The Introduction of the Euro and its Effects on Portfolio Decisions*

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ABSTRACT

By examining investment behavior around the Euro introduction, we learn about the relevance of different investment determinants. There are two potential sources of portfolio reallocation: First, exchange rate risk and transaction costs diminished within the EMU. Second, correlation of intra-EMU returns has been increased. We test for structural breaks in the holdings of German investors and estimate a market model to account for the two effects. We observe a significant decrease in national and an increase in intra-EMU and US investments. Comparing the observed holdings with benchmark portfolios, we find a decrease in home bias since the Euro introduction.

Keywords: investment behavior, home bias, portfolio allocation, realized volatility, Euro introduction
JEL Classification: F21, F33, F36, G15

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1 Introduction

From a theoretical point of view, the introduction of the Euro has an ambiguous effect on portfolio decisions of European investors. On the one hand, cross-border transaction and information cost have been reduced, while currency risk has been completely eliminated for intra-EMU investments (Adjaoute and Danthine 2001). Hence, investments within the EMU might be stimulated. On the other hand, the bundling of monetary policy might have decreased diversification opportunities within the EMU, hence, stimulating investment outside the currency union. The purpose of this paper is to empirically disentangle these effects and the concomitant change in the investment home bias of European investors.

The Euro introduction constitutes an unique event to single out factors that influence investment behavior. The change of the currency regime has influenced a number of factors that have been identified as determinants of investment home bias in the previous literature.[1] Two factors that have been used to explain investment home bias have changed since the Euro introduction: exchange rate risk and transaction costs for intra-EMU investments. Exchange rate risk makes foreign investments less appealing to risk averse investors (Michaelides 2003). As pointed out by Hau and Rey (2004) and Gourinchas and Rey (2005), the exchange rate is an important determinant for portfolio composition and rebalancing. If the purchasing power parity condition is violated, there is demand for domestic securities that hedge exchange rate risk (Lewis 1999). Such a country specific asset demands is one explanation of home bias. Furthermore, transaction costs are generally higher for cross-country compared to national investments. Since the Euro introduction, currency conversion became obsolete for intra-EMU investments, significantly reducing transaction costs. According to Tesar and Werner (1995), however, transaction costs seem not to be the only explanation for investment home bias.[2]

[1] For a broad review of the home bias puzzle the reader may consult Lewis (1999) and Karolyi and Stulz (2003).

[2] In their study, they find that foreign investments show a higher transaction rate than domestic ones, even-

Recent literature has also pointed out two factors as an explanation of investment home bias that have not been influenced by the change in the European currency regime: information asymmetries and "familiarity". Ahearne et al. (2004) argue that information asymmetries involved with investing in a foreign country act as barrier to international investment. Along similar lines, Portes and Rey (2005) and Coval and Moskowitz (1999) find that geographic proximity is preferred for investments in order to overcome asymmetric information between domestic and external investors.[3] A different explanation is offered by Huberman (2001) who argues that the home bias reflects a deviation from the postulate of rational behavior of agents since agents have a desire "to invest in the familiar". In this case, home bias is induced by irrationalities like "familiarity" of an asset rather than economic factors.

In order to examine the impact of the Euro introduction on investment home bias, we construct a new dataset comprising holding positions of German investors, based on statistics of the Deutsche Bundesbank.[4] Different to most related studies in this area, our work relies on stock and bond holdings of German investors from 1980 until 2003 rather than flow statistics.[5] In the second place we rely on time series analysis to infer on structural shifts characterizing in the latter holding series. For this issue we treat the timing of the potential shift in an endogenous manner. Finally, we estimate a market model for investment shares allowing for possible structural breaks. We find that both stock and bond investments show a break just before the advent of the Euro in 1999 with two separate effects on portfolio allocation being detected. First, the elimination of exchange rate risk and reduction of transaction costs for intra-EMU investments caused an increase of intra-EMU investments. Second, as a consequence of higher integration of European financial markets, intra-EMU returns become more correlated in the post-Euro period. This second effect increases the

though much of this activity has little impact on net foreign investment positions.

[3]The latter empirical studies are in line with the theoretical work of Haliassos and Michaelides (2003) referring to information asymmetries as a source of the investment home bias.

[4]See Warnock and Cleaver (2003) for explaining the advantages of holdings versus flow statistics to measure portfolio positions.

[5]Ahearne et al. (2004) and Chan et al. (2005) are a notable exception.

share of international investment allocated in countries that are not part of the EMU. Both effects result in a reduction of investment home bias compared to a benchmark portfolio.

The remainder of this paper is organized as follows: Section 2 presents our theoretical underpinnings and hypotheses. Section 3 sketches our methodology, outlines the concept of realized volatility' that we employ to measure second order features of the data and presents the theoretical optimal benchmark portfolios. Empirical results are discussed in Section 4, and concluding remarks are made in Section 5. Technical details on unit root testing under structural shifts are given in Appendix A.

2 Portfolio composition and the Euro introduction

As a starting point, we briefly outline optimal portfolio allocation theoretically. The optimal portfolio share of a representative investor is generally modeled by the ICAPM, initially derived by Solnik (1974). The following portfolio selection model under continuous trading and perfect market conditions was developed by Merton (1969), (1972). Taxes and transaction costs are not considered in this framework and investors' expectations are homogeneous by assumption. Asset prices follow a geometric Brownian Motion in continuous time. Bodie et al. (1985) further simplify this general framework by assuming that a representative agent's utility function takes the constant relative risk aversion form of the HARA (hyperbolic absolute risk aversion) family of utility functions. In this framework, the vector of optimal portfolio shares for a set of n risky assets comprising a market is obtained as

$$w^* = \frac{1}{\rho}\Omega^{-1}(\mu - \mu_{min}\mathbf{1}) + w_{min} \tag{1}$$

In (1), the vector w^* collects the optimal proportions of wealth invested in risky assets, and accordingly μ is short for the $n-$dimensional vector of expected returns. The expected return of the so-called minimum-variance portfolio (MVP) is denoted as μ_{min}; the vector of portfolio weights in the MVP is w_{min}; ρ denotes Pratt's measure of relative risk aversion

(Pratt 1964) and **1** is a column vector of ones. The $n \times n$ covariance matrix Ω collects along its diagonal variances, σ_i^2, and the off-diagonal covariances, $\sigma_{i,j}$.

Equation (1) can be applied to the example of a representative German investor, in order to detect consequences of the Euro introduction on investment demand. Such an investor has the choice to either invest into domestic, EMU (excluding Germany) or rest-of-the-world assets. This decision depends on the expected returns of these three assets, their (co)variances and his degree of risk aversion. In equation (1) the demand for intra-EMU investments depends inversely on the variance of intra-EMU investments, which is composed of the variance of the respective national returns and the variance of exchange rate movements. Thus, exchange rate variation provides an additional source of risk for cross-border holdings which has completely vanished since the Euro introduction. Empirically, Hau and Rey (2006) find that foreign exchange rate risk is generally unhedged in practice. Consequently, once exchange rate risk drops to zero, intra-EMU investments should, all else being equal, become more attractive.

Furthermore, the introduction of the Euro also let to further integration of European financial markets since all Eurozone assets are quoted in the same currency. This reduces transaction costs of intra-EMU investments (no currency conversion has to take place anymore). In the previous model, transaction cost are ruled out by assumption. Therefore, the introduction of the Euro may cause an increase in intra-EMU investment beyond the effect measured by (co)variances. Summarizing the latter arguments, the introduction of the Euro is supposed to have the following implications for the portfolio allocation decision of a representative European investor:

Hypothesis 1 (H1):

The elimination of exchange rate risk and the reduction of transaction costs through the establishment of the EMU, result, ceteris paribus, in an increase of intra-EMU investments.

Owing to a common monetary policy within the EMU area, the correlation between

EMU interest rates increased considerably (see Fratzscher 2002). The same trend could also been observed for the equity markets. Adjaoute and Danthine (2001) find a significant increase in the degree of correlation between national stock indices in the Eurozone. The correlation between national and intra-EMU returns enters the demand equation for intra-EMU assets (1) through the covariance between national and intra-EMU returns. An increase of the correlation of national Eurozone returns means that diversification opportunities for intra-EMU investments have been reduced. The latter arguments lead to the formulation of a second hypothesis concerning investment behavior:

Hypothesis 2 (H2):

Induced by the introduction of the Euro the unification of monetary policy results, ceteris paribus, in a decrease of intra-EMU investments and an increase in rest-of-the-world investments.

Overall, the two hypotheses H1 and H2 have the following implications for asset holdings of a representative European investor: H1 states a switch from domestic investments to intra-EMU assets. H2 implies some rebalancing from intra-EMU investment to rest-of-the-world investments. Thus, the direction of the net effect on intra-EMU investments is a priori unclear and depends on the relative magnitude of the two adverse effects. Both effects, however, will reduce the holdings of domestic assets, and therefore, investment home bias.

3 Methodology and data

In this section the methodology and data collection are described. Owing to intrinsic non-linearity of the model in (1), its empirical implementation is rather demanding. Further, the technical assumptions underlying the model's derivation, as e.g. HARA type utility coupled with constant relative risk aversion, could be subject to criticism. It is, however, not the purpose of this paper to test the validity of the equilibrium model by Merton (1972), but

to identify determinants of portfolio composition in general. For this task, the theoretical model in (1) provides valuable guidance by formalizing the relation between an optimal portfolio composition on one hand and moment properties of asset returns on the other. By the nature of optimization in a higher dimensional system, it is worthwhile to point out that not merely return variances are seen as determining factors of investment behavior but also the systems' covariances. As mentioned, the latter moments are assumed time invariant in the theoretical model. From an econometric viewpoint, however, second order moments of speculative prices are known to cluster over time. Since risk or (co)variances are latent by nature a major problem of implementing the model in (1) is the measurement of most of the right hand side variables.

A representative German investor has the choice to either invest into domestic, EMU or rest-of-the-world assets. This decision depends on the expected returns of these assets and their (co)variances formalizing the following regression model:

$$\begin{bmatrix} w_{GER} \\ w_{EMU} \end{bmatrix}_t = b + B_1 \begin{bmatrix} \mu_{GER} \\ \mu_{EMU} \\ \mu_{rest} \end{bmatrix}_t + B_2 \begin{bmatrix} \sigma^2_{GER} \\ \sigma_{GER,EMU} \\ \sigma_{GER,rest} \\ \sigma^2_{EMU} \\ \sigma_{EMU,rest} \\ \sigma^2_{rest} \end{bmatrix}_t + u_t. \tag{2}$$

In (2) b denotes a (2×1) parameter vector and B_1 and B_2 are (2×3) and (2×6) parameter matrices, respectively. The bivariate zero mean disturbance term u_t is assumed to be serially uncorrelated. Since the German, EMU and rest-of-the-world portfolio shares add up to unity, the portfolio share for the rest-of-the-world is implicitly determined by the two others, and thus, left out of the system (2). In order to estimate the empirical model in the actual portfolio shares, returns and respective variance/covariance measures have to be approximated. Note that opposite to the theoretical model in (1), the empirical model builds upon time variation of first (μ_t) and second order moments (σ_t) of returns. To improve the

readability of the model, the indices are shorthand versions for the considered regional markets. For the empirical application of the model in (2) to equity and bond markets, we refer to the same formal representation.

Before equation (2) can be estimated, the appropriate data has to be collected. We will first describe the measures of equity and bond holdings and discuss stationarity of these portfolio holdings. In the second step, the construction of market returns and respective second-order moments are considered. Finally, theoretical optimal portfolio shares for the underlying market data are presented.

3.1 Measuring bond and equity holdings of investors

Measuring portfolio shares held by German investors is difficult since households do not report their portfolio compositions. Nevertheless, this information is indispensable when analyzing changes in investment behavior. In related studies, net foreign portfolio holdings have often been approximated by means of capital flow statistics and valuation adjustments (e.g. Tesar and Werner 1995, Bekaert and Harvey 2000, Buch and Piazolo 2001).[6] Warnock and Cleaver (2003), however, demonstrate potential pitfalls of estimating portfolio holdings using flows. In many cases, major financial centers such as London or Frankfurt act as intermediaries for transactions and differ from their final destination. As a consequence, flow statistics are biased toward financial centers.

In this paper, we construct a more precise measure of portfolio allocations. Owing to the difficulty to obtain data for each member of the EMU, we concentrate the analysis on the investment decisions of German investors. In terms of market capitalization, the German capital market makes up for about one fourth of European capital markets (Buch and Lapp 1998). Therefore, our results could be regarded as representative for the Euro area.

[6]The studies by Ahearne et al. (2004) and Chan et al. (2005) are exceptions. Ahearne et al. (2004) use cross-border holdings data for the United States. Chan et al. (2005) build on equity holdings of mutual funds in various countries. Their data covers the years 1999 and 2000.

The total values of German stock and bond holdings are separated into assets issued in Germany, the EMU-member countries (excluding Germany) and the rest-of-the-world. Throughout this study, the rest-of-the-world is approximated by the US market. This seems reasonable since the US market alone accounts for more than two-third of all German investments out of the EMU in 2003 (Morgan Stanley Capital 2004). The value of German portfolio holdings of foreign and EMU assets have been constructed by the Deutsche Bundesbank for this study. The total value of German stock and bond holdings are determined by means of the financial accounts for Germany (Deutsche Bundesbank 2004). The listed portfolio shares are representative for private agents and enterprises. We exclude the financial sector from the analysis to avoid double counting of various assets.[7]

All time series are available at the bi-annual frequency from 1980:1 until 2003:2. Figures 1a/b display the resulting portfolio shares for stock and bond markets, respectively. These graphs visualize the tendency of German investors' retaining more than 40 percent of domestic stocks and bonds in their portfolios. Nevertheless, since the 1980s there has been a clear trend toward international diversification in both the stock and bond markets. A change in the levels of portfolio shares can be diagnosed from an eyeball inspection. Regarding the stock market, the share of nationally held assets has gradually decreased over the 1980s, followed by a sharp decrease in the mid 1990s. Accordingly, the shares of assets issued in rest-of-the-world or in the EMU have moved in the opposite direction. For fixed income investments, a similar but less extreme pattern is also visible.

Under the assumption of stable portfolio shares, random shocks have only transitory effects on the time series. In this case, one would expect the empirical portfolio shares to exhibit some pattern of mean reversion. Unit root test results obtained from common ADF regressions are shown in the upper panels of Table1. For the stock market, a unit root cannot be rejected for the EMU and rest-of-the-world equity holdings series. Similarly, for the bond market, the holdings series of national and rest-of-the-world investments are integrated of

[7] A description of data sources and the construction of the portfolio holdings is provided in Table 5.

order 1. These findings, make the use of the portfolio holdings series as dependent variables in system (2) problematic. Nevertheless, from the econometric literature on testing for nonstationarity of time series processes, it is known that shifts in the deterministic components of a time series could give rise to classifying the series as nonstationary, i.e. to contain stochastic trends. Including deterministic shifts at a known break date in Augmented Dickey Fuller test regressions is discussed in Perron (1989). Perron (1997) generalizes the latter issues, allowing for a break occurring at an unknown instance of time. As a byproduct, the latter approach also delivers some data driven estimate of the presumed break date.

At the first sight, analyzing the case of shifts in mean reverting dynamics caused by the introduction of the Euro, qualifies itself for an exogenous treatment of the break date. However, we will examine possible level shifts in the portfolio shares under the assumption of an unknown break date for two reasons. First, in previous studies, different dates at which the introduction of the Euro could have influenced investment behavior, have been identified. Investment behavior should change as soon as investor's expectations about the fixed parities formalized by the common currency change. Thus, investment behavior might have changed well before the factual advent of the Euro in 1999:1. Using an endogenous method no a-priori assumptions concerning the break date have to be imposed. Second, since an endogenous method will provide an estimate of the presumed break date in a data driven manner, it will be of interest if the detected period corresponds to the implementation or advent of the new currency. The latter estimates are of their own relevance when judging the case for economic relations formalized e.g. in H1 and H2.

The followed procedure to test for unit roots under structural breaks is detailed in Appendix A and results are summarized in Table 1. For the stock market, a unit root can be rejected for all portfolio holding processes with 10% significance once accounting for a structural break. The identified break dates are between 1994:1 and 1997:1 and thus, in accordance with a time period during which the fixed parities of the currencies entering the

Euro became known with certainty. These results justify to model equity holdings in system (2) as dependent variables when accounting for a structural break. For the bond market unit root test results are less clear in comparison with the stock market. Similar arguments apply for the value of EMU investment obtaining a potential shift date 2000:1. For the value of domestic as well as rest-of-the-world investments the unit root hypothesis, i.e. the random walk with drift, cannot be rejected.

3.2 Return determination

The return for a German investor holding assets in the EMU or in the rest-of-the-world is composed by the local market returns plus appreciation or minus deprecation of the local currencies against the German Mark (the Euro from 1999:1 on). The return of the rest-of-the-world portfolio is approximated by returns earned on the US market. The EMU portfolio returns are constructed by adding up all local market returns with the gains or losses from exchange rate changes weighted by the market capitalization of the respective market.[8] For the bond market, we use ”Tracker indices” provided by DataStream.

Figures 1c/d display the return series (measured in German currency) of the three different portfolios for the stock and the bond market, respectively. The graphs illustrate that stock market returns were, on average, higher than bond market returns but also show a higher unconditional volatility. Apart from the unconditional level of return uncertainty both stock and bond market returns reveal subperiods of lower and higher return variation. For instance, the early 1990s are characterized by relatively low volatilities whereas over the late 1990s and the beginning of the new millennium, stock and bond markets show an increase in return uncertainty. For the stock market, all three return series are highly correlated with each other. The latter characteristic is less pronounced for the bond market where US assets show, by far, the highest volatility.

[8]The weights of the bond and stock market are calculated with data on the market capitalization provided by the Federation of International Exchanges. See Table 5 for further details.

To implement the regression model in (2), some measure of the expected market returns is required. As a starting point, rational expectations are assumed, therefore, observed returns are used to substitute their expected counterparts. Since returns are difficult to predict a second specification is implemented based on adaptive expectations. To obtain the latter from the raw returns, we use moving averages over time windows covering the most recent five periods, i.e. the last 2.5 years.

3.3 Measuring second order moments

Volatility clustering characterizes processes of speculative prices at various frequencies including the bi-annual as displayed in Figures 1c/d. In the sequel of its introduction, the class of (Generalized) Autoregressive Conditionally Heteroskedatic ([G]ARCH) processes (Engle 1982, Bollerslev 1986) has been successfully applied in numerous empirical studies of higher order dynamics of asset prices (Bollerslev et al. 1994). As mentioned, not merely volatility clustering but also cross market correlation is a central feature of the return processes investigated in this paper. When turning to a higher dimensional analysis of asset returns, multivariate parametric models easily suffer from the curse of dimensionality. With regard to the present analysis of biannual data covering a sample period of 25 years, we presume that parametric volatility models are hardly feasible.

For the latter reasons, we a-priori opt for a model free approach to volatility estimation which has recently become popular as 'realized volatility' (Andersen et al. 2001, 2003, Barndorff-Nielsen and Shephard 2002a, 2002b).[9] Owing to its consistency for the process of conditional variances 'realized volatility' has a particular appeal since it makes the latent volatility observable in the limit. Owing to both, computational feasibility and theoretical underpinning, 'realized volatility' methods suggest themselves also for an analysis of (realized) conditional covariances (Barndorff-Nielsen and Shephard 2004, Andersen et al.

[9] For a detailed review over the field, the reader may consult Andersen et al. (2005).

2004).

Building upon the theory of quadratic variation (Protter 1990), realized volatility estimates are obtained as the sum of squared uncorrelated intraperiod returns $r_{m,t}$ measured at an equidistant grid of time instants $t - l_0\delta, t - l_1\delta, \ldots, t - l_M\delta,\ l_i = (M-i)/M$, i.e.

$$\hat{\sigma}_t^2 = \sum_{m=1}^{M} r_{m,t}^2, \tag{3}$$

with

$$r_{m,t} = p\left((t-1)\delta + \frac{m\delta}{M}\right) - p\left((t-1)\delta + \frac{(m-1)\delta}{M}\right),\ m = 1, \ldots, M. \tag{4}$$

Consistency of the realized volatility estimator in (3) has been proven by Andersen et al. (2001). Barndorff-Nielsen and Shephard (2002a) prove that the estimator obeys an asymptotic normal distribution. It is worthwhile to point out that, in the theoretical context asymptotic results are derived throughout under the assumption that the number of intraperiod observations tends to infinity, i.e. $M \to \infty$. For the present investigation, realized (co)variance estimates at the biannual frequency exploit about $M = 120$ daily price variations which should be sufficiently large to obtain quite accurate second order measures.

The resulting realized variance estimates for German, EMU and US stock and bond markets are displayed in Figures 1e/f. For almost every sample point, estimated US volatility exceeds the corresponding measures obtained for the European markets. All estimated time paths of second order moments are stable and could be used to identify periods of lower and higher financial market uncertainty.

Realized correlations are presented in Figure 2a/b for the stock and bond markets. As argued in Section 2, the correlation between German and (rest) EMU returns may have seen an increase with the introduction of the Euro, owing to a unification of the monetary policy and a strengthening of financial market integration. For the equity market, the unconditional correlation between German and intra-EMU returns has been 0.61 in the period of 1980 until 1998. From 1999 until 2003, this figure rose to 0.87. For the bond market, the most apparent

dynamic feature is that the correlation between European markets and the US has clearly decreased in the second half of the nineties. The correlation between the German and EMU bond markets has been remarkably stable since the mid 1980s. As a consequence, in order to gain diversification benefits German investors should substitute intra-EMU investments with investments in other countries with less correlated business cycles.

3.4 Optimal and minimum variance portfolio shares

Having obtained the returns and elements of the time varying variance-covariance matrices in the previous section, the theoretically implied optimal portfolio shares for the stock and bond markets according to equation (1) can easily be obtained. For these calculations, the dynamic hedging needs as implied by the MVP shares are required. Following Huang and Litzenberger (1988), the composition of the MVP is the solution to the quadratic minimization problem:

$$\min_{w_{min,t}} \quad w'_{min,t}\,\Omega_t\,w_{min,t}, \quad \text{subject to} \quad \mathbf{1}'\,w_{min,t} = 1. \tag{5}$$

Owing to time variation of the second order moments, optimization is done for every time period t in order to obtain the minimum portfolio weights over time. These MVP shares can be applied in equation (1) to obtain the theoretical optimal portfolio shares.

The MVP shares are displayed in Figures 2c/d and optimal portfolio shares for a degree of risk aversion of 5 are shown in Figures 2e/f. For the stock as well as bond markets, the US share in the MVP is remarkably stable over time. In all figures, one can identify from an eyeball inspection that the proportion of German assets has clearly fallen in the second part of the nineties, while the EMU share has increased. Thus, according to portfolio theory, it is optimal to reduce the proportion of national assets which might be explained by lower risk involved with intra-EMU investment due to the currency union. This informally hints at the viability of H1.

Note that in the previous analysis the optimal portfolio shares were derived based on only three assets. Further, the portfolio shares were not restricted to take a positive value due to the possibilities of short sales. In practice, however, investors have considerably more assets to choose and banks only pursue short sales for customers with a good credit record. These flaws can explain the quite drastic changes of portfolio shares over time, as seen in Figures 2c-f.

4 Empirical results

In this section, we examine how investment home bias has changed since the introduction of the Euro. We discuss the estimation results obtained from system (2) for the stock and bond markets. Further, we examine whether home bias has been changed relative to our benchmark portfolios in the post-Euro period. Before presenting these findings, structural breaks of the overall system are determined.

4.1 Break point detection

The previous section and the results in Appendix A showed that once allowing for a structural break, the value of portfolio components held by German investors is trend stationary. From this intermediate result, we conjecture that an empirical implementation of the model in (2) also has to account for a structural shift in the determinants of portfolio shares. On the one hand, it is a-priori tempting to impose the endogenously determined break points, identified by means of unit root testing in the previous section also for an empirical analysis of portfolio shares. On the other hand, one may use a model like (2) to determine the time point of a potential structural variation in a data-driven manner. Along these lines followed here, it will be of interest if the detected break points correspond to previous findings, and thus, to the introduction of the Euro. In addition, even when presuming a structural break,

it is not clear if the new currency has only impacted on the deterministic components of portfolio selection but has also affected the slope coefficients of the empirical model. For the latter reasons, our strategy to estimate the parameters in (2) will first address the issue of break point detection. For this purpose, we will consider the two portfolio share equations, separately ignoring the potential of contemporaneous cross equation error correlation. The determination of a presumed break date will proceed under the assumption that all parameters, intercept terms and slope coefficients of the model in (2), are allowed to exhibit a structural variation.

Formally, the latter issues may be sketched as follows: Let $w_t = (w_{GER,t}, w_{EMU,t})' = (w_{1t}, w_{2t})'$ denote the bivariate vector of dependent variables in (2) and let accordingly, column vectors $\mathbf{x}_{1t}$ and $\mathbf{x}_{2t}$ collect the 10 explanatory variables (including the constant) governing portfolio weights. Moreover, presume the model equations to undergo some structural variation in unknown time point $T_j^*, j = 1,2$. Then by means of a dummy variable, both equations can be given compactly as:

$$w_{jt} = \mathbf{x}_{jt}'\theta_j + (d_t\mathbf{x}_{jt})'\tilde{\theta}_j + u_{jt},\ d_t = \begin{cases} 0 & 1 \leq t < T_j^* \\ 1 & T_j^* \leq t \leq T, \end{cases} \quad j = 1,2. \tag{6}$$

The unknown break date can be determined from the data by running OLS with alternative choices of the break date, and, finally determining $\hat{T}_j^*$ such that the implied sum of squared residuals obtained over the entire sample information, $\mathrm{RSS}_j = \sum_{t=1}^{T} \hat{u}_{jt}^2(T_j^*)$, is minimized. It is not ruled out that the identified time points of structural variation are equation specific, i.e. differ for the determinants of $w_{GER,t}$ and $w_{EMU,t}$. Time points of structural breaks are estimated for a model specified with observed return series and, alternatively, implementing adaptive return expectations via a moving average over recent returns. The obtained time points of structural variation are given in Table 2. The empirical implementation of the latter scheme for the bond market delivers a model with positive serial correlation. In order to correct for this issue, we include a lagged endogenous variable (AR1) in the set

of explanatory variables $\mathbf{x}_{jt}$ in model (6). The empirically identified time points of structural variation are all between 1997:1 and 1999:1 for both, the stock and bond markets (see Table 2 for details). Note that irrespective of the choice of the return series, these dates correspond rather closely to the advent of the Euro in January 1999.

The inclusion of structural breaks in our basic model (2) has been motivated econometrically in order to account for shifts in the dependent variable. Theoretically, these breaks might be interpreted as the elimination of transaction costs caused by the Euro introduction. As pointed out in section 2, transaction costs are not captured in the theoretical equilibrium model (1). Thus, a reduction of these transaction costs caused by the change in currency regime can be modeled in our empirical equation (2), as a one time structural break.

4.2 Determinants of equity portfolio weights

The break dates detected in Section 4.1 are used to generalize the bivariate empirical model. Taking the potential of cross equation error correlation into account, the empirical specification (2) is estimated simultaneously by means of the "Seemingly Unrelated Regression" methodology (SUR, Zellner 1962). Making allowance of complete interaction between a time shift dummy variable and all right hand side variables in (2) the general model specification, might suffer from its high dimensional parameter space. Therefore, we consider a subset version of the general model where those variables are successively removed from the model that have the smallest $t-$ratio in absolute value. To avoid the imposition of too strong restrictions, the latter iterative specification strategy is terminated, once all parameter estimates remaining in the system are significant at the 10% level.

Empirical results obtained from SUR modeling of stock market portfolio shares are summarized in Table 4 with implementations derived under rational and adaptive expectations indicated as 'Equity 1' and 'Equity 2', respectively.[10] We provide $t-$ratios in paren-

[10]The highly parameterized unrestricted model and the subset specification turned out to obtain qualita-

theses underneath the coefficient estimates. In both specifications, the degree of explanation is about 96 percent and the Durbin-Watson statistic does not indicate the prevalence of serial correlation.

As a starting point, consider first the model specified under the assumption of rational expectations ('Equity 1'). The inclusion of returns and second order moments as explanatory variables of the respective markets into the system, also controls for market turbulences that were present in the sample period. Note that several coefficients of the interaction between the structural break dummy variable and the market measures are highly significant. This is a first evidence that the determinants of the portfolio composition have seen some change between the two identified subsample periods. Furthermore, the intercept dummy for a structural break at the time of the Euro introduction, is negatively significant in the equation explaining the German, and positively significant in the equation explaining intra-EMU investments. This result indicates a decrease in national investments induced by the introduction of the Euro and an increase in intra-EMU investment. Both effects are in line with the predictions of H1. Thus, the results on structural breaks obtained from the pure time series models in Section 3.1, remain robust after controlling for market measures governing investment behavior such as e.g. expected returns, variances and covariances. In sum, these results confirm that shifts in investment behavior are not only the result of market movements, but of a structural nature.[11]

Another important result is that, in absolute value, the decrease in national investment as reflected by the coefficient of the break dummy variable, is well above the respective increase in intra-EMU investments. Thus, all else equal, investments in the US market have also accumulated over the post-break period which, in turn, underpins the case for H2. Overall, the introduction of the Euro has decreased the unconditional level of the in-

tively very similar results. Since the subset model provides a condensed view at the likely significant determinants of portfolio weights we only provide empirical results for this model version. Results from the unrestricted models are available from the authors upon request.

[11] Buch and Lapp (1998) expect a smooth adjustment of financial markets in response to the Euro's introduction. Our findings of considerable structural shifts are more supportive for an abrupt adjustment.

vestment home bias. In the prior stated hypotheses (H1 and H2), the net effect of the Euro introduction on EMU holdings is left unspecified. Since this analysis has shown that intra-EMU investments have, in fact, risen, we conclude that the effect stated in H1 dominates the counter-effect postulated in H2. The latter finding is well in line with Buch and Lapp (1998) and Fratzscher (2002).

Next, the influences of the market measures are examined. The portfolio share of domestically issued equities depends negatively, and the share of intra-EMU equity positively on the expected intra-EMU return. Thus, high expected returns in the EMU result in lower domestic and higher intra-EMU investments. The magnitude of this effect has considerably increased in the post-break period. No significant impact of the German stock market returns on portfolio shares can be diagnosed in 'Equity 1'. US stock market returns contribute significantly to equity composition merely over the post-break period. Higher US returns have a positive impact on the domestic and negative impact on the intra-EMU portfolio share. Although the first marginal effect is at odds with economic intuition, it might be explained by the high factual correlation between German and US returns in the post-break period (see Figure 2a).

The higher the German stock market volatility, the more risky are domestic investments and, consequently, the lower should be the share of domestic and the higher, the share of intra-EMU investments. Both effects can be inferred from the 'Equity 1' system which also points to the conclusion that the marginal response of domestic portfolio shares to domestic risk has increased after 1999:1. In contrast to economic intuition, we find that a high EMU risk is positively, and a high US market risk is negatively related to intra-EMU investments. A possible explanation for this finding might be, that an investors' perception of foreign markets' risk is mainly determined by the US market and, thus, EMU portfolio shares are reduced over periods of higher US market risk. For the subperiod after the break, however, the US risk measure enters the equation with the expected sign.

As potential determinants of portfolio shares, the correlations between market returns play an important role especially since the Euro's introduction. All correlation measures enter both equations highly significant for the second subsample period. From the perspective of a German investor, a high correlation between EMU and national returns decreases diversification benefits for intra-EMU investments. Therefore, an increase in this correlation should result in reduced EMU equity holdings and higher shares of domestic investments. The empirical observation of a risen correlation between German and intra-EMU returns since the introduction of the Euro led to H2. This hypothesis is clearly supported by the observed coefficients of the EMU/GER correlations in the post-Euro period. According to portfolio theory, an increase of the correlation between US and German returns, induces diversification benefits for US investments to decrease. All else being equal, intra-EMU investments become more attractive. Further, a higher correlation between the two foreign investment alternatives (EMU and US) diminishes foreign diversification benefits. According to the respective parameter estimates, a rise in this correlation measure diminishes intra-EMU investments, and increases domestic investments. Since the absolute value of the coefficient in the equation with the national portfolio share is well above the coefficient in the equation with the EMU portfolio share, one can conclude that the share of US investment decreases as well, in response to an increased comovement of foreign markets.

In 'Equity 2' the same model as in 'Equity 1' is estimated except that return expectations are formalized adaptively. Basically, the most important results stated before, also hold for this specification, such that our main conclusions are remarkably robust in this direction. One interesting result is the role of the realized EMU volatility in 'Equity 2'. A higher EMU volatility, boosts national and lessens intra-EMU investments. This effect is even more pronounced in the post-break period, as can be seen by the higher magnitude of the post-break coefficients. Note that the EMU market volatility includes the volatility of exchange rate movements. In the post-Euro period, the latter has shrunken to zero. Therefore, a direct influence of the termination of the exchange rate risk on investment behavior,

can be observed by the coefficients of the EMU volatility.

4.3 Determinants of bond portfolio weights

As already noted in Section 4.1, estimation of system (2) for the bond market suffers from positive serial correlation. Therefore, when estimating the overall model, we include an autoregressive term of order one (AR1) in the bivariate model. Further, for the post-break period, it turns out that the realized variances determined for the German and EMU bond markets were numerically very close (see Figure 2b), not allowing to separate their marginal effects on the portfolio shares by means of the generalized regression model. For the latter reason, we employ only one interaction term of the dummy variable with one realized standard deviation estimate.[12]

Empirical results obtained from the subset models explaining bond holdings, are also given in Table 4, 'Bonds 1' and 'Bonds 2'.[13] As for the models describing equity holdings, 'Bonds 1' is estimated using actual returns while in 'Bonds 2' adaptive returns are applied. The R^2 measures are somewhat higher in comparison with the results obtained for the stock market, which can be addressed to the inclusion of the AR(1) terms.

Most conclusions derived for the stock market, also hold for the results of 'Bonds1'. First, the coefficients of the structural break dummies indicate a reduction in national and an increase in intra-EMU investments. Since the magnitude of the first effect is higher than the second, US investment shares have also seen an increase unconditionally. Therefore, the results for the bond market also provide evidence for both hypotheses stated in this paper.

In the post-Euro period, German investors expand their national portfolio share with an increase in expected national returns and reduce this share when EMU returns increase.

[12] For the equation with the German portfolio share as the dependent variable, the interaction with the German realized standard deviation is included, while for the second equation explaining the EMU share the EMU standard deviation is included.

[13] As for the stock market, results for the full model are available from the authors upon request.

The intra-EMU portfolio share rises with EMU returns. In the pre-break period, a negative relationship between realized market volatility and the respective investment share, could be observed for both markets. The correlation between the EMU and GER market, however, does not enter the system in the post-Euro period significantly. Nevertheless, the two other covariances (between GER & USA and EMU & USA) enter the system with the identical signs as for the stock market, thereby underscoring previous results.

In system 'Bonds2', the amount of market measures that enter the system significantly, is considerably less than for 'Bonds1'. This is also captured in the somewhat lower degree of explanation. A difference occurs concerning the coefficient estimate of the structural break dummy variable: While the variables enter the system significantly with the expected signs, the magnitude of the coefficient indicating an increase in intra-EMU investments, is above the coefficient indicating a reduction in national investments. Thus, the previously identified raise in US investments must be captured by other variables in the model. In the post-break period, high EMU returns over the past five periods cause a reduction of the national portfolio share, while high national returns in the past, go along with a reduction in the intra-EMU portfolio share. A high correlation between German and intra-EMU returns as observed in the post-Euro period, has a significant negative impact on intra-EMU investments.

4.4 Changes in home bias since the introduction of the Euro

By definition, home bias is the difference between the actual and optimal share of international investments. Thus, providing an in depth analysis of the determinants of portfolio shares, the results in the previous section are not directly informative for the impact of the common currency on the home bias issue. For this purpose, one may follow the same modeling steps as before, with replacing the dependent actual portfolio shares by the difference $w_{jt} - w_{jt,opt}(\rho)$, $j = 1,2$, with $w_{jt,opt}(\rho)$ being some optimal portfolio share according to risk aversion, ρ, and expected first and second order return features. The latter measures

remain, however, unobserved, and therefore, actual calculations are based on historical returns and variances. Similarly, the determination of optimal shares requires knowledge or some selection of ρ. The optimal portfolio shares for $\rho = 5$ are illustrated in Figures 2e/f. Summarizing the latter remarks, any choice $w_{jt,opt}(\rho)$ is likely to suffer from approximation error, complicating a direct approach to model home bias. We leave the discussion about the correctly specified theoretical portfolio holdings aside (Lewis 1999) and build upon the former results, obtained from modeling observable portfolio shares. With varying degrees of risk aversion $\rho = 1, 5, 10, 20$ we determine optimal portfolio shares $w_{jt,opt}(\rho)$ and replace the dependent variable w_{jt} in (6) by deviations $h_{jt} = w_{jt} - w_{jt,opt}(\rho)$. For the model, we regard the coefficient of the shift dummy variable in (6) to measure the home bias effect, conditional on impacts of first and second order return features.[14] Estimation results obtained from these exercises are provided in Table 3.

Equity home bias decreased by about 19 percent for risk aversion parameters between 1 and 20. For the bond market, this effect is even more pronounced, indicating a reduction in home bias of around 55 percent. With one exception (bond market, $\rho = 1$) all shift estimates are significant at the 5% level. Apart from its significance, the documented effects are remarkably stable over the alternative degrees of risk aversion presumed to derive optimal portfolio shares.

5 Conclusions

By constructing a new dataset, we can identify the stock and bond portfolio holdings of German investors for national, intra-EMU and rest-of-the-world (US) investments over the period from 1980 until 2003. For these portfolio holdings, we detect structural breaks dated at the advent of the Euro in 1999. For both, the stock and the bond markets, German in-

[14] In this estimation we refrain from including interaction terms of the structural shifts and the market measures due to an over-specification of the model.

vestors have decreased national investments and increased their share in intra-EMU and US investments. These one time structural shifts might be explained by a reduction of transaction costs caused by the Euro introduction.

Furthermore, we observe changes in investment behavior that are in line with the two main effects of the Euro's introduction on the underlying second order market features. The first effect is that exchange rate risk for intra-EMU investments has been overcome, thereby, decreasing the overall risk of intra-EMU investments. This effect is captured by a lower volatility for intra-EMU investments. Second, the higher integration of European financial markets induced by the establishment of the EMU causes a higher correlation between national returns of EMU member states. This effect serves as the rationale behind the higher share of US investments. Both effects result in a reduction of investment home bias. The latter result has been shown by comparing the actual investment holdings with optimal benchmark portfolios.

Regarding potential sources of the investment home bias, the Euro introduction affected the risk-return trade-off for intra-European investments (e.g. by diminishing exchange rate risk), and thus, influenced European investment behavior. These findings are in line with studies claiming the role of exchange rate risk in influencing investment decisions (e.g. Dumas and Solnik 1995 and Michaelides 2003). Structural breaks in the portfolio shares remained significant even after having controlled for all market measures. One explanation is that the integration of the Euro, reduced market imperfections like transaction costs which remain unobserved in the market measures included in our analysis. In a recent theoretical paper, Martin and Rey (2004) has shown that an increase in the market size (e.g. through integration with other intra-European markets) should result in a reduction of home bias. The role of such market imperfections on investment decisions has been underscored by Lewis (1999). Our findings do not support related literature that regards investments decisions as driven mainly by factors like geographic proximity or "familiarity" (e.g. Portes

and Rey 2005, Coval and Moskowitz 1999 and Huberman 2001). Although the latter factors were not influenced by the change in the currency regime, investment behavior has changed markedly. Finally, the findings of this paper, are in line with studies arguing that the EMU changed the landscape of European financial markets toward more integration and intra-EMU portfolio holdings (e.g. Berglund and Aba Al-Khail 2002; Danthine et al. 2000).

Further research is necessary to completely disentangle the influence of currency risk and market imperfections on investment home bias. As a particular avenue of future research, one may follow a systematic comparison of portfolio decisions of representative European intra and extra-EMU investors.

A Unit root tests for portfolio holdings

Since by construction portfolio shares are bounded between zero and unity, we refrain from testing these series by means of common ADF regressions or extensions motivated in Perron (1997). Note that unit root tests have been introduced to discriminate the random walk against some stationary autoregression. These processes, however, are unbounded rendering them as poor approximations to processes of portfolios shares. For the latter reason, we perform unit root tests for the value processes directly and address the issue if, these processes could be classified as trend stationary.

In case both value processes entering a portfolio share are found to be (trend) stationary, once allowing for a structural break, the ratio of these two time series is mean reverting as well if the break dates of both series involved are equal. Unit root test results obtained from common ADF regressions are shown in the upper panels of Table 1. All reported ADF statistics result from test implementations with automatic lag length selection according to the Schwarz criterion (SC). Furthermore, a trend and an intercept term are included in each specification. For the stock market, a unit root is rejected at the 5% level for the value of German domestic investments, and with 10% significance for the total value of all equity holdings. Note that under the alternative hypothesis, these series are trend stationary since the deterministic trend term enters the test regression significantly. Regarding the value of EMU and rest-of-the-world investments, a unit root is rejected when testing the changes of the time series, i.e. their first differences. Thus, these series appear to be integrated of order one. For the bond market, the picture is similar. For both, the values of German and rest-of-the-world investments, the unit root hypothesis cannot be rejected while the values of EMU and total bond holdings are found to be trend stationary. As mentioned, evidence in favor of unit roots is often spurious in the sense that, a shift in the deterministic part of the process invalidates the commonly used critical values of the ADF-test, which are only valid under time homogeneity of deterministic terms. For the latter reason, we now consider unit root test results obtained when allowing a shift in deterministic terms that occur at unknown time (Perron 1997).

The approach we follow allows for exactly one possible break for each series. Model I accounts for a change in the intercept coefficient:[15]

$$y_t = \mu + \theta DU_t + \beta t + \delta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t, \tag{A1}$$

with T_b the time of the break, $DU_t = 1(t > T_b)$ and $D(T_b) = 1(t = T_b + 1)$. Model II accounts for both, a change in the slope as well as in the intercept coefficient and can be written as:

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \delta y_{t-i} + e_t, \tag{A2}$$

[15] For a more detailed discussion of the subsequent three models, refer to Perron (1989).

with $DT_t = 1(1 > T_b)t$. The final specification (Model III) accounts for a change in the slope, but both segments of the trend function are joined:

$$y_t = \mu + \beta t + \gamma DT_t^* + \tilde{y}_t, \tag{A3}$$

$$\tilde{y}_t = \alpha \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t$$

with $DT_t^* = 1(t > T_b)(t - T_b)$.

In all three models, the autoregressive order of the test regression is estimated with a data-dependent method allowing a maximum lag order of $k_{max} = 8$. Results are also shown in Table 1. The break point is chosen as such that, the t-statistic for testing the null hypothesis of a unit root is the smallest among all possible break points (Perron 1997).

In order to decide on the appropriate structural break model for a given time series, we consider the Akaike information criterion (AIC) and SC as shown in Table 1 in the first two lines for each model. Thereafter, the chosen autoregressive order, the detected break date and the unit root test statistic are given.[16] For the stock market, a unit root can be rejected for all value processes with 10% significance once accounting for a structural break. The identified break dates are between 1994:1 and 1997:1. For the German series, Model I (a change in intercept) obtains the smallest value of the AIC and for all other series, Model II (a change in both slope and intercept) is the preferred specification according to the AIC.[17]

For the bond market unit root test results are less clear in comparison with the stock market. According to the model selection criteria, the identified patterns of structural variation are a change in the intercept (Model I) for the total portfolio value, investments in EMU and rest-of-the-world issued assets. A change in both intercept and slope (Model II) is detected for the value of domestically issued assets. Regarding the total value of bond holdings, trend stationarity is diagnosed for the structural break model with 1998:2 found as break date. Similar arguments apply for the value of EMU investment obtaining a potential shift date 2000:1. For the value of domestic investments, the unit root hypothesis, i.e. the random walk with drift, cannot be rejected. The minimum $t-$statistic is obtained for 1994:2 and, thus, corresponds with the political process introducing the common currency. The value invested in the US market is found to be nonstationary. According to the change point model the latter is most likely in 2000:1. For completeness, unit root test results for the processes of realized variances are also provided in last row of Table 1. Apparently all variance processes are found to be stationary.

[16] Note that for specifications with different orders k pre-sample values are adjusted such that the effective sample size used to determine the the AIC and SC is equal over all specifications under comparison.

[17] Regarding the SC the latter outcomes are confirmed with the value process for domestic investments being the only exception.

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Table 1: Unit root tests of portfolio shares

The table reports unit root tests for the value of German national, EMU, rest-of-the-world and total investments for both the stock and the bond market. In the first part ADF-test statistics are reported for a test in levels and first differences. Model (I) to (III) report unit root test statistics allowing for a structural break (see Appendix A for formal representations of the test regressions). *k* is the autoregressive order of the ADF test regression. *, ** and *** indicate significance at the 10%, 5% and 1% significance level.

	Stock market				Bond market			
	Ger	EMU	Rest	Total	Ger	EMU	Rest	Total
	ADF-test for level variables							
AIC	11.84	9.10	9.66	12.37	9.53	8.05	8.07	8.41
SC	12.13	9.57	9.82	12.61	9.74	8.52	8.15	8.69
ADF	-3.53**	3.73	-2.15	-3.41*	-0.79	-3.31*	-2.08	-5.19***
const.	-30.19	4.47	-10.74	-51.84	30.56	-24.22	3.04	103.60
	(-0.80)	(0.34)	(-1.06)	(-1.12)	(1.68)*	(-3.07)***	(0.84)	(5.76)***
trend	8.84	-0.62	1.12	10.12	0.13	2.11	1.04	13.73
	(2.68)***	(-0.88)	(2.07)**	(2.79)***	(0.15)	(3.76)***	(2.07)**	(5.17)***
	ADF-test for differenced variables							
AIC		9.30	9.72		9.50		8.03	
SC		9.63	9.85		9.67		8.16	
ADF		-6.02***	-3.93**		-5.50***		-6.70***	
const.		-19.38	0.09		18.17		5.34	
		(-1.97)*	(0.01)		(2.01)**		(1.36)	
trend		1.25	0.17		-0.51		0.03	
		(3.24)***	(0.53)		(-1.61)		(0.23)	
	Model (I)							
AIC	**11.77**	8.94	9.08	12.21	9.16	**7.45**	**7.81**	**8.40**
SC	12.15	9.40	9.59	12.67	9.62	7.82	8.32	8.78
k	4	6	7	6	6	4	7	4
date	95/2	99/1	98/1	95/2	99/2	00/2	00/1	98/2
t-alpha	-4.78	-3.24	-5.83***	-3.01	-2.10	-6.28***	-3.67	-5.47**
	Model (II)							
AIC	11.77	**8.47**	**8.87**	**12.09**	**9.07**	7.98	7.93	8.53
SC	12.32	8.94	9.42	12.51	9.58	8.39	8.39	8.91
k	7	5	7	4	6	5	4	4
date	91/2	97/1	96/1	94/1	94/2	99/1	93/2	89/2
t-alpha	-4.32	-9.04***	-7.22***	-5.82**	-2.84	-4.75	-4.23	-5.11**
	Model (III)							
AIC	11.80	9.16	9.16	12.45	9.48	8.04	7.87	8.52
SC	12.01	9.36	9.49	12.87	9.82	8.38	8.21	8.73
k	4	4	7	4	7	7	7	4
date	85/1	94/1	94/1	88/1	02/1	00/1	00/1	86/2
t-alpha	-4.49*	-5.15**	-5.04**	-5.11**	-2.31	-3.14	-3.24	-4.88***
	Realized Variances							
ADF	-5.62***	-6.10***	-5.44***		-4.90**	-4.73**	-5.03***	

Table 2: Dates of the structural break tests

This table reports endogenous structural break dates obtained from estimating system (6). In the estimation all parameters, intercept terms and slope coefficients of the model are allowed to exhibit a structural variation. In the first part of this table, actual returns are used to measure expected returns. In the second part of this table, average returns over the past 2.5 years are applied to measure expected returns.

	Stock market		Bond market	
	GER	EMU	GER	EMU
actual returns	1999:1	1998:2	1998:1	1998:2
average past returns	1997:1	1997:1	1998:1	1998:2

Table 3: Change in investment home bias since Euro introduction

In this table coefficients of the structural break dummy variables that have been regressed on the difference between actual and optimal portfolio shares are reported. t-statistics are reported in parentheses. * and ** indicate significance at the 5% and 1% significance level.

I. Stock market

structural break date	Degree of risk aversion (ρ)			
	1	5	10	20
1999:1	-0.197	-0.190	-0.189	-0.188
	(-2.29)**	(-2.32)**	(-2.28)**	(-2.27)**

II. Bond market

structural break date	Degree of risk aversion (ρ)			
	1	5	10	20
1998:1	-0.554	-0.551	-0.550	-0.550
	(-1.51)	(-2.60)**	(-2.75)**	(-2.75)**

Table 4: SUR Estimates for the stock and bond market

The table reports coefficient estimates for system (2) for the stock (Equity 1 and 2) and the bond (Bonds 1 and 2) market. In Equity 1 and Bonds 1 actual returns are included as explanatory variables, while in Equity 2 and Bonds 2 past average returns are used as described in Section 3.2. The dates of the structural breaks are given in Table 2. t-statistics are reported in parentheses. The bottom line of the table gives the degree of explanation and the Durbin-Watson statistic for each equation. * and ** indicate significance at the 5% and 1% significance level.

	Equity 1		**Equity 2**		**Bonds 1**		**Bonds 2**	
	(3) p_GER	(4) p_EMU	(3) p_GER	(4) p_EMU	(3) p_GER	(4) p_EMU	(3) p_GER	(4) p_EMU
const.	1.045 (47.45)**	-0.023 (-3.33)**	0.882 (34.76)**	0.022 (2.64)*	0.143 (3.97)**	0.012 (1.66)	0.16 (4.07)**	0.02 (3.28)**
r_GER	-	-	0.102 (2.13)*	-	-	-	-	-
r_EMU	-0.187 (-4.52)**	0.050 (4.27)**	-	-0.053 (-3.01)**	-	-	0.35 (3.89)**	-0.11 (-2.16)*
r_USA	-	-	0.262 (2.03)*	-0.091 (-2.21)*	-0.125 (-5.05)**	0.036 (2.78)**	-	-
st_GER	-7.331 (-4.70)**	1.828 (3.64)**	-4.887 (-1.70)	1.708 (1.82)	18.944 (4.12)**	-	-	-
st_EMU	-	1.174 (2.36)*	5.838 (1.68)	-2.090 (-1.64)	-	-6.544 (-3.93)**	-	-
st_USA	-	-0.853 (-2.27)*	-	-	-3.758 (-1.84)	1.778 -1.74	2.99 (1.96)	-
co_GER/EMU	-0.113 (-3.55)**	0.039 (4.38)**	-	0.008 (2.11)*	-0.035 (-1.97)	-	-0.09 (-3.29)**	-
co_GER/USA	-	-	-	-	0.056 (3.13)**	-	0.13 (4.76)**	-0.04 (-2.67)**
co_USA/EMU	-	-	-	-	-0.042 (-1.97)	-	-	-
d_t	-4.404 (-2.60)**	0.998 (10.97)**	-0.282 (-3.28)**	0.081 (2.94)**	-0.453 (-6.18)**	0.211 (6.65)**	-0.10 (-1.88)	0.18 (2.42)*
d_t*r_GER	-	-	-1.364 (2.62)*	0.502 (3.00)**	6.573 (2.59)*	-	-	-7.89 (-4.24)**
d_t*r_EMU	-1.562 (-2.35)**	0.377 (7.73)**	-	-	-9.466 (-3.66)**	2.073 (10.11)**	-0.55 (-2.05)*	-
d_t*r_USA	1.937 (3.11)**	-0.482 (-10.53)**	1.355 (2.57)*	-0.415 (-2.47)**	-0.165 (-1.95)	0.125 (2.79)**	-	4.37 (3.07)**
d_t*st_GER	-10.242 (-1.83)	-	-	-	-	-	-	-
d_t*st_EMU	-	-	10.931 (2.12)*	-3.910 (-2.36)*	-	-	-	-
d_t*st_USA	-	2.412 (2.54)*	-12.041 (-2.36)*	4.005 (2.45)*	69.654 (5.77)**	-29.299 (-5.56)**	19.9 (2.02)*	-13.24 (-1.99)
d_t*co_GER/EMU	4.620 (2.32)*	-1.028 (-9.42)**	-	-	-	-	-	-0.14 (-2.13)*
d_t*co_GER/USA	-2.523 (2.43)*	0.530 (9.34)**	-0.987 (-5.64)**	0.316 (5.63)**	-0.199 (-3.33)**	0.120 (3.72)**	-0.14 (-2.38)*	-
d_t*co_USA/EMU	2.977 (2.32)*	-0.628 (-8.98)**	0.918 (4.69)**	-0.283 (-4.52)**	0.217 (3.84)**	-0.126 (-4.25)**	0.10 (1.83)	-
PGER(-1)					0.827 (23.71)**	-	0.78 (18.16)**	-
PEMU(-1)					-	0.855 (26.96)**	-	0.91 (22.22)**
R-squared	95.69%	96.04%	95.39%	95.17%	98.81%	99.11%	96.7%	97.3%
DW	1.69	1.54	2.08	2.10	1.69	1.94	1.99	1.90

Table 5: Definition of variables

Variable	Definition	Source
German holdings of stocks and bonds issued by non-residents	Portfolio investments of German corporations and households in foreign issued stocks and bonds according to the net financial position of Germany (West-Germany before 1990) toward foreign countries. The financial position is mainly based on account notifications.	Deutsche Bundesbank (2004): Statistical Supplement to the Monthly Report 2 - Capital Market Statistics: Security Deposits, decomposition into single countries upon request, various issues.
Total German stock and bond holdings	Wealth of the households and corporations in stocks and bonds. The financial sector is excluded in order to avoid double counting. Assets and bonds are priced at market values.	Deutsche Bundesbank (2004): Special Statistical Publication 4: Financial accounts for Germany, various issues.
Stock market return indices	To construct an MSCI country index, every listed security in the market is identified, and data on its price, outstanding shares, significant owners, free float, and monthly trading volume are collected. The securities are then organized by industry group, and stocks are selected, targeting 60 per cent coverage of market capitalization. Selection criteria include: size, long- and short-term volume, cross-ownership and float. By targeting 60 per cent of each industry group, the MSCI index captures 60 per cent of the total country market capitalization while maintaining the overall risk structure of the market because industry, more than any other single factor, is a key characteristic of a portfolio or a market.	Morgan Stanley Capital (2005)
Bond market return indices	The bonds used in calculating the Tracker index are selected from those in equivalent All-traded index in order of decreasing market value until either: 20 or more bonds have been selected and at least 25 per cent of the group by market value has been included, or more than 50 per cent of the group by market value is included. The Tracker index also includes any bonds representing more than 5 per cent of the market, and any bonds identical in size to the smallest selected. All constituents of the Tracker are such that the resulting index closely tracks the performance of the All traded index.	DataStream (2005).
Stock market and bond market capitalization	The market capitalization of a stock or bond exchange is the total number of issued shares/bonds of domestic companies, including their several classes, multiplied by their respective prices at a given time. This figure reflects the comprehensive value of the market at that time.	World Federation of Exchanges (2005).

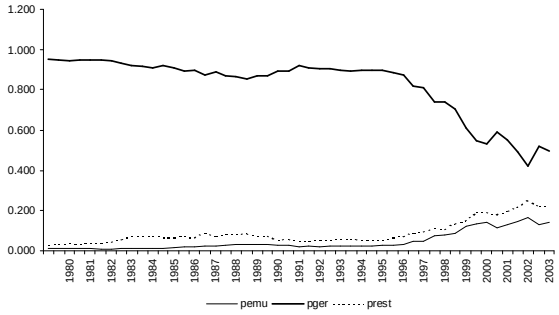

Figure 1a: Portfolio shares of German stock market investments

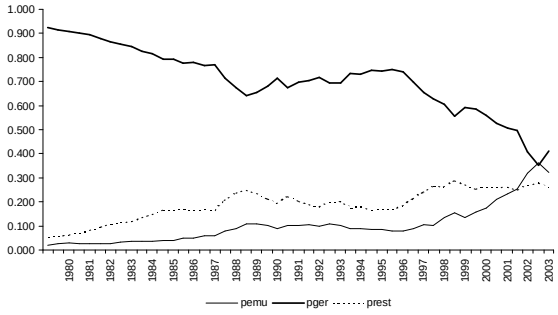

Figure 1b: Portfolio shares of German bond market investments

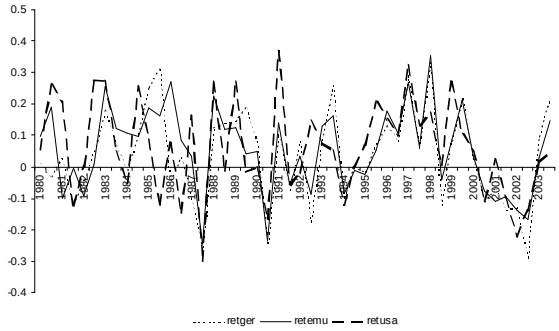

Figure 1c: Returns of the stock market portfolio

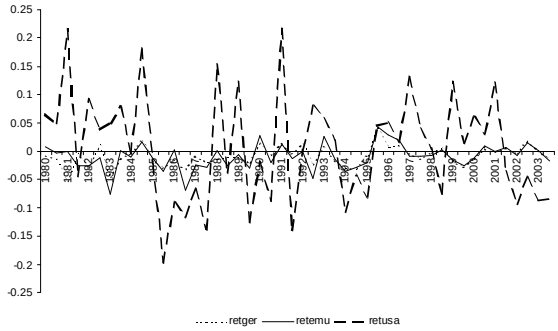

Figure 1d: Returns of the bond market portfolio

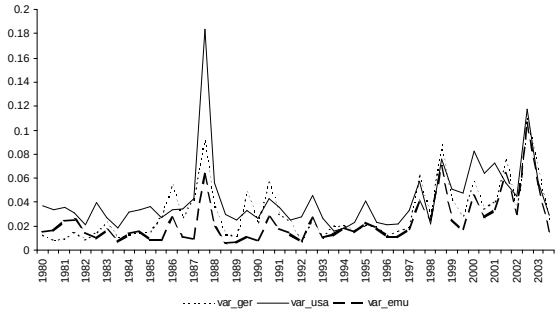

Figure 1e: Variances of the stock market portfolio

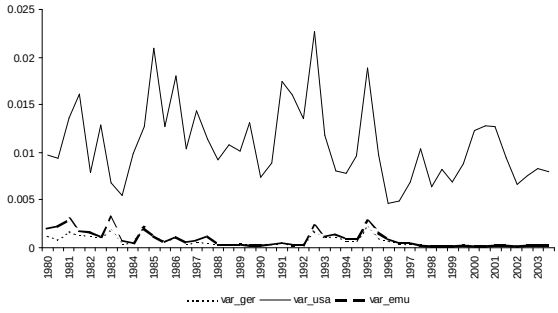

Figure 1f: Variances of the bond market portfolio

Figure 1: Portfolio shares, market returns and variances of German investors

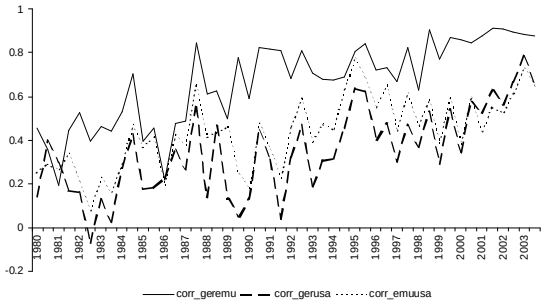

Figure 2a: Correlations between assets on the stock market

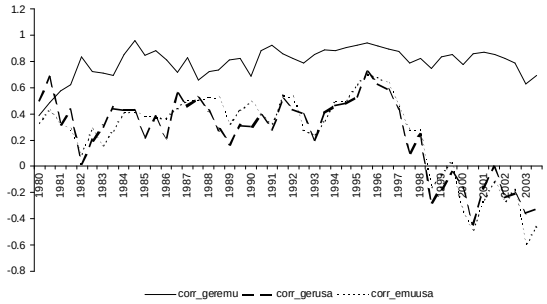

Figure 2b: Correlations between assets on the bond market

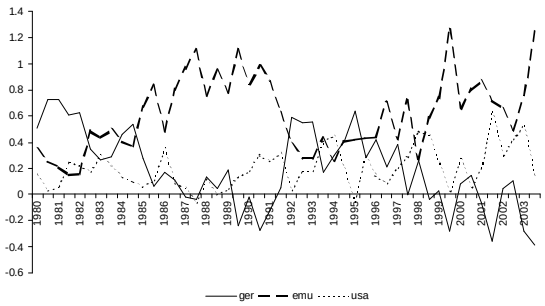

Figure 2c: Shares of the minimum-variance portfolio (stock market)

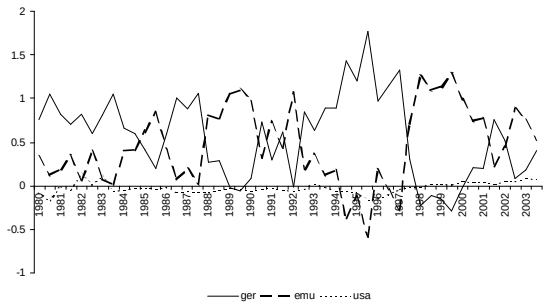

Figure 2d: Shares of the minimum-variance portfolio (bond market)

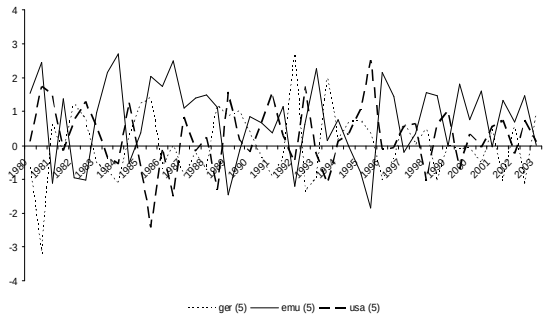

Figure 2e: Optimal portfolio shares for risk aversion of 5 (stock market)

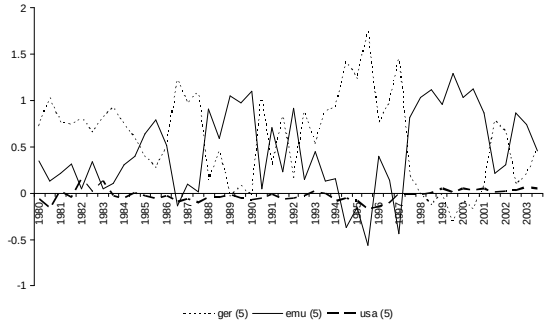

Figure 2f: Optimal portfolio shares for risk aversion of 5 (bond market)

Figure 2: Correlations of asset returns, minimum-variance portfolio shares and theoretical optimal portfolio shares for German investors