.773728    | 0.0002 |
| DREBA      | 3.534312    | 1.449669  | 2.438012    | 0.0149 |
| DTBAB      | 7.737866    | 1.516024  | 5.104054    | 0.0000 |
| HOECHST    | 2.150356    | 0.230785  | 9.317554    | 0.0000 |
| HYPO       | 10.75419    | 1.872927  | 5.741915    | 0.0000 |
| KARSTADT   | 3.720817    | 1.749451  | 2.126848    | 0.0336 |
| KAUFHOF    | 4.624596    | 1.551298  | 2.981114    | 0.0029 |
| LINDE      | 3.793637    | 0.418697  | 9.060582    | 0.0000 |
| LUFT       | 0.358720    | 0.604661  | 0.593259    | 0.5531 |
| MAN        | 4.957009    | 0.785099  | 6.313863    | 0.0000 |
| MANNES     | 8.760351    | 0.969516  | 9.035799    | 0.0000 |
| METALLGES  | 1.394012    | 0.859540  | 1.621813    | 0.1050 |
| PREUSSAG   | 8.859515    | 0.729473  | 12.14509    | 0.0000 |
| RWE        | 5.797818    | 0.327540  | 17.70112    | 0.0000 |
| SCHERING   | -3.249808   | 0.942846  | -3.446805   | 0.0006 |
| SIEMENS    | 8.593559    | 1.029148  | 8.350172    | 0.0000 |
| THYSSEN    | -0.313872   | 0.632207  | -0.496471   | 0.6196 |
| VEBA       | 8.312369    | 0.414949  | 20.03225    | 0.0000 |
| VW         | -1.494515   | 1.146070  | -1.304035   | 0.1924 |

Table 3 (continued), dependent Variable:  $\beta_{it}$  (Dollar Exposure)

| Variable   | Coefficient | Std. Error | t-Statistic | Prob.  |
|------------|-------------|------------|-------------|--------|
| <b>IMQ</b> |             |            |             |        |
| ALLIANZ    | -1.527587   | 0.970603   | -1.573853   | 0.1157 |
| BASF       | -0.049263   | 0.463998   | -0.106172   | 0.9155 |
| BAYER      | 1.784936    | 0.738182   | 2.418018    | 0.0157 |
| BMW        | 1.248133    | 0.923219   | 1.351936    | 0.1766 |
| BV         | -7.471968   | 1.937930   | -3.855645   | 0.0001 |
| COBA       | -8.700053   | 2.912558   | -2.987083   | 0.0029 |
| CONTI      | -5.820870   | 2.712945   | -2.145591   | 0.0320 |
| DAIMLER    | -10.35040   | 1.739282   | -5.950962   | 0.0000 |
| DEGUSSA    | -5.491447   | 1.302999   | -4.214469   | 0.0000 |
| DEUTSCHE   | -9.994597   | 2.915032   | -3.428640   | 0.0006 |
| DREBA      | -5.106149   | 2.277955   | -2.241550   | 0.0251 |
| DTBAB      | -6.414207   | 2.072279   | -3.095242   | 0.0020 |
| HOECHST    | 0.016155    | 0.367141   | 0.044004    | 0.9649 |
| HYPO       | -13.78437   | 2.894909   | -4.761590   | 0.0000 |
| KARSTADT   | -5.138117   | 2.718344   | -1.890164   | 0.0589 |
| KAUFHOF    | -7.514820   | 2.316059   | -3.244659   | 0.0012 |
| LINDE      | -2.686711   | 0.690933   | -3.888526   | 0.0001 |
| LUFT       | 2.486841    | 1.333628   | 1.864719    | 0.0624 |
| MAN        | -0.295544   | 1.258778   | -0.234786   | 0.8144 |
| MANNES     | -10.60344   | 1.343647   | -7.891533   | 0.0000 |
| METALLGES  | -0.482136   | 1.407930   | -0.342443   | 0.7321 |
| PREUSSAG   | -4.278607   | 1.029591   | -4.155639   | 0.0000 |
| RWE        | -7.787978   | 0.615798   | -12.64696   | 0.0000 |
| SCHERING   | 1.938685    | 1.549980   | 1.250781    | 0.2112 |
| SIEMENS    | -11.03102   | 1.578293   | -6.989208   | 0.0000 |
| THYSSEN    | 0.611898    | 1.055158   | 0.579912    | 0.5620 |
| VEBA       | -10.88777   | 0.676996   | -16.08248   | 0.0000 |
| VW         | 3.794932    | 1.851460   | 2.049697    | 0.0405 |

| Variable             | Coefficient |                    |          |
|----------------------|-------------|--------------------|----------|
| <b>Fixed Effects</b> |             |                    |          |
| ALLIANZ              | -0.246071   |                    |          |
| BASF                 | 0.776674    |                    |          |
| BAYER                | 0.478084    |                    |          |
| BMW                  | -0.121443   |                    |          |
| BV                   | 0.583659    |                    |          |
| COBA                 | 1.080264    |                    |          |
| CONTI                | 0.367608    |                    |          |
| DAIMLER              | 1.191925    |                    |          |
| DEGUSSA              | 0.560677    |                    |          |
| DEUTSCHE             | 1.399370    |                    |          |
| DREBA                | 1.247930    |                    |          |
| DTBAB                | 0.653365    |                    |          |
| HOECHST              | 0.131662    |                    |          |
| HYP0                 | 0.929176    |                    |          |
| KARSTADT             | 2.281332    |                    |          |
| KAUFHOF              | 2.316939    |                    |          |
| LINDE                | 0.621133    |                    |          |
| LUFT                 | -0.064246   |                    |          |
| MAN                  | 0.203859    |                    |          |
| MANNES               | 1.144521    |                    |          |
| METALLGES            | 1.153988    |                    |          |
| PREUSSAG             | -0.000107   |                    |          |
| RWE                  | 0.794732    |                    |          |
| SCHERING             | 1.950895    |                    |          |
| SIEMENS              | 1.137906    |                    |          |
| THYSSEN              | 1.406799    |                    |          |
| VEBA                 | 0.508832    |                    |          |
| VW                   | 0.741550    |                    |          |
| R-squared            | 0.702885    | Mean dependent var | 0.386864 |
| Adjusted R-squared   | 0.684481    | S.D. dependent var | 0.386864 |
| S.E. of regression   | 0.217306    | Sum squared resid  | 84.62144 |
| Log likelihood       | 2621.246    | F-statistic        | 51.07627 |
|                      |             | Prob(F-statistic)  | 0.000000 |

Notes: Sample: Quarterly observations from 28 DAX corporations of the period 1976:i – 1992:iv (1904 observations). Monthly observations are transformed to quarterly observations by merging last observations. Endogenous dollar exposures have been shifted to the centre of their moving window (four years), i.e. they enter the estimation as (t+24). Estimates include company-specific constants and consider company-specific heteroskedasticity under the assumption that residuals are contemporaneously uncorrelated. Estimates are based on FGLS with variances estimated from a first-stage pooled OLS regression. In parentheses: t-values based on White's (1980) heteroskedasticity consistent covariance matrix.

**Table 4: Dollar exposure of 28 DAX corporations as a linear function of export ratio EXQ, import ratio IMQ, and DM/\$ exchange rate; restricted parameters**

|                 | <u>Indicator of Dollar exposure</u> |                 |                 |                 |                 |                 |
|-----------------|-------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | $\beta_{it}$                        | $t_{it}$        | $\beta_{it}$    | $\beta_{it}$    | $\beta_{it}^*$  | $t_{it}^*$      |
| Constant        | FE                                  | FE              | 0.54<br>(4.7)   | FE              | FE              | FE              |
| EXQ             | 4.7<br>(11.1)                       | 13.2<br>(9.3)   | 4.7<br>(11.1)   | -               | 4.5<br>(12.1)   | 12.0<br>(9.7)   |
| IMQ             | -3.7<br>(6.1)                       | -10.1<br>(5.0)  | -3.7<br>(6.1)   | -               | -3.4<br>(6.6)   | -9.2<br>(5.2)   |
| EXQ-IMQ         | -                                   | -               | -               | 4.8<br>(11.2)   | -               | -               |
| DM / \$         | -0.43<br>(18.2)                     | -1.48<br>(19.0) | -0.43<br>(18.2) | -0.42<br>(17.7) | -0.45<br>(22.3) | -1.55<br>(23.0) |
| $\bar{R}^2$     | 0.553                               | 0.560           | 0.506           | 0.556           | 0.559           | 0.562           |
| Restriction ok? | -                                   | -               | no              | no              | -               | -               |

Notes: SUR estimation based on quarterly observations from 28 DAX corporations of the period 1976:i – 1992:iv (1904 observations). Monthly observations are transformed to quarterly observations by merging last observations; in case of  $\beta_{it}^*$  and  $t_{it}^*$  frequency conversion by averaging monthly observations. Endogenous dollar exposures have been shifted to the centre of their moving window (four years), i.e. they enter the estimation as (t+24). FE="fixed effects".



**Table 5: Aggregate Dollar exposure as a linear function of export ratio EXQ, import ratio IMQ, and DM/\$ exchange rate; ECM-t-Ratio test of cointegration**

|                             | $\Delta \mathbf{b}_t = c - \mathbf{g}(\mathbf{b}_{t-1} - \mathbf{a}'x_{t-1}) + \mathbf{d}\Delta x_{t-1}$ |                |                      |                |
|-----------------------------|--|----------------|----------------------|----------------|
|                             | moving window size: 4 years  |                |                      |                |
|                             | „merge last observation“   |                | „merge by averaging“ |                |
| constant                    | 0.18<br>(2.3)  | 0.16<br>(3.1)  | 0.11<br>(2.7)        | 0.12<br>(2.7)  |
| $\gamma$                    | 0.31<br>(3.9)  | 0.33<br>(4.1)  | 0.24<br>(3.4)        | 0.23<br>(3.7)  |
|                             | long-run parameters ( $\mathbf{a}$ )   |                |                      |                |
| EXQ                         | 3.7<br>(4.0)   | -              | 3.1<br>(3.3)         | -              |
| IMQ                         | -4.1<br>(2.9)  | -              | -3.0<br>(2.0)        | -              |
| EXQ-IMQ                     | -  | 3.5<br>(4.2)   | -                    | 3.2<br>(2.9)   |
| Dollar                      | -0.25<br>(5.2)   | -0.25<br>(5.7) | -0.25<br>(4.8)       | -0.25<br>(4.8) |
|                             | short-run parameters ( $\mathbf{d}$ )  |                |                      |                |
| $\Delta \text{Dollar}_{-1}$ | 0.10<br>(2.0)  | -              | -                    | -              |
| $\Delta \mathbf{b}_{-1}$    | 0.10<br>(2.1)  | 0.11<br>(0.9)  | 0.21<br>(1.8)        | 0.21<br>(1.8)  |
| $\bar{R}^2$                 | 0.162  | 0.167          | 0.140                | 0.154          |
| DW                          | 1.81   | 1.99           | 2.10                 | 2.10           |
| Restriction ok?             | -  | ja             | -                    | Ja             |
| Crit. Val. 5%               | 3.82   | 3.57           | 3.82                 | 3.57           |
| Crit. Val. 1%               | 4.59   | 4.29           | 4.59                 | 4.29           |
| ECM-t-Ratio                 | 3.9*   | 4.1*           | 3.4                  | 3.7*           |

Notes: ECM cointegration test (Banerjee et al., 1998); sample period: quarterly observations of the period 1976:i – 1992:iv (68 observations. Endogenous dollar exposures have been shifted to the centre of their moving window (four years), i.e. they enter the estimation as (t+24). \*) Significant at the 5%-level.

## **5. Assessing the Dollar exposure in an APT model**

The APT model, presented in equation (4) of Section 2, is a system of seemingly unrelated non-linear regressions with  $(N-1)K$  cross-equations restrictions (imposing that the  $I$ 's are the same for each of the  $N$  securities). It is estimated using the ITNLSUR (Iterated Non-linear Seemingly Unrelated Regressions) technique developed by Burmeister and McElroy (1988).

The estimates of the risk premia of the APT-model are displayed in Table 6. During the first period from 04/77 – 12/79, the risk premia for the business climate, inflation, the term structure and the dollar are significant on the 95 % level which implies that these risks are not diversifiable and therefore investors have to be compensated with a higher expected return for bearing these risks. During the second period from 01/80 – 12/85, only the dollar and the residual market factor are significant. The third period from 01/86 – 12/90 shows only one significant risk premium, that for the inflation variable, whereas in the fourth period none is significant. This might reflect the increasing efficiency of markets where due to the global integration of financial markets and sophisticated derivative instruments more and more risks can be hedged, such that the exchange rate risk is not priced.

Table 7 displays estimated factor sensitivities for the business climate variable. They turn out to be unstable depending on the time period under consideration. During the first period from 04/77 – 12/79, the relationship between changes in the business climate and stock returns turns out to be negative, which is counterintuitive since an improved business climate should result in improved expectations of firm profits. The sign of factor sensitivities reverses during the other three estimation periods.

Results for the inflation variable are shown in Table 8. During the first three periods, signs of the factor sensitivities are negative. This might imply, contrary to the Fisher hypothesis, that investors expect a negative impact of increasing money depreciation on firm profits. The relationship becomes positive in the fourth period from 01/91 – 03/95, when 26 of the 28 estimated factor sensitivities are significant on the 5 % level.

Table 9 shows the results for the term structure variable. During all four estimation periods the relationship between changes in the term structure and stock returns is negative. It becomes even stronger over time: the number of significant factor sensitivities increases from 7 in 04/77 – 12/79 to 24 in 01/91 – 03/95. This result is in accordance with the rational expectations hypothesis of the term structure, as an increase in the term structure

implies the expectation of increasing interest rates in the future, and therefore a heavier discounting of future profits.

The results of the US-dollar, which is the variable of major interest in our work, are displayed in Table 10. During the first estimation period 04/77 – 12/79, the relationship is mostly positive, but only 4 t-values are above 1.96. The sign of factor sensitivities turns negative during the second period from 01/80 – 12/85. The relationship during this period is highly significant as 22 of the 28 factor sensitivities are significant on the 5 % level. This period coincides with the period of the second oil shock and a sharply rising dollar (see Figure 3), which led to increasing input costs of the German economy. The prospect of increasing prices for foreign inputs apparently had a negative impact on German stock prices. This result confirms our previous findings.

The relationship again reverses to a positive association during the third and fourth period from 01/86 – 12/90 and 01/91 – 03/95, respectively. Out of 28 factor sensitivities, 26 are positive and 10 are significant during the third period, whereas in the fourth period even all 28 coefficients are positive out of which 12 are significant. The rising German trade surplus from the mid-eighties on (see Figure 3) has let exporters more strongly profit from a rising dollar. These estimates, too, are in line with our results presented in Section 4.

Table 11, finally, displays parameter estimates for the residual market factor. All estimated coefficients are positive and significant with t-values up to 14. Thus, not surprisingly, the market return is the most important single factor influencing stock returns.

**Table 6: APT-modelling: estimated risk premia**

|                              | 04/77-12/79 | 01/80-12/85 | 01/86-12/90 | 01/91-03/95 | 04/77-3/95 |
|------------------------------|-------------|-------------|-------------|-------------|------------|
| Business climate             | -0.213603   | 0.108629    | -0.003178   | -0.977582   | -0.006482  |
|                              | -3.424870   | 0.224226    | -0.015727   | -0.855645   | -0.775972  |
| Inflation                    | 0.001246    | 0.001719    | 0.001387    | -0.009511   | -0.000182  |
|                              | 6.022274    | 1.230012    | 3.298397    | -1.128937   | -0.293946  |
| Interest rate term structure | 0.001694    | -0.003828   | -0.001016   | -0.001968   | -0.002098  |
|                              | 2.660712    | -1.490610   | -0.861853   | -0.999591   | -1.823590  |
| Dollar                       | 0.033745    | 0.235939    | -0.002807   | -0.042578   | 0.038019   |
|                              | 3.262461    | 2.306820    | -0.250563   | -0.907591   | 2.327922   |
| Residual market factor       | 0.001876    | 0.038074    | -0.000541   | 0.049311    | 0.002529   |
|                              | 1.137838    | 3.538150    | -0.108985   | 1.217405    | 1.105950   |

**Table 7: APT-modelling: Sensitivity to the “business climate”**

|                         | 04/77-12/79            | 01/80-12/85            | 01/86-12/90            | 01/91-03/95            |
|-------------------------|------------------------|------------------------|------------------------|------------------------|
| Allianz (1)             | -0.037808<br>-6.056247 | 0.000218<br>0.045478   | 0.021181<br>4.084276   | -0.006400<br>-1.444770 |
| BASF (2)                | -0.005132<br>-0.711987 | 0.002656<br>0.805184   | 0.004328<br>0.889396   | -0.001976<br>-0.468190 |
| Bayer (3)               | -0.004052<br>-0.605755 | 0.002304<br>0.849288   | 0.006864<br>1.476547   | 0.009234<br>2.286698   |
| BMW (4)                 | -0.014307<br>-1.386800 | 0.001587<br>0.345780   | 0.004833<br>0.720741   | 0.008975<br>1.589014   |
| Bayer. Vereinsbank (5)  | -0.025602<br>-2.934911 | 0.003283<br>0.960529   | 0.016096<br>3.447230   | 0.001252<br>0.298751   |
| Commerzbank (6)         | -0.015109<br>-2.226771 | 0.006609<br>1.474257   | 0.012667<br>2.513174   | 0.002861<br>0.783602   |
| Continental (7)         | -0.007681<br>-0.484700 | 0.008637<br>1.444075   | 0.006474<br>0.693160   | 0.005449<br>0.760279   |
| Daimler-Benz (8)        | -0.009903<br>-1.495731 | 0.006638<br>1.801508   | 0.014661<br>2.612782   | 0.012636<br>2.927361   |
| Degussa (9)             | -0.006621<br>-0.921201 | -0.000336<br>-0.081165 | 0.007978<br>1.119602   | -0.004601<br>-0.871308 |
| Deutsche Bank (10)      | -0.019420<br>-3.257705 | 0.005730<br>1.634590   | 0.016151<br>2.910664   | -0.001223<br>-0.379376 |
| Dresdner Bank (11)      | -0.011780<br>-2.032117 | 0.006789<br>1.622943   | 0.016005<br>3.398943   | -0.001254<br>-0.357835 |
| Deutsche Babcock (12)   | -0.030232<br>-3.200422 | 0.004803<br>0.828826   | 0.002618<br>0.319059   | -0.001999<br>-0.304095 |
| Hoechst (13)            | -0.005126<br>-0.636510 | 0.004315<br>1.608288   | 0.010924<br>2.030225   | 0.000769<br>0.175424   |
| Hypobank (14)           | -0.016391<br>-2.187269 | 0.009554<br>1.978922   | 0.016238<br>3.309445   | 0.001263<br>0.334045   |
| Karstadt (15)           | 0.001428<br>0.115808   | 0.007744<br>-1.370526  | -0.005823<br>-0.682933 | -0.006999<br>-1.278536 |
| Kaufhof (16)            | -0.006487<br>-0.532033 | 0.003558<br>0.702268   | -0.008106<br>-1.013207 | -0.000389<br>-0.065383 |
| Linde(17)               | -0.041523<br>-4.760518 | -0.000727<br>-0.223464 | 0.014549<br>3.053431   | -0.003222<br>-0.823440 |
| Lufthansa (18)          | -0.004446<br>-0.264911 | 0.008045<br>1.408628   | 0.011969<br>1.551473   | 0.003101<br>0.346309   |
| MAN (19)                | -0.028979<br>-3.433244 | 0.004086<br>0.004086   | 0.019093<br>2.345312   | 0.009400<br>1.704461   |
| Mannesmann (20)         | -0.004473<br>-0.433193 | 0.007888<br>1.874838   | 0.021195<br>2.625758   | 0.011987<br>2.151401   |
| Metallgesellschaft (21) | -0.037678<br>-3.158826 | 0.006883<br>1.357734   | 0.023443<br>2.801088   | 0.012182<br>1.110943   |
| Preussag (22)           | -0.030627<br>-2.127880 | 0.009652<br>-1.677105  | 0.030164<br>3.313558   | 0.004824<br>0.761658   |
| RWE (23)                | -0.017358<br>-2.003099 | 0.003106<br>0.900312   | 0.002794<br>0.383519   | -0.008914<br>-2.343336 |
| Schering (24)           | 0.011166<br>1.007141   | -0.007572<br>-2.106714 | 0.011055<br>1.676620   | 0.004586<br>0.820756   |
| Siemens (25)            | -0.019537<br>-3.840200 | 0.003608<br>1.316164   | 0.021165<br>3.852693   | -0.000591<br>-0.181074 |
| Thyssen (26)            | 0.005684<br>0.517758   | 0.006568<br>1.230938   | 0.009752<br>1.451967   | 0.019680<br>3.405292   |
| VEBA (27)               | -0.041710<br>-3.862136 | 0.008074<br>2.300695   | 0.010177<br>1.943665   | -0.001006<br>-0.261166 |
| VW (28)                 | -0.021309<br>-1.885862 | 0.011574<br>2.089541   | 0.016514<br>2.559311   | 0.016235<br>2.497194   |

**Table 8: APT-modelling: Sensitivity to inflation**

|                         | 04/77-12/79            | 01/80-12/85            | 01/86-12/90            | 01/91-03/95          |
|-------------------------|------------------------|------------------------|------------------------|----------------------|
| Allianz (1)             | -2.562619<br>-1.139575 | -4.207588<br>-1.628070 | -1.704562<br>-0.569462 | 8.391110<br>5.945107 |
| BASF (2)                | -4.912299<br>-1.892373 | -0.112472<br>-0.063093 | -1.950335<br>-0.697900 | 5.096868<br>4.629656 |
| Bayer (3)               | -7.863918<br>-3.262143 | -2.760371<br>-1.883117 | -4.986297<br>-1.834363 | 2.698319<br>2.367297 |
| BMW (4)                 | -5.972126<br>-1.607506 | -3.622408<br>-1.461138 | -2.215328<br>-0.556279 | 4.025023<br>2.679085 |
| Bayer. Vereinsbank (5)  | -3.952464<br>-1.258992 | -3.698605<br>-2.002566 | -4.127887<br>-1.549807 | 5.346297<br>4.480344 |
| Commerzbank (6)         | -1.168826<br>-0.478019 | -2.636571<br>-1.087116 | -3.399644<br>-1.185620 | 4.667351<br>4.302154 |
| Continental (7)         | -1.284306<br>-0.224682 | -4.559430<br>-1.410883 | -3.180366<br>-0.599250 | 3.995226<br>2.059594 |
| Daimler-Benz (8)        | -7.732466<br>-3.242119 | 1.470096<br>0.736288   | -9.678805<br>-2.984303 | 4.403909<br>3.201607 |
| Degussa (9)             | -4.043052<br>-1.562409 | -1.070851<br>-0.478368 | -1.168919<br>-0.274179 | 5.490750<br>3.836988 |
| Deutsche Bank (10)      | -2.907208<br>-1.355014 | -2.816861<br>-1.486504 | -5.645212<br>-1.748574 | 5.844345<br>5.968609 |
| Dresdner Bank (11)      | -6.179998<br>-2.961972 | -4.888743<br>-2.158048 | -0.371073<br>-0.135466 | 5.499666<br>5.138584 |
| Deutsche Babcock (12)   | 2.979087<br>0.875206   | 5.863190<br>-1.867910  | -3.235105<br>-0.682355 | 9.020569<br>4.986530 |
| Hoechst (13)            | -6.159668<br>-2.122340 | -2.162964<br>-1.491359 | -3.976949<br>-1.269849 | 5.178930<br>4.645982 |
| Hypobank (14)           | -2.372182<br>-0.879327 | -5.932031<br>-2.271468 | -6.104263<br>-2.173483 | 5.891808<br>5.086090 |
| Karstadt (15)           | -13.45788<br>-3.031070 | -4.446943<br>-1.455499 | 1.774349<br>0.356633   | 3.443173<br>1.986493 |
| Kaufhof (16)            | -14.48828<br>-3.299988 | -4.705350<br>-1.718676 | 2.777547<br>0.573227   | 6.288466<br>3.199158 |
| Linde(17)               | 1.585603<br>0.504115   | -0.577846<br>-0.328579 | -0.100556<br>-0.037343 | 5.663656<br>4.695808 |
| Lufthansa (18)          | -5.768072<br>-0.954945 | -11.44680<br>-3.687992 | -2.027017<br>-0.458797 | 4.662036<br>2.051522 |
| MAN (19)                | 3.096887<br>1.017408   | -1.514339<br>-0.630077 | -1.208915<br>-0.261523 | 3.865769<br>2.181367 |
| Mannesmann (20)         | -8.400767<br>-2.255851 | -1.813177<br>-0.797682 | -2.183424<br>-0.471031 | 4.327588<br>2.890596 |
| Metallgesellschaft (21) | -0.985271<br>-0.229420 | -0.045272<br>-0.016525 | 6.744132<br>1.382826   | 8.474352<br>2.156620 |
| Preussag (22)           | -9.504113<br>-1.834855 | -1.352553<br>-0.434453 | 7.917035<br>1.429599   | 2.889504<br>1.574442 |
| RWE (23)                | 2.696646<br>0.863697   | -3.051313<br>-1.636452 | 4.649981<br>1.062894   | 5.776350<br>5.279105 |
| Schering (24)           | -7.622816<br>-1.908382 | -2.357077<br>-1.209594 | 1.483030<br>0.389091   | 3.102239<br>2.232727 |
| Siemens (25)            | -1.576070<br>-0.859439 | -5.425008<br>-3.656648 | -3.597979<br>-1.150874 | 4.906491<br>5.570770 |
| Thyssen (26)            | -7.038219<br>-1.778059 | -2.709193<br>-0.939999 | -0.645119<br>-0.169050 | 2.931726<br>1.777640 |
| VEBA (27)               | -7.491346<br>-1.922802 | -0.745175<br>-0.392919 | 0.109741<br>0.037038   | 3.978945<br>3.548902 |
| VW (28)                 | -7.979597<br>-1.959804 | -2.865680<br>-0.956542 | -8.711869<br>-2.291628 | 5.047158<br>2.733066 |

**Table 9: APT-modelling: Sensitivity to the term structure**

|                         | 04/77-12/79            | 01/80-12/85            | 01/86-12/90            | 01/91-03/95            |
|-------------------------|------------------------|------------------------|------------------------|------------------------|
| Allianz (1)             | -1.310459<br>-1.496661 | -1.865668<br>-1.929210 | -5.194704<br>-4.186206 | -11.21016<br>-5.682718 |
| BASF (2)                | -2.493986<br>-2.465395 | -1.382845<br>-2.073604 | -2.687058<br>-0.697900 | -5.716532<br>-3.047428 |
| Bayer (3)               | -1.720128<br>-1.834820 | -1.425935<br>-2.599502 | -3.579248<br>-3.213612 | -3.871451<br>-2.155605 |
| BMW (4)                 | -0.035953<br>-0.024837 | -0.781879<br>-0.842697 | -2.077894<br>-1.291402 | -6.203242<br>-2.470894 |
| Bayer. Vereinsbank (5)  | 0.000175<br>0.000143   | -1.078173<br>-1.560005 | -5.054664<br>-4.529271 | -9.380692<br>-5.032006 |
| Commerzbank (6)         | -1.243738<br>-1.308050 | -2.015278<br>-2.224031 | -4.855552<br>-4.031853 | -6.141989<br>-3.780611 |
| Continental (7)         | -0.113345<br>-0.051133 | -1.965694<br>-1.625420 | -2.765700<br>-1.239373 | -9.265576<br>-2.908140 |
| Daimler-Benz (8)        | 1.604563<br>1.728175   | -0.112589<br>-0.151227 | -5.540447<br>-4.125930 | -7.973133<br>-4.147560 |
| Degussa (9)             | -2.238007<br>-2.218434 | -0.328849<br>-0.392597 | -0.890473<br>-0.520332 | -5.619599<br>-2.393759 |
| Deutsche Bank (10)      | -1.389460<br>-1.659128 | -2.460347<br>-3.471291 | -6.412475<br>-4.825724 | -7.961788<br>-5.549343 |
| Dresdner Bank (11)      | -1.661779<br>-2.040478 | -2.866052<br>-3.390079 | -5.353727<br>-4.748004 | -6.362636<br>-4.077856 |
| Deutsche Babcock (12)   | -1.332694<br>-1.006578 | 0.851955<br>0.727553   | -2.215563<br>-1.128327 | -9.517714<br>-3.256764 |
| Hoechst (13)            | -3.564580<br>-3.158524 | -1.907696<br>-3.517035 | -1.747473<br>-1.356203 | -5.578516<br>-2.863149 |
| Hypobank (14)           | 0.266294<br>0.253076   | -0.742870<br>-0.761225 | -5.386441<br>-4.591753 | -8.030865<br>-4.769906 |
| Karstadt (15)           | -2.710569<br>-1.567269 | 0.062974<br>0.055129   | -4.231178<br>-2.071556 | 0.210493<br>0.086345   |
| Kaufhof (16)            | -1.501035<br>-0.877160 | -1.142507<br>-1.115338 | -5.259155<br>-2.733600 | 2.398557<br>0.905022   |
| Linde(17)               | 0.100381<br>0.082232   | -0.654978<br>-0.996179 | -3.079640<br>-2.706637 | -4.707531<br>-2.702560 |
| Lufthansa (18)          | -3.284558<br>-1.393325 | -0.485598<br>-0.421118 | -1.727243<br>-0.936413 | -11.35674<br>-2.854502 |
| MAN (19)                | 0.088553<br>0.074969   | -1.822918<br>-2.030669 | -4.536211<br>-2.332409 | -9.506939<br>-3.870534 |
| Mannesmann (20)         | -2.265588<br>-1.568356 | -0.879254<br>-1.033497 | -5.869965<br>-3.040740 | -6.841233<br>-2.762225 |
| Metallgesellschaft (21) | -0.755498<br>-0.451207 | 0.115980<br>0.113152   | -0.576691<br>-0.287698 | 1.473586<br>0.301249   |
| Preussag (22)           | 0.512858<br>0.253587   | -1.175943<br>-1.010799 | 0.361665<br>0.165143   | -4.946992<br>-1.755849 |
| RWE (23)                | -2.417548<br>-1.990042 | -1.010799<br>-0.487107 | -5.434959<br>-3.105762 | -4.622722<br>-2.731842 |
| Schering (24)           | -2.732853<br>-1.758058 | -2.516609<br>-3.465858 | -4.760925<br>-3.017140 | -5.537031<br>-2.230555 |
| Siemens (25)            | -2.571130<br>-3.608229 | -0.487401<br>-0.879681 | -3.753835<br>-2.859607 | -5.235493<br>-3.608663 |
| Thyssen (26)            | -4.257975<br>-2.770621 | -1.050679<br>-0.973698 | -2.546323<br>-1.586835 | -7.144126<br>-2.779178 |
| VEBA (27)               | -0.212407<br>-0.140644 | -0.170052<br>-0.239664 | -1.944063<br>-1.554711 | -4.757537<br>-2.776617 |
| VW (28)                 | 2.111389<br>1.333219   | -3.391726<br>-3.029085 | -3.424896<br>-2.213706 | -5.757580<br>-1.991120 |

**Table 10: APT-modelling: Sensitivity to Dollar movements**

|                         | 04/77-12/79            | 01/80-12/85            | 01/86-12/90            | 01/91-03/95          |
|-------------------------|------------------------|------------------------|------------------------|----------------------|
| Allianz (1)             | -0.004606<br>-0.072073 | -0.118845<br>-2.942663 | 0.058385<br>0.664388   | 0.164780<br>1.734495 |
| BASF (2)                | 0.102862<br>1.392689   | -0.107094<br>-3.800522 | 0.048737<br>0.590938   | 0.280191<br>3.094935 |
| Bayer (3)               | 0.096361<br>1.408947   | -0.097310<br>-4.259209 | 0.027313<br>0.346880   | 0.142051<br>1.640058 |
| BMW (4)                 | 0.027181<br>0.257188   | -0.060796<br>-1.580642 | 0.188607<br>1.661649   | 0.334268<br>2.759314 |
| Bayer. Vereinsbank (5)  | 0.257188<br>0.271493   | -0.079241<br>-2.750427 | 0.158728<br>2.005301   | 0.158847<br>1.767028 |
| Commerzbank (6)         | 0.110512<br>1.593226   | -0.205454<br>-5.073234 | 0.250561<br>2.932397   | 0.031369<br>0.400595 |
| Continental (7)         | -0.278017<br>-1.721159 | -0.109992<br>-2.186452 | 0.373449<br>2.358318   | 0.285933<br>1.860148 |
| Daimler-Benz (8)        | 0.001972<br>0.029095   | -0.117528<br>-3.271778 | 0.310095<br>3.261456   | 0.515357<br>5.566667 |
| Degussa (9)             | 0.195366<br>2.651987   | -0.094757<br>-2.705430 | 0.420750<br>3.488749   | 0.386453<br>3.412070 |
| Deutsche Bank (10)      | 0.064943<br>1.061435   | -0.144234<br>-4.775309 | 0.277771<br>2.954908   | 0.124914<br>1.806802 |
| Dresdner Bank (11)      | 0.145019<br>2.437319   | -0.195016<br>-4.933935 | 0.129032<br>1.617576   | 0.012332<br>0.164029 |
| Deutsche Babcock (12)   | 0.039512<br>0.409046   | -0.131928<br>-2.375848 | 0.332366<br>2.390498   | 0.249980<br>1.773243 |
| Hoechst (13)            | 0.123310<br>1.497804   | -0.110131<br>-4.744283 | -0.043001<br>-0.471778 | 0.268596<br>2.855792 |
| Hypobank (14)           | 0.032789<br>0.426645   | -0.072864<br>-1.682275 | 0.292017<br>3.511323   | 0.055338<br>0.682146 |
| Karstadt (15)           | 0.178303<br>1.412288   | -0.056928<br>-1.149292 | 0.253886<br>1.757769   | 0.377474<br>3.214940 |
| Kaufhof (16)            | 0.258629<br>2.069859   | -0.065819<br>-1.531888 | 0.418875<br>3.094912   | 0.214490<br>1.681324 |
| Linde(17)               | 0.014598<br>0.164061   | -0.101333<br>-3.547084 | 0.146101<br>1.808238   | 0.367441<br>4.378376 |
| Lufthansa (18)          | 0.173477<br>1.007329   | 0.054114<br>0.865635   | 0.014847<br>0.113544   | 0.267151<br>1.391007 |
| MAN (19)                | 0.093140<br>-1.081803  | -0.179159<br>-4.410100 | 0.014636<br>0.106041   | 0.660426<br>5.583742 |
| Mannesmann (20)         | 0.022406<br>0.212827   | -0.120999<br>-3.443393 | 0.056997<br>0.416643   | 0.432408<br>3.618515 |
| Metallgesellschaft (21) | -0.008916<br>-0.072916 | -0.106816<br>-2.477040 | -0.025510<br>-0.179936 | 0.228537<br>0.971785 |
| Preussag (22)           | -0.035825<br>-0.242432 | -0.070974<br>-1.375417 | 0.286024<br>1.857735   | 0.555758<br>4.091376 |
| RWE (23)                | 0.121377<br>1.369300   | -0.059607<br>-2.030123 | 0.145243<br>1.178403   | 0.110953<br>1.359883 |
| Schering (24)           | 0.282589<br>0.0129     | -0.112220<br>-3.127653 | 0.044985<br>0.402639   | 0.184105<br>1.536119 |
| Siemens (25)            | 0.155162<br>2.985798   | -0.080959<br>-3.212608 | 0.214002<br>2.297772   | 0.277545<br>3.965073 |
| Thyssen (26)            | 0.213323<br>1.903968   | -0.111529<br>-2.541879 | 0.024964<br>0.219229   | 0.465127<br>3.752378 |
| VEBA (27)               | 0.089848<br>0.816545   | -0.074557<br>-2.496618 | 0.129873<br>1.462866   | 0.124495<br>1.507106 |
| VW (28)                 | 0.067549<br>7.113015   | -0.171268<br>-3.474283 | 0.138990<br>1.272088   | 0.189876<br>1.361675 |



**Table 11: APT-modelling: Sensitivity to the residual market factor**

|                         | 04/77-12/79          | 01/80-12/85          | 01/86-12/90          | 01/91-03/95          |
|-------------------------|----------------------|----------------------|----------------------|----------------------|
| Allianz (1)             | 0.871771<br>5.492081 | 1.452645<br>9.854710 | 1.277198<br>14.69842 | 1.279106<br>9.497071 |
| BASF (2)                | 0.712715<br>3.883372 | 0.910422<br>8.950020 | 0.843724<br>10.34569 | 1.130005<br>8.836085 |
| Bayer (3)               | 1.113212<br>6.557257 | 1.003411<br>12.00269 | 0.876608<br>11.26068 | 0.909046<br>7.420565 |
| BMW (4)                 | 1.761988<br>6.709928 | 1.034157<br>7.315605 | 1.308202<br>11.65904 | 1.286657<br>7.516651 |
| Bayer. Vereinsbank (5)  | 0.979477<br>4.397832 | 0.894315<br>8.490150 | 1.103114<br>14.09278 | 0.966817<br>7.602904 |
| Commerzbank (6)         | 1.120024<br>6.505246 | 1.523373<br>10.98139 | 0.980945<br>11.60897 | 0.932421<br>8.411159 |
| Continental (7)         | 1.771611<br>4.424896 | 1.199462<br>6.508466 | 0.753869<br>4.813959 | 0.732019<br>3.369332 |
| Daimler-Benz (8)        | 0.994767<br>5.910958 | 1.323645<br>11.54794 | 1.300288<br>13.83105 | 1.307453<br>9.961587 |
| Degussa (9)             | 0.874055<br>4.773869 | 0.961320<br>7.528789 | 0.859478<br>7.209689 | 1.229109<br>7.677863 |
| Deutsche Bank (10)      | 0.848008<br>5.573159 | 1.360653<br>12.57888 | 1.064982<br>11.45839 | 0.981337<br>10.02222 |
| Dresdner Bank (11)      | 0.713554<br>4.822291 | 1.513640<br>11.65724 | 1.137031<br>14.41664 | 0.884119<br>8.302374 |
| Deutsche Babcock (12)   | 1.055325<br>4.400920 | 1.164041<br>6.465452 | 1.020927<br>7.426159 | 1.557132<br>7.812853 |
| Hoechst (13)            | 0.823543<br>4.030127 | 1.010502<br>12.20360 | 0.777655<br>8.629285 | 1.185061<br>8.922982 |
| Hypobank (14)           | 0.972797<br>5.091741 | 1.033099<br>6.918197 | 1.113213<br>13.53643 | 1.023140<br>8.903657 |
| Karstadt (15)           | 0.989688<br>3.155409 | 0.707287<br>4.052545 | 0.977536<br>6.845279 | 0.891425<br>5.356067 |
| Kaufhof (16)            | 1.438526<br>4.632716 | 0.775753<br>4.967023 | 0.880914<br>6.585420 | 1.536207<br>8.486964 |
| Linde(17)               | 1.309768<br>5.936082 | 0.978386<br>9.738289 | 0.977718<br>12.23581 | 1.169388<br>9.835662 |
| Lufthansa (18)          | 1.146274<br>2.676625 | 0.637749<br>3.555675 | 1.081031<br>8.360482 | 0.974309<br>3.592708 |
| MAN (19)                | 1.535757<br>7.194000 | 1.163776<br>8.460785 | 1.118500<br>8.194385 | 1.162344<br>6.930601 |
| Mannesmann (20)         | 1.528651<br>5.857201 | 1.100323<br>8.490648 | 1.154220<br>8.532539 | 1.330889<br>7.880702 |
| Metallgesellschaft (21) | 1.755691<br>5.777079 | 0.819809<br>5.244904 | 1.287927<br>9.188124 | 1.665545<br>4.981233 |
| Preussag (22)           | 1.180039<br>3.210572 | 0.942932<br>5.296979 | 1.150227<br>7.559103 | 1.133981<br>5.899637 |
| RWE (23)                | 0.670998<br>3.048751 | 0.625544<br>5.880106 | 0.825636<br>6.777041 | 1.005281<br>8.708476 |
| Schering (24)           | 1.223797<br>4.344750 | 1.103938<br>9.856036 | 0.958472<br>8.676193 | 0.822194<br>4.859684 |
| Siemens (25)            | 0.899957<br>6.979635 | 1.212563<br>14.27769 | 1.194540<br>12.96975 | 1.046331<br>10.57656 |
| Thyssen (26)            | 1.389852<br>5.001628 | 1.075179<br>6.547216 | 1.025764<br>9.109022 | 1.263599<br>7.206072 |
| VEBA (27)               | 0.332112<br>1.217957 | 0.802119<br>7.413012 | 0.813405<br>9.264314 | 0.915546<br>7.831997 |
| VW (28)                 | 2.040186<br>7.113015 | 1.279086<br>7.469244 | 1.312754<br>12.15317 | 1.296567<br>6.573379 |

## **6. Conclusions**

According to many financial market analysts, there should be a positive correlation between German stock prices and the DM/\$ rate, respectively a negative correlation between the German stock prices and the EURO/\$ exchange rate. The supposition is based on Germany's export strength, such that any depreciation of the German/European currency would mean good news to German companies.

In this paper, we have tried to shed some light on the DAX-Dollar relationship. It turns out to be rather unstable, as has been demonstrated on the basis of an extended, time-variant exchange-rate exposure model in the tradition of Adler and Dumas (1980, 1984), and Jorion (1990), and by using an APT framework. Estimated Dollar exposures are significantly negative at the beginning of the 80's, but they change their sign in the late 80's and early 90's. The negative correlation is a result of the second oil shock and a sharply rising dollar, which have led to increasing import costs. The prospect of increasing prices for foreign inputs apparently had a negative impact on stock prices. The positive association reflects the rising German trade surplus from the mid-eighties on which has let exporters more strongly profit from a rising dollar.

These conclusions follow from numerous estimates, based on the performance indices of 28 German DAX corporations, inclusion of macroeconomic risk factors, data on export and import involvement, as well as on econometric panel, GLS, SUR and cointegration techniques.

Our analysis is completed by estimating an APT-model. The time pattern of estimated Dollar sensitivities is in line with our results on estimated Dollar exposures. As regards estimated risk premia, it turns out that the Dollar risk is the only risk which is priced in two out of four considered sub-periods. In general, however, the Dollar risk premium becomes less significant over time, and from 1986 on no significant risk premium remained. This might reflect the increasing efficiency of markets where due to the global integration of financial markets and sophisticated derivative instruments more and more risks can be hedged, such that the exchange rate risk is not priced.

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