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The Introduction of the Euro and its Effects on Investment Decisions

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The Introduction of the Euro and its Effects on Investment Decisions

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ABSTRACT

In this paper we examine changes on investment decisions induced by the introduction of the Euro. There are two potential sources of portfolio reallocation. First, the introduction of the Euro diminished exchange rate risks within the EMU region, which relieved European investors from currency risk associated with intra-EMU investments. Second, monetary policy has been bundled within one single institution, which increased the correlation of different national stock and bond market returns. We test for structural breaks in the portfolio holdings of German investors and estimate a market model in the latter in order to account for the two described effects. We observe a significant decrease in national and an significant increase in intra-EMU as well as US investments. Therefore, the establishment of the EMU led to a decrease of investment home bias.

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

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1. Introduction

International investment behavior is generally characterized by a strong focus on national assets which is typically referred to as the investment home bias (OBSTFELD AND ROGOFF (2000)). Explanations for the strong preference in favor of domestic investments that deviates from theoretical rationale are plentiful, but cannot fully account for the observed preference for national assets (LEWIS (1999)). The launch of a single currency in Europe has a direct impact on some of the factors that were used to explain investment home bias. Cross-border transaction and information cost have been reduced, while currency risk has been completely eliminated for intra-EMU investments (ADJAOUTE AND DANTHINE (2001)). Therefore, the formation of a currency union in Europe constitutes a unique event in order to shed light on the determinants of the investment home bias. There is no consensus on the impact of the EMU on investment behavior in the current literature. While BERGLUND AND ABA AL-KHAIL (2002) and DANTHINE, GIAVAZZI AND VON THADDEN (2000) agree that the EMU changed the landscape of European financial markets toward more integration and intra-EMU portfolio holdings, AMADI (2004) finds no significant impact of monetary unions on investment behavior.

The aim of this paper is to empirically evaluate the implications of the introduction of the Euro for investment behavior of German investors which are seen as representative for other intra EMU portfolio holders. For this purpose we firstly construct a new data set including the stock and bond holdings of German investors from 1980 until 2003. These portfolio holdings can be classified into national, intra-EMU and rest-of-the-world investments. In the second place we rely on time series analysis to infer on structural shifts characterizing the latter value processes. 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 structural break just before the advent of the Euro in 1999. From the perspective of a German investor, we identify two separate effects on portfolio allocation triggered by the EMU. First, exchange rate risk for intra-EMU investments vanished, thereby increasing intra-EMU investments. Second, as a consequence of the currency union, European financial markets and business cycles have become more integrated, leading to a higher correlation of intra-EMU returns. This second effect increases the share of international investment allocated in countries that are not part of the EMU. Both effects result in a reduction of the national investment share and therefore reduce the investment home bias.

The remainder of this paper is organized as follows: Section 2 reviews the related literature and presents our hypotheses. In Section 3 we sketch briefly the theoretical foundations of investment behavior along with its determinants. Section 4 provides the data and some descriptive statistics, and outlines the concept of 'realized volatility' that we employ to measure second order features of the data. Moreover, the econometric methodology used for the empirical analysis is given in some detail. Empirical results are discussed in Section 5, and concluding remarks are made in Section 6.

2. Portfolio composition and the Euro introduction

The well-known Capital Asset Pricing Model (CAPM) founded on the original work of SHARPE (1964), LINTNER (1965) and MOSSIN (1966) suggests an optimal risk return trade-off for investments through a diversification into all risky assets of a market. The international version of this theory, the ICAPM derived by SOLNIK (1974), formalizes that the share of wealth invested in the domestic market should be equal to the country's share of world capitalization. Such an investment strategy yields the most efficient risk adjusted return which is the rationale behind cross-border investments. As observed by TESAR AND WERNER (1995), however, these theoretical implications do not match empirical evidence. According to empirical evidence investors hold a much larger proportion of domestically issued assets in their portfolio as implied by the ICAPM.[1] This mismatch between theory and factual evidence is generally referred to as the home equity bias puzzle in the literature. When also considering the need for hedging nontraded human capital, the diversifica-

[1]E.g. the MSCI World index assigns Germany a weight of 3,18% (Morgan Stanley Capital 2002). In fact, German investors hold about 60% of domestically issued stocks in their portfolios (DEUTSCHE BUNDESBANK (2001)).

tion puzzle is even deepened (BAXTER AND JERMANN (1997)). ROWLAND AND TESAR (2004) find that the extent of the home bias is generally larger in bond portfolios in comparison with equity portfolios.[2]

2.1. Explaining the investment home bias

In the past decade, a great strand of both theoretical and empirical literature has addressed the issue to explain the investment home bias. Mainly two avenues of economic reasoning have been followed: The first is to explain the puzzle on the basis of transaction costs whereas the second approach focuses on hedging-needs that go back to currency risk characterizing flexible exchange rate systems.

Non tariff burdens for international transactions and higher information costs due to distance are likely to play a role in international investment behavior. TESAR AND WERNER (1995) conclude that transaction costs are not the sole reason for the investment bias. They examine the transaction rate of foreign compared to domestic investments. One of their findings is that foreign investments show a higher transaction rate than domestic ones. This suggests that investors frequently adjust the composition and size of their portfolios, even though much of this activity has little impact on net foreign investment positions (TESAR AND WERNER (1995)). Further, not only buying a stock at a foreign exchange, but also gathering information about foreign legislation is not only more costly but also more complicated in comparison with the same action in domestic markets. Various empirical studies underline the role of information asymmetries when explaining the home bias puzzle. AHEARNE, GRIEVER AND WARNOCK (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. Both transaction and information costs involved with cross-border investments should have been considerably reduced by the fast liberalization (BEKAERT, HARVEY AND LUMSDAINE (2002)) and integration (ALBU-

[2]For a broad review of the home bias puzzle the reader may consult LEWIS (1999).

QUERQUE, LOAYZA AND SERVEN (2005)) of financial markets that took place over the last decades. 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.

The second vein to solve the home bias puzzle relates to flexible exchange rates. Since the return of foreign investments is directly linked to exchange rate movements, the exchange rate is not only an important determinant for portfolio composition and rebalancing (HAU AND REY (2004), GOURINCHAS AND REY (2005)), but it can also explain the home bias. One way is to account for deviations from purchasing power parity (PPP). In case PPP holds, expected differences in international returns would cancel out differences in international inflation rates or exchange rate movements. If the latter relationship is violated, the return on an international investment can differ for two countries owing to different domestic inflation rates and/or exchange rate movements. This effect creates a demand for securities that hedge domestic inflation and/or exchange rate risk (LEWIS (1999)). Such a hedge differs across economies and therefore implies country specific asset demands. In such a framework exchange rate risk is an important factor in explaining returns on investment. DUMAS AND SOLNIK (1995) conclude that foreign exchange risk premia are a significant component of securities' rates of return in international financial markets. MICHAELIDES (2003) shows that exchange rate risk makes foreign investments less appealing to risk averse investors.

Since both approaches mentioned before cannot explain the investment home bias completely, HUBERMAN (2001) argues that its occurrence might reflect a deviation from the postulate of rational behavior of agents. Instead of striving for the highest utility via international diversification agents have a desire ”to invest in the familiar”. It follows that investors tend to hold assets that are most visible to them rather than making their investment decisions in accordance to any asset allocation model. In this case, home bias is induced by irrationalities like ”familiarity” of an asset rather than economic factors like currency risk.

2.2. The home bias puzzle and the introduction of the Euro

The foregoing discussion has important implications for the potential influences of the Euro's introduction on investment behavior. If the home bias is based on irrationalities, the change in the currency regime within Europe is hardly of any influence on net foreign investment positions of European investors. If, however, exchange rate flexibility plays a key role in disentangling the home bias puzzle, the introduction of the Euro should have a measurable effect on the portfolio composition of European investors. With the new currency regime in Europe, exchange rate risk of intra-EMU investments vanished completely. Exchange rate variation provides an additional source of risk for cross-border holdings, as long as there are floating or not-unequivocally fixed exchange rates. This extra risk is not necessarily priced in the investment itself. Since agents are risk averse, exchange rate risk leads to a decrease in cross-border holdings. Consequently, once exchange rate risk drops to zero, intra-EMU investments should, all else equal, become more attractive. 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 through the establishment of the EMU results 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 and financial market integration increased considerably (see FRATZSCHER (2002)). The implementation of the currency union with the ECB's responsibility for the monetary policy of the entire EMU area resulted in a convergence of macroeconomic policies that, in turn, led to a convergence of national interest rates (BUCH AND LAPP (1998)). This sparks higher co-movements of national bond market returns observed over the set of EMU members. The same trend also occurred in the equity markets, since business cycles become more synchronized over economies that share the same monetary policy. Correlation of stock returns is further boosted by the rising integration of European equity markets. Both effects reduce diversification benefits of intra-EMU investments. 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 synchronization of European markets (financial market integration, comovement of business cycles, 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 enforced by the reduction of currency risk. Hypothesis 2 implies a switch from intra-EMU investment to rest-of-the-world investments provoked by higher correlation between national and EMU returns. 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 thus, the investment home bias.

3. Optimal portfolio shares

This section firstly presents a theoretical model to determine the optimal portfolio share of a representative investor.[3] Secondly, we provide the econometric specification used to investigate if the implications of the hypotheses H1 and H2 are supported empirically. The basic model of portfolio selection under continuous trading and perfect market conditions was developed by MERTON (1969), (1971), (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

[3] For a detailed formal derivation of the presented results the reader is referred to MERTON (1971) and BODIE, KANE AND MCDONALD (1985).

shares for a set of n risky assets comprising a market is obtained as

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

In (1) the vector w^* collects the optimal proportions of wealth invested in the risky assets, and, accordingly μ is short for the $n-$dimensional vector of expected returns of the risky assets. The expected return of the so-called minimum-variance portfolio (MVP) is denoted as μ_{min} whereas the vector of portfolio weights of the n assets in the MVP is denoted by w_{min}[4] and ρ is Pratt's measure of relative risk aversion (PRATT (1964)). The $n \times n$ covariance matrix Ω collects along its diagonal variances, σ_i^2, and the off-diagonal covariances, $\sigma_{i,j}$. It is worthwhile to point out that, by assumption, all first and second order properties of asset returns, and, thus the composition of the minimum variance portfolio, are time invariant by assumption.

The model in (1) gives several insights into asset demand. The optimal proportion of an asset in a portfolio can be split into two components (BODIE ET AL. (1985)). First, into a speculative demand, which depends inversely on the degree of risk aversion and positively on the risk premium. Second, into a hedging demand, which is the weight of an asset in the MVP. Another important conclusion from equation (1) is that the optimal portfolio share of an asset is independent of the agent's time preference, but depends on the mean and variability of a risky asset, as well as on the investors' rate of risk aversion.

Owing to intrinsic nonlinearity 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 subjected to criticism. It is, however, not the purpose of this paper to test the validity of the equilibrium model (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 the one hand as well as first and second order properties of asset returns on the other hand. By the nature of optimization in a

[4]The minimum variance portfolio minimizes the portfolio variance subject to the constraint that the portfolio weights sum to unity. See Section 4.4 for further details.

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 time invariant by assumption 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 (excluding Germany) 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:

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

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.

4. Data

Before the empirical model given in the previous section can be estimated the appropriate data has to be collected. In this section we will firstly describe the measures of equity and bond holdings. In a second step, the construction of market returns and respective second-order moments is considered. Finally, stationarity of the portfolio holdings is investigated where we account for possible structural shifts in the underlying data.

4.1. Measuring bond and equity holdings of investors

Measuring the share of assets held by German investors issued domestically, in the EMU (excluding Germany) or in the rest-of-the-world is difficult, since households do not report their portfolio composition. 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)).[5] WARNOCK AND CLEAVER (2003), however, demonstrate potential pitfalls of flow statistics substituting portfolio holdings. 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 the shares of portfolio allocation. Owing to the difficulty of obtaining 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.

[5] The studies by AHEARNE ET AL. (2004) and CHAN, COVRIG AND NG (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 only cover the years 1999 and 2000. Therefore, this data set is of limited scope when discussing potential changes of investment behavior going back to the advent of the Euro in 1999. Both studies concentrate on equity holdings leaving bond holdings aside.

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 makes up for more than two-third of all German investments out of the EMU in 2003 (Morgan Stanley Capital 2004). The portfolio shares are calculated with German holdings of foreign and EMU assets taken from the security deposit statistics (DEUTSCHE BUNDESBANK (2004B)). The total value of German stock and bond holdings are determined by means of the financial accounts for Germany (DEUTSCHE BUNDESBANK (2004A)). 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.[6] Since the portfolio shares are a ratio, stock market valuation effects affect both the numerator and denominator in the same way and thus cancel out each other. This ensures that the further analysis is not driven by the high volatilities in the stock markets caused by the so called ”new economy hype”. By building our analysis on holding instead of flow statistics, our results are not blurred by the problem of attributing the correct destination country of investments that is involved when using flow data. All time series are available at the bi-annual frequency from 1980:1 until 2003:2. Figures 1a and 1b display the resulting portfolio shares for stock and bond markets, respectively.

Figure 1a and Figure 1b visualize the existence of a home bias 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 the bond market. The latter trend has sharply accelerated in the mid 1990s. If this acceleration has been caused by the introduction of the Euro or other influences on investment behavior will be analyzed subsequently.

[6] A detailed description of data sources and the construction of the portfolio holdings is provided in Table IV in the Appendix.

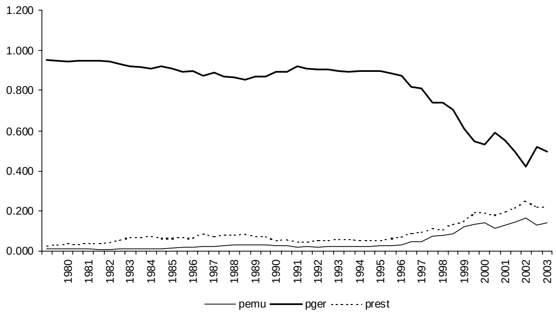

Figure 1a: Portfolio shares of German stock market investments

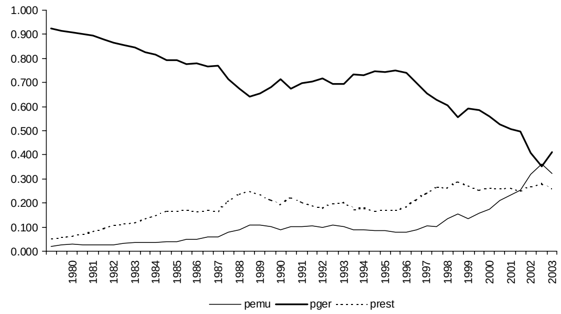

Figure 1b: Portfolio shares of German bond market investments

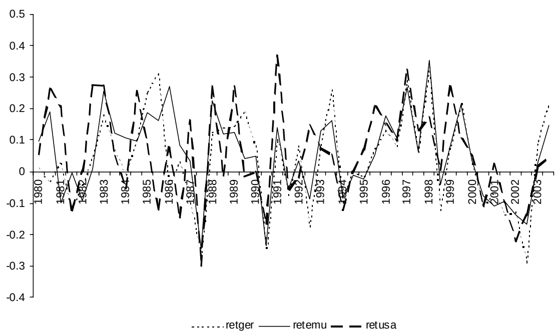

Figure 1c: Returns of the stock market portfolio

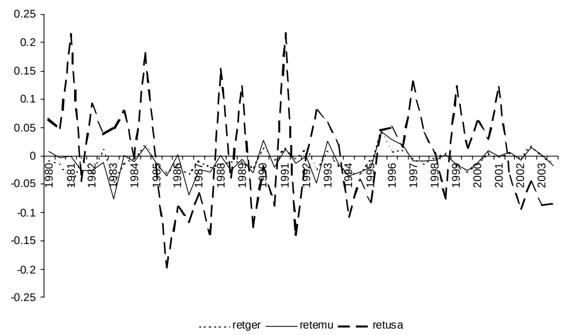

Figure 1d: Returns of the bond market portfolio

Figure 1. Portfolio shares of German investors and market returns for the stock and bond market

4.2. Return determination

According to the ICAPM, investment decisions depend on a risk-return trade-off. 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.[7] For the bond market we use ”Tracker indices” provided by DataStream.

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

Figures 1c and 1d show the return series (measured in German currency) of the three different portfolios for the stock and the bond market, respectively. The graphs show 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.

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, in addition, 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.

4.3. Measuring second order moments

Volatility clustering characterizes processes of speculative prices at various frequencies including the bi-annual as displayed in Figure 1c and Figure 1d. 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, ENGLE AND NELSON (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, BOLLERSLEV, DIEBOLD AND LABYS (2001), (2003) , BARNDORFF-NIELSEN AND SHEPHARD (2002A), (2002B)). For a detailed review over the field the reader may consult ANDERSEN, BOLLERSLEV AND DIEBOLD (2005). 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.

Early attempts to estimate lower frequency variances by summing up the squares of uncorrelated higher frequency returns are e.g. SCHWERT (1989) constructing monthly (stock) variance estimates and SCHWERT (1990) estimating daily variances from intraday price variations. With the recent contributions mentioned before a sound statistical theory on 'realized volatility' is now available. 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, BOLLERSLEV, DIEBOLD AND WU (2004)).

In the light of the novelty of 'realized volatility' we mention briefly the main theoretical results. It is assumed that in continuous time the log price process of a speculative asset $(p(\tau), \tau \geq 0)$ is a special semimartingale (BACK (1991)) and may be given as the solution of a stochastic differential equation (SDE)

$$dp(\tau) = \mu(\tau)d\tau + s(\tau)dW(\tau), \tag{3}$$

where $\mu(\tau)$ is a possibly time varying drift term. The spot volatility process $(s(\tau), \tau \geq 0)$ is strictly stationary by assumption, locally square integrable and independent of the standard Brownian motion $W(\tau)$. Note that the latter assumptions are met e.g. by the prominent GARCH diffusion model (NELSON (1990)). In case with constant drift and variance the SDE in (3) collapses to the model introduced by MERTON (1973).

Discrete compounded returns measured over a sequence of intervals of length δ (half a year, say) are obtained as

$$r_t = p(t\delta) - p((t-1)\delta),\ t = 1, 2, \ldots \tag{4}$$

From the specification in (3) it is apparent that the latter will exhibit a mixed normal distribution, i.e

$$r_t|\sigma_t^2 \sim N(0, \sigma_t^2),\ \sigma_t^2 = \sigma^2(t\delta) - \sigma^2((t-1)\delta),\ \sigma^2(\tau) = \int_0^\tau s^2(u)du, \tag{5}$$

where σ_t^2 is often referred to as the actual variance (BARNDORFF-NIELSEN AND SHEPHARD (2002B)). Building upon the theory of quadratic variation (PROTTER (1990)) realized volatility estimates of σ_t^2 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.

$$\hat{\sigma}_t^2 = \sum_{m=1}^{M} r_{m,t}^2, \tag{6}$$

with

$$r_{m,t} = p\left((t-1)\delta + \frac{m\delta}{M}\right) - p\left((t-1)\delta + \frac{(m-1)\delta}{M}\right),\ m = 1, \ldots, M. \tag{7}$$

Consistency of the realized volatility estimator in (6) 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 throughout derived 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. Owing to the property that asymptotic results for realized volatility are derived for the intraperiod frequency shrinking to zero it is clear that the underlying volatility diffusion in (3) may undergo some structural variations at lower frequencies, the weekly or monthly say. Note that the prevalence of such structural changes is rather likely when analyzing longitudinal data and might adversely effect the performance of parametric (multivariate) volatility models.

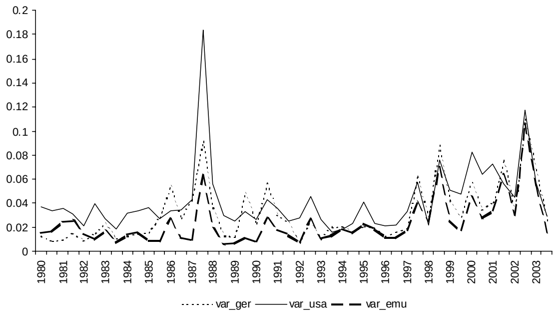

Figure 2a: Variances of the stock market portfolio

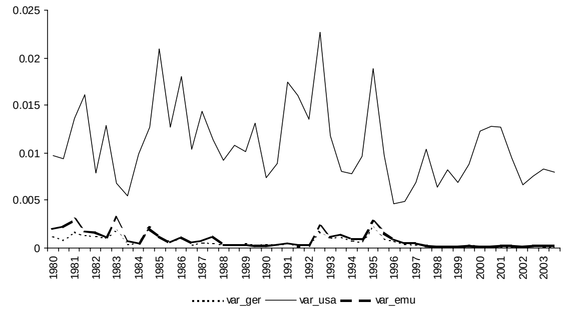

Figure 2b: Variances of the bond market portfolio

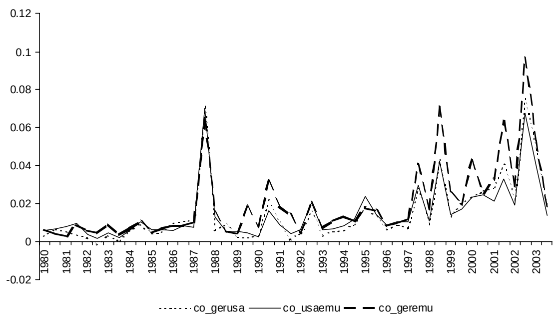

Figure 2c: Covariances of the stock market portfolio

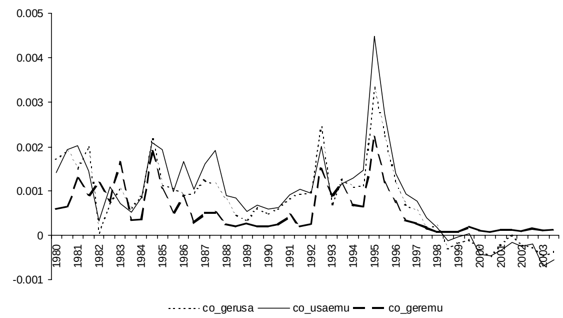

Figure 2d: Covariances of the bond market portfolio

Figure 2. Variances and covariances for the stock and bond market

Realized variance estimates for German, EMU and US stock and bond markets are displayed in Figure 2a and Figure 2b, respectively. 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. For completeness, realized covariances are presented in Figure 2c and Figure 2d for the stock and bond market, respectively.

4.4. Realized correlations and the realized minimum variance portfolio shares

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. Realized correlations as implied

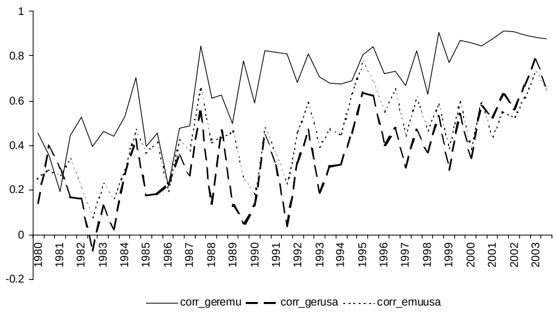

Figure 3a: Correlations between assets on the stock market

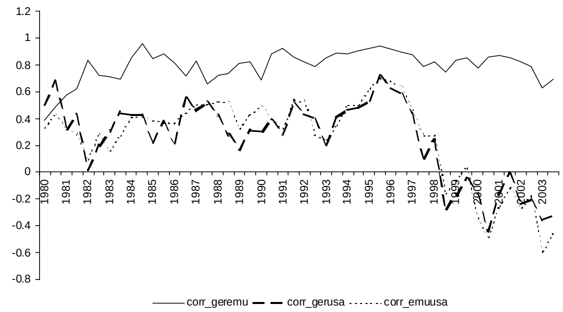

Figure 3b: Correlations between assets on the bond market

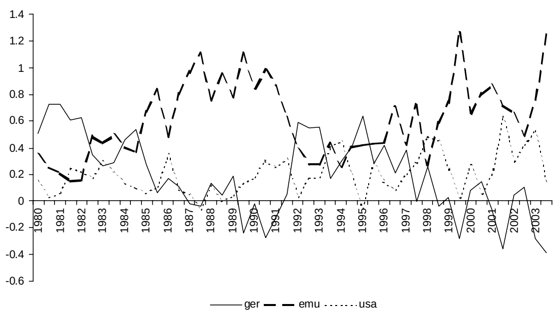

Figure 3c: Shares of the minimum-variance portfolio (stock market)

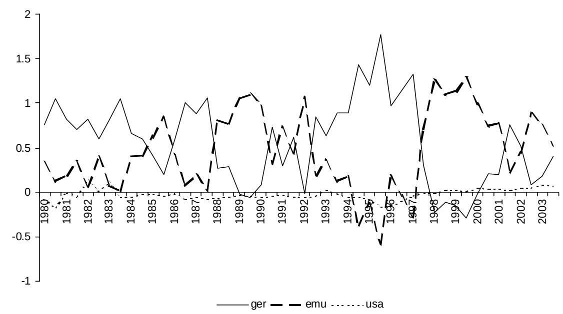

Figure 3d: Shares of the minimum-variance portfolio (bond market)

Figure 3. Correlations of asset returns and minimum-variance portfolio shares for the stock and bond market

by the covariance estimates provided above are displayed in Figure 3a for the stock and Figure 3b for the bond market. 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.

Having obtained the elements of the time varying variance-covariance matrices in the previous section, the dynamic hedging needs as implied by the MVP shares for the stock and bond market can easily be obtained. Following HUANG AND LITZENBERGER (1988) the composition of the MVP is the solution to the quadratic minimization problem:

$$\min_{w_{min,t}} \quad w_{min,t}^{'} \Omega_t w_{min,t}, \quad \text{subject to} \quad \mathbf{1}^{'} w_{min,t} = 1, \tag{8}$$

where, in our case, $w_{min,t}$ is the trivariate vector of portfolio weights at time t and **1** is a vector of ones. The solution for the optimum MVP shares is the following:

$$w_{min,t}^{*} = \frac{1}{C}\Omega_t^{-1}\mathbf{1}, \text{ with } C = \mathbf{1}^{'}\Omega_t^{-1}\mathbf{1}. \tag{9}$$

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. The MVP shares are displayed in Figure 3c and Figure 3d for the stock and the bond markets, respectively. For both markets, the US share in the MVP is remarkably stable over time. The proportion of German assets has clearly fallen in the second part of the nineties, while the EMU share has increased. According to the previously presented theoretical model, this should have a direct impact on the actual portfolio holdings of German investors. Theoretically, the demand for a risky asset is driven by a speculative and a hedge demand, while the MVP shares constitute the hedging demand. Any increase in the MVP share of an asset should have a proportional increase in the actual share of the asset in the portfolio. Note that for the previous estimation, the MVP shares were not restricted to take a positive value due to the possibilities of short sales. In practice, however, banks only pursue short sales for customers with a good credit record and generally also require a deposit for doing so. These kinds of restrictions on short sales account for a difference in the observed amount and theoretically desirable amount of short sales. For the latter reasons the dynamic features of correlations and MVP shares informally hint at the viability of hypotheses 2 (H2).

4.5. Level shifts in the portfolio values

Observing the graphs of the portfolio shares (Figures 1a & 1b) a change in their levels over the considered sample period can be diagnosed from 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. Pointing to a stronger prevalence of the investment home bias for fixed income investments a similar but less extreme pattern is also visible for bond markets.

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. 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 unit root 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 (e.g. ROULET, ADJAOUTE, SABBATINI AND BARBAUD (1999)). From theoretical considerations investors should change their investment behavior as soon as they anticipate with certainty the introduction of the Euro or the fixed parities formalized by the common currency. 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. Secondly, 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 the hypotheses H1 and H2.

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 I. 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 in Germany. 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) is referred to as the ”innovational outlier model” and accounts for a change in the intercept coefficient. Model (II) allows for both, a change in the slope as well as in the intercept

Table I
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***	

coefficient and Model (III), the so-called "additive outlier model", allows for a change in the slope only. Formal representations of these models are given in Appendix A. 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 I. The break point is chosen such that the t-statistic for testing the null hypothesis of a unit root is the smallest among all possible break points (PERRON (1997)). Alternatively, a second method is applied determining the break date via maximizing the absolute value of the t-statistic of the dummy coefficient in Model (I) and of the slope coefficient in Model (II) and (III). From this procedure very similar results are obtained which we do not provide for space considerations.

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 I 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.[8] 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, and, thus in accordance with a time period during which the fixed parities of the currencies entering the Euro became known with certainty. 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. Regarding the SC the latter outcomes are confirmed with the value process for domestic investments being the only exception.

For the bond market unit root test results are less clear in comparison with stock market portfolio holdings. 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

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

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 and, owing to the significance of the deterministic trend coefficient one may also infer a quadratic trend in the level data. The latter, however, is rather unlikely and significance of the deterministic trend might be better explained as an artifact of ignoring potential changes in the process' deterministic components. According to the change point model the latter is most likely in 2000:1.

It is worthwhile to point out that for almost all considered investment value processes particular test regressions allowing for a structural shift (models (I) to (III)) yield smaller values of the AIC or SC as the time invariant test regression. For both the values of national and rest-of-the-world bond holdings a unit root cannot be rejected when accounting for a structural break.

For completeness, unit root test results for the processes of realized variances are also provided in last row of Table I. Apparently all variance processes are found to be stationary.

5. Determinants of portfolio shares - empirical results

In this section we will provide and discuss the estimation results obtained from system (2) for the stock and the bond market. Before presenting these findings, structural breaks of the overall system will be determined.

5.1. Break point detection

The previous section 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 also an empirical implementation of the model in (2) will likely have 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, however, one may also 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:

$$w_{jt} = \mathbf{x}'_{jt}\theta_j + (d_t\mathbf{x}_{jt})'\tilde{\theta}_j + u_{jt},\ d_t = \begin{cases} 0 & 1 \leq t < T_j^* \\ 1 & T_j^* \leq t \leq T, \end{cases} \quad j = 1,2. \tag{10}$$

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 $\text{RSS}_j = \sum_{t=1}^{T} \hat{u}_{jt}^2(T_j^*)$ is minimized. Note that along these lines 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

Table II
Dates of the structural break tests

	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

II. 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 (AR(1)) in the set of explanatory variables $\mathbf{x}_{jt}$ in model (10). The empirically identified time points of structural variation are all between 1997:1 and 1999:1 for both the stock and the bond market. Note that irrespective of the choice of the returns series these dates correspond rather close to the advent of the Euro in January 1999.

5.2. Determinants of equity portfolio weights

After its determination the break date is 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 III with implementations derived under rational and adaptive expectations indicated as 'Equity 1' and 'Equity 2', respectively.[9] We provide $t-$ratios in parentheses 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/covariance matrix as independent variables of the respective markets into the system also control 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 hypothesis 1 (H1). Thus, the results on structural breaks obtained from the pure time series models in Section 4.5 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. The findings in BUCH AND LAPP (1998) point to the expectation of a smooth adjustment of financial markets in response to the Euro's introduction. The fact that we find structural shifts of a considerable magnitude close to the introduction of the Euro is more supportive for an abrupt adjustment.

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

[9]The highly parameterized unrestricted model and the subset specification turned out to obtain qualitatively 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.

also accumulated over the post break period which, in turn, underpins the case for hypothesis 2 (H2). Overall, the introduction of the Euro has decreased the unconditional level of the investment 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 countereffect postulated in H2. The latter finding is well in line with BUCH AND LAPP (1998) and FRATZSCHER (2002).

Next, the influence of the other market measures is examined. From the perspective of German investors 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 results in lower domestic and higher intra-EMU investments. The magnitude of this effect has considerably increased in the post-break period as can be seen from the coefficient estimates of the interaction between the expected EMU return and the break dummy variable. Note that the absolute value of these post break coefficients is about eight times higher compared to the pre-break coefficients. A significant impact of the German stock market returns on portfolio shares cannot be diagnosed in the system '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 2c).

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

Table III
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 4.2. The dates of the structural breaks are given in Table II. 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 DW	95.69% 1.69	96.04% 1.54	95.39% 2.08	95.17% 2.10	98.81% 1.69	99.11% 1.94	96.7% 1.99	97.3% 1.90

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 the second hypothesis stated in this paper. 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 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 of 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 is the sum of the volatility of national returns and the volatility of exchange rate movements. Since the Euro introduction, 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.

While most of the previously shown results are well in line with prior intuition, there were also some coefficients at odds with portfolio theory. Two possible explanations might account for this outcome. First, most market measures available as explanatory variables are highly correlated with each other. Second, the number of observations included is relatively low for the high amount of parameters resulting in low degrees of freedom. Both effects are especially pronounced for the post-Euro period.

5.3. Determinants of bond portfolio weights

As already noted in Section 5.1, estimation of system (2) for the bond market suffers from positive serial correlation. Therefore, also when estimating the overall model we include an autoregressive term of order one (AR(1)) in the bivariate model. Further, for the post break point part of the sample 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.[10]

Empirical results obtained from the subset models explaining bond holdings are also given in Table III, 'Bonds 1' and 'Bonds 2'.[11] 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

[10] 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.

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

increase in intra-EMU investments. Since the magnitude of the first effect is higher than the second, also US investment shares have seen an increase unconditionally. Therefore, also the results for the bond market 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. 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 does, however, 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 considerable less than for 'Bonds1'. This is also captured in the somewhat lower degree of explanation. One 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 of between German and intra-EMU returns, as observed in the post-Euro period has a significant negative impact on intra-EMU investments.

6. 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 investors have decreased national investments and increased their share in intra-EMU and US investments. These changes in investment behavior 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 could serve as an explanation of the observed increase in EMU investments. Second, the higher integration of European business cycles induced by the establishment of the EMU causes a higher correlation between national returns of EMU member states. This effect serves as a rationale behind the higher share of US investments. The obtained results remain robust after controlling for first and second order moments of asset returns. Therefore, the change in the currency regime had an effect on investment behavior that goes beyond the influence of the observed market measures. As a possible explanation one could think of effects that come along with the higher integration of EMU financial markets like reduced information and transaction costs for cross-border investments.

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 removed market imperfections which remain unobserved in the market measures included in our analysis. The role of such market imperfections on investment decisions has been underscored by LEWIS (1999). The results of our analysis are at odds with related literature that regards investments decisions as driven 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, our observation of a substantial change in investment behavior is in contrast to studies arguing that currency unions have, if any, only minor impacts influence investment decisions (e.g. AMADI (2004) and BUCH AND LAPP (1998)).

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.

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A. Unit root tests with structural breaks

This Appendix briefly illustrates the three different models used for the unit root tests in paragraph 4.5.[12] Model (I), the ”innovational outlier model”, accounts for a change in the intercept coefficient:

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

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:

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

with $DT_t = 1(1 > T_b)t$. The final specification (Model 3) accounts for a change in the slope, but both segments of the trend function are joined. This model is named as the ”additive outlier model”:

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

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

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

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

Table IV
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 Deopsits, 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).