Time-Varying Integration, Interdependence and Contagion

Lieven Baele
Tilburg University, CentER, and Netspar

Department of Finance
PO Box 90153
NL 5000 LE Tilburg
The Netherlands
Telephone: +31 13 466 3257
Fax: +31 13 466 2875
E-mail: Lieven.Baele@uvt.nl

Koen Inghelbrecht
Ghent University

Department of Finance
W. Wilsonplein 5D
B-9000 Gent, Belgium
Telephone: +32 9 264 89 78
Fax: +32 9 264 89 95
E-mail: Koen.Inghelbrecht@UGent.be

This Version: September 2006

Time-Varying Integration, Interdependence and Contagion

Abstract

Bekaert, Harvey, and Ng (2005a) define contagion as “correlation over and above what one would expect from economic fundamentals”. Based on a two-factor asset pricing specification to model fundamentally-driven linkages between markets, they define contagion as correlation among the model residuals, and develop a corresponding test procedure. In this paper, we investigate to what extent conclusions from this contagion test depend upon the specification of the time-varying factor exposures. We develop a two-factor model with global and regional market shocks as factors. We make the global and regional market exposures conditional upon both a latent regime variable and two structural instruments, and find that, for a set of 14 European countries, this model outperforms more restricted versions. The structurally-driven increase in global (regional) market exposures and correlations suggest that market integration has increased substantially over the last three decades. Using our optimal model, we do not find evidence that further integration has come at the cost of contagion. We do find evidence for contagion, however, when more restricted versions of the factor specifications are used. We conclude that the specification of the global and regional market exposures is an important issue in any test for contagion.

JEL Classification: G15, G12, F30, F32, F35

Keywords: Contagion, Financial integration, Volatility spillover models, Time-varying correlations, Regime-switching models.

1 Introduction

To what extent have globalization and regional market integration made equity markets both in the developed and developing world more vulnerable to contagion? Ever since the series of financial crises at the end of the 1990s, this question has received a lot of attention, not only by academics, but also by policy makers and in the popular press. Despite the considerable amount of papers published on the topic[1], no consensus has been reached yet on the true existence of contagion.

The disagreement on whether contagion is observed or not stems to a large extent from the lack of agreement on a definition of contagion, and hence also on an appropriate testing technique. In this paper, we follow the so-called 'restrictive' definition of contagion which defines contagion as "a significant increase in cross-market linkages after a shock to one country (or group of countries)". As pointed out by Boyer et al. (1999) and Forbes and Rigobon (2002), one cannot test for this type of contagion by directly comparing correlations between tranquil and crisis periods, as one would expect correlations to increase during highly volatile crisis periods even under the null of no contagion. After correcting for this so-called conditioning bias, Forbes and Rigobon (2002) no longer find evidence for contagion during three important turmoil periods (the 1987 crash, the Mexican crisis, and the East-Asian crisis).

More recently, Bekaert, Harvey, and Ng (2005a) (BHN, henceforth) proposed an alternative contagion test. They define contagion as excess correlations, i.e. correlation over and above what one would expect from economic fundamentals. The natural interdependence between markets is modeled by means of a multifactor model. In this setting, equity markets are correlated because they are jointly exposed to the same fundamental factors. Similarly, correlations will increase with factor volatility, the magnitude by which will depend upon the actual factor loadings. Having corrected for economically-driven correlation between markets, BHN test for contagion by investigating whether there is any correlation left in the model's residuals. Their results indicate the presence of contagion during the East-Asian crisis, but not during the Mexican crisis.

[1] See Boyer, Gibson, and Loretan (1999), Kodres and Pritsker (2002), Ribeiro and Veronesi (2002), Sola, Spagnolo, and Spagnolo (2002), Billio, Lo Duca, and Pelizzon (2003), Billio and Pelizzon (2003), Ciccarelli and Rebucci (2003), Karolyi (2003), Rigobon (2003), Hartmann, Straetmans, and de Vries (2004), Baele (2005), Billio, Lo Duca, and Pelizzon (2005), Corsetti, Pericoli, and Sbracia (2005), Phylaktis and Xia (2006) and Rodriguez (Forthcoming) for a number of recent contributions to the contagion literature.

By specifying a dynamic factor model to characterize cross-market interlinkages, BHN overcome a major disadvantage of the Forbes and Rigobon (2002) bias correction, namely that their test does not work well in the presence of common shocks. At the same time, though, the BHN contagion test requires a correct characterization of fundamental linkages between markets. In this respect, their null hypothesis is a joint test for no contagion and a correct factor specification. The main aim of this paper is to investigate to what extent conclusions from the BHN contagion test depend on the actual specification and complexity of the dynamic factor model chosen.

BHN choose for a specification with the global and regional equity market shocks as factors, and potentially time-varying factor exposures. This two-factor model, first developed by Ng (2000), constitutes a substantial improvement over the one-factor model of Bekaert and Harvey (1997), and has been successfully used before by Fratzscher (2002), Baele (2005), and Christiansen (Forthcoming) among others. From an economic point of view, it distinguishes between (partial) global and/or regional market integration. From an econometric point of view, this type of model outperforms the one-factor global market model considerably in modeling cross-country and industry correlations, while it is only slightly outperformed by a more complex APT model (see e.g. Bekaert, Hodrick, and Zhang (2005b)). Given the support for this two-factor specification, we follow BHN and estimate a model with a global and a regional factor.

Our paper differs from BHN, however, in how we model the exposures or 'betas' with respect to the factors. Clearly, failing to account correctly for the time variation in the factor exposures may lead to either type I or type II errors in the contagion test. In this paper, we allow for a vast array of beta specifications, and test whether different beta specifications lead to different conclusions about contagion or not. We start by estimating a specification with very general global and regional beta dynamics. More specifically, we follow Baele and Inghelbrecht (2006) and make the exposures conditional upon some economic instruments and a latent regime variable. We include two structural instruments, respectively proxying for trade integration and industry structure convergence. Previous evidence strongly suggests that global (regional) market exposures and cross-market correlations are positively related to trade openness (see e.g. Chen and Zhang (1997)). Trade integration may also proxy for financial integration, and hence a convergence of cross-country risk premiums. For instance, Bekaert and Harvey (1995) found that countries with open economies are generally better integrated with world capital markets. In BHN, the time variation in the betas is entirely driven by this trade integration variable.

As an additional structural instrument, we also include a measure for industry structure alignment, as one would expect markets to become more correlated when their industry structures become more aligned (see e.g. Carrieri, Errunza, and Sarkissian (2004)). Betas may not only vary with structural changes in the economic or financial system, but also with fluctuations in the economic cycle. This feature of our model is particularly important within the context of this paper, as it should accommodate for the well-known asymmetry in correlations, i.e. the fact that correlations are higher in downturns than in upturns (see Aydemir (2004), Das and Uppal (2004), Ang and Bekaert (2002), Longin and Solnik (2001), and De Santis and Gerard (1997) among others), a phenomenon which should not be mistaken with financial contagion. We accommodate for this potential cyclicality in betas in two ways. First, we make the factor exposures dependent on a latent regime variable. To facilitate the interpretation of the states as expansions and recessions, and to avoid that our regime variable also captures contagion periods, we limit the number of possible states to two. Second, and alternatively, we make betas conditional on the term spread, i.e. the difference between long and short-term government bond yields. Previous research (see Ang, Piazzesi, and Wei (2006) for an overview) has shown that this variable predicts cyclical movements.

Apart from testing the impact of the beta specification on the BHN contagion test, this paper has two additional contributions. First, we provide for a new interpretation of the BHN contagion test. More specifically, we distinguish between a misspecification test for the underlying factor model and a test for contagion. Second, while the existing contagion literature has predominantly focused on emerging markets, we focus on the case of 14 developed European equity markets. Over the last 25 years, Western Europe has evolved from a region with mostly segmented equity markets to an area with a largely integrated financial system. In this paper, we investigate whether the benefits from opening up European equity markets to foreign investors (e.g. a reduced cost of equity capital) comes at the cost of being increasingly vulnerable to financial contagion.

The main findings of this paper can be summarized as follows. First, our specification tests indicate that the model with both structural instruments and a latent regime variable is preferred over more restricted versions in all but one of the countries. Both global and regional market betas have increased substantially over the last three decades, reflecting increasing economic and financial integration. Second, conditional on our preferred model, we do not find evidence for contagion during any of the crisis periods we consider, namely the Mexican crisis, the Asian crisis, the Russian / LTCM crisis, the Nasdaq Rash, the 9/11 terrorist attacks, and periods of high market volatility. Third, specifications with constant global (regional) market exposures miscorrectly identify contagion during the Asian crisis, the 9/11 terrorist attacks, and periods of high volatility. Models with time-varying betas, either modeled by (a subset of) structural instruments or a latent regime variable, yield mostly the same conclusions with respect to contagion as our preferred model. Finally, our model misspecification test indicates that the various factor models are indeed misspecified. The degree of misspecification, however, decreases with model complexity. Moreover, the biases on parameter estimates are generally small in economic terms.

The remainder of this paper is organized as follows. Section 2 develops the two-factor model with time-varying factor exposures and describes the contagion test. Section 3 describes the data, and reports the main empirical results. Section 4 concludes.

2 Methodology

In this section, we first develop a two-factor model with time-varying factor exposures. This model accommodates for the fundamental linkages between markets. We provide for a very general specification for the time-varying factor exposures. Second, we briefly describe the contagion test of BHN.

2.1 A Structural Regime-Switching Factor Model

The existing spillover literature has made the global (regional) market exposures, or betas, time-varying by making them conditional on some structural information variables (see e.g. Bekaert and Harvey (1997), Ng (2000) and Fratzscher (2002)) or on a latent regime variable (see Baele (2005)). Both specifications individually have, however, their limitations. While the first approach allows betas to change with structural changes in the economic and financial environment, it cannot accommodate cyclical variation in the betas. The second approach does allow betas to vary over the cycle, but is less suited to deal with *permanent* changes in market betas. In a recent paper, Baele and Inghelbrecht (2006) combine both features into one structural regime-switching volatility spillover model. We build upon their model.

We first decompose global market returns $r_{w,t}$ in an expected component $\mu_{w,t-1}$ and a global market shock $e_{w,t}$. The expected excess world market return is modeled as a linear function of lagged values of the US short rate, dividend yield, term spread, default spread, as well as own returns. In a second step, we identify region-specific shocks by estimating the following equation:

$$r_{reg,t} = \mu_{reg,t-1} + \beta^{w}_{reg,t} e_{w,t} + e_{reg,t} \qquad (1)$$

where $\mu_{reg,t-1}$ represents the expected regional return[2] and $e_{reg,t}$ the region-specific shock. This decomposition guarantees that the region-specific shocks are orthogonal to the global market shocks. In our most general specification, the region's global market beta varies with both structural economic instruments $X^{w}_{reg,t-1}$ and a latent regime variable $S_{reg,t}$, hereby allowing for both structural and cyclical changes in the global market beta:

$$\beta^{w}_{reg,t} = \beta^{w}_{reg,0}(S_{reg,t}) + \beta^{w}_{reg} X^{w}_{reg,t-1}.$$

At the country level, the specification is given by

$$r_{c,t} = \mu_{c,t-1} + \beta^{w}_{c,t} e_{w,t} + \beta^{reg}_{c,t} e_{reg,t} + e_{c,t} \qquad (2)$$

where $r_{c,t}$ is the return for country c, $\mu_{c,t-1}$ the time $t-1$ expected return[3] of country c, $e_{w,t}$ and $e_{reg,t}$ respectively the global and regional market shocks, $e_{c,t}$ the country-specific shock, and $\beta^{w}_{c,t}$ and $\beta^{reg}_{c,t}$ the time-varying exposures of country c's returns with respect to the global and regional market shocks. Similar to the region's global market beta, the countries' global (regional) market betas are conditioned both on a number of structural economic instruments *and* a latent regime variable. The general specification for the global (regional) market betas is given by:

$$\beta^{w(reg)}_{c,t} = \beta^{w(reg)}_{c}(S_{c,t}) + \beta^{w(reg)}_{c} X^{w(reg)}_{c,t-1}. \qquad (3)$$

The latent regime variable $S_{c,t}$ is allowed to be different for each country. We do impose the same latent variable on both the global and regional market beta for each country. This does not mean that we impose global and regional market shocks to have the same evolution over time, as global and regional market betas are still allowed to have a specific exposure to respectively global and region-specific structural instruments.

Both at the regional and the country level, we include two structural instruments, respectively proxying for the region/country's degree of trade integration (TI) and industry structure alignment (IA). At the country level, we calculate both measures with respect to either the world or

[2]The expected regional return is modeled as a linear function of lagged values of both the US and the regional market return, the US short rate, dividend yield, term spread, and default spread.

[3]The expected country return also depends on the lags of the own return (beyond the variables contained in the expected regional return equation).

the region. For more details on the motivation to use particularly this two instruments and on how they are constructed, we refer to Section 3.1.

The specifications for the betas nest a number of restricted versions that have previously been used in the literature. Contagion tests based on the Forbes and Rigobon (2002) methodology typically assume constant market linkages. BHN allow global and regional market exposures to vary with a trade integration measure, but neither with industry structure alignment nor with a regime-switching variable. In Baele (2005), market exposures switch between a low and a high spillover state, but do not vary with structural instruments. In the following table, we list the various specifications for the global and regional market betas with increasing complexity:

Model	Beta Specification
Constant Beta Model	$\beta^z_{c,t} = \beta^z_{c,0}$
Regime-Switching Beta Model	$\beta^z_{c,t} = \beta^z_{c,0}(S_{c,t})$
Instrumental Beta Model	$\beta^z_{c,t} = \beta^z_{c,0} + \beta^z_c X^z_{c,t-1}$
RS Instrumental Beta Model	$\beta^z_{c,t} = \beta^z_c(S_{c,t}) + \beta^z_c X^z_{c,t-1}$

where $z = \{w, reg\}$. In this paper, we will investigate to what extent the BHN test for contagion yields different results for alternative beta specifications. Notice that our instrumental beta model conditions the global (regional) market exposures both on a trade integration and industry structure alignment instrument, while BHN only consider the former variable. To make our results comparable to those of BHN, we will also perform the contagion test using trade integration as the sole driver of beta dynamics.

Within the context of this paper, one may be concerned that the regime variable does not (only) pick up cyclical movements in market betas, but also contagion periods itself. While we try to avoid this by limiting the number of regimes to two, we cannot guarantee that the latent regime variable also picks up contagion episodes. To rule out this possibility while still allowing for cyclical movements in the global (regional) market betas, we replace the regime-switching intercept by an affine function of the lagged term spread $TS_{c,t-1}$, an often used predictor for cyclical movements:

$$\beta^{w(reg)}_{c,t} = \beta^{w(reg)}_{c,0} + \beta^{w(reg)}_{c,1} TS_{c,t-1} + \beta^{w(reg)}_{c} X^{w(reg)}_{c,t-1}. \tag{4}$$

To complete the model, we have to provide for a specification of the conditional variance of the global, region-specific, and country-specific shocks, as well as for the regime-switching probabilities. We model the conditional variance of the global market shocks by means of a regime-switching Asymmetric GARCH(1,1) model:

$$e_{w,t}|\Omega_{t-1} \backsim N(0, \sigma^2_{w,t})$$

$$\sigma^2_{w,t} = \psi_{w,o}\left(S_{w,t}\right) + \psi_{w,1}\left(S_{w,t}\right)e^2_{w,t-1} + \psi_{w,2}\left(S_{w,t}\right)\sigma^2_{w,t-1} + \psi_{w,3}\left(S_{w,t}\right)e^2_{w,t-1}I\{e_{w,t-1} < 0\} \tag{5}$$

with $I\{e_{w,t-1} < 0\}$ an indicator function which takes on the value 1 when $e_{c,t-1} < 0$ and zero otherwise[4]. The conditional heteroskedasticity of the region and country-specific shocks is modeled through an Asymmetric GARCH(1,1) model. Specification tests indicate that such model is sufficient once betas are allowed to be time varying.

Finally, we assume a constant transition probability matrix for the latent regime variable which can take two states, i.e.

$$\Pi_c = \begin{pmatrix} P_c & 1 - P_c \\ 1 - Q_c & Q_c \end{pmatrix} \tag{6}$$

where the transition probabilities are given by $P_c = prob(S_{c,t} = 1|S_{c,t-1} = 1)$, and $Q_c = prob(S_{c,t} = 2|S_{c,t-1} = 2)$. By imposing this parsimonious structure on the latent regime variable, we hope to limit the probability that our regime-switching variable also captures contagion episodes.

2.2 Contagion Tests

In this section, we briefly discuss the BHN test for contagion. They first assume that correlation induced by fundamentals is well captured by the estimated factor model. Second, they test for contagion by measuring the correlation of the model's country-specific shocks[5]. More specifically, they estimate the following time-series cross-section regression model:

$$\hat{e}_{c,t} = w_c + v_{z,t}\hat{e}_{z,t} + u_{c,t} \tag{7}$$

$$v_{z,t} = v_{z,0} + v_{z,1}D_t \tag{8}$$

where $\hat{e}_{c,t}$ and $\hat{e}_{z,t}$ are the estimated idiosyncratic return shocks of country c and benchmark market z (i.e. global or regional market), and D_t is a dummy variable that takes on a value of

[4] Baele and Inghelbrecht (2006) show that the conditional volatility of global equity market shocks is better described by a regime-switching Asymmetric GARCH model rather than by a single regime Asymmetric GARCH model.

[5] A similar approach is used by Wongswan (2003).

1 in a particular crisis period and zero otherwise. BHN test whether $v_{z,0}$ and $v_{z,1}$ are jointly equal to zero (overall test for contagion) and whether $v_{z,1}$ is significantly different from zero (contribution of particular periods to contagion).

In the context of this paper, we estimate the following specification:

$$\hat{e}_{c,t} = w_c + v_{w,t}\hat{e}_{w,t} + v_{reg,t}\hat{e}_{reg,t} + u_{c,t} \tag{9}$$

with

$$v_{w,t} = (v_{w,0} + v_{w,1}D_t) \tag{10}$$

$$v_{reg,t} = (v_{reg,0} + v_{reg,1}D_t). \tag{11}$$

The dummy variable D_t represents 7 crisis periods (see Section 3.1 for more details on the exact specification of the crisis dummies). We test for contagion during a particular crisis period either at the global or regional level by testing respectively whether $v_{w,1} = 0$ and $v_{reg,1} = 0$. BHN also perform an overall test for contagion by testing whether $v_{w,0} = v_{w,1} = 0$ and $v_{reg,0} = v_{reg,1} = 0$. In our view, one should be careful with interpreting a significant intercept as evidence for contagion. As explained in detail in Appendix A, a negative $v_{w,0}$ and/or $v_{reg,0}$ does signal contagion, but a positive $v_{w,0}$ and/or $v_{reg,0}$ indicates misspecification rather than contagion. The systematic underestimation of the betas may be caused by measurement problems with respect to the global (regional) market shocks or by an omitted factor. In the empirical part, we focus primarily on the significance of $v_{w,1}$ and $v_{reg,1}$ to test for contagion.

We estimate equation (9) with fixed effects and accommodate for groupwise heteroskedasticity. The standard errors of the parameters are corrected for heteroskedasticity using the White heteroskedasticity consistent covariance matrix.

3 Estimation results

This section first reviews the data used in the analysis. Second, we briefly describe the estimation results from the two-factor models. Third, we discuss the main findings from the contagion tests based on the estimates of the best performing model. Finally, we compare the contagion test results for various levels of complexity of the specification of the global and regional market exposures.

3.1 Data Description

We investigate the effect of a particular choice for the beta specification on contagion tests using a sample of 14 European countries (see Table 1). We use weekly US$ total returns from Datastream for the period January 1973 till December 2004. As argued before, we use two structural instruments in our specification of global and regional market exposures, namely a trade integration measure and an industry misalignment measure. The trade integration measure is calculated as the ratio of imports plus exports over GDP. The empirical model distinguishes between global and regional market shocks, and so does our trade integration measure. More specifically, the trade integration measure entering the regional market beta only considers the country's trade with other countries within Europe. Similarly, the trade variable entering the global market beta contains the country's trade with all countries outside Europe. All data is quarterly and has been obtained from the OECD[6]. The misalignment of the industrial composition of the countries relative to the world (region) is measured as the square root of the mean squared errors between industry weights, i.e.

$$X_{c,t}^{w(reg)} = \sqrt{\sum\nolimits_{i=1}^{N} \left(w_i^c - w_i^{w(reg)}\right)^2}, \tag{12}$$

where N is the number of industries, w_i^c the weight of industry i in country c and $w_i^{w(reg)}$ the weight of industry i in the world (region). Weights are computed as the market capitalization of a certain industry in a particular country to the total market capitalization in that country. Market capitalizations are obtained from Datastream. The evolution of the trade integration and industry misalignment measures is depicted in Table 1. We observe an substantial increase in both intra and extra-regional trade for nearly all 14 European countries. For all countries, within-region trade is substantially higher than trade with countries outside Europe. Industry alignment has decreased substantially over the last 30 years in nearly all countries, both with respect to the world and to the region. Noticeable exceptions are Finland and Sweden, whose stock markets became both dominated by TMT related firms at the end of the 1990s. The fact that industry structures seem to be more aligned across countries in the 1990s compared to the 1970s - at least when measured through the equity market - suggests that integration has not yet lead to further specialization in the sense of Krugman.

As argued before, we model the potential cyclicality of the global (regional) market betas by

[6]The import and export data are obtained from the module 'Monthly Foreign Trade Statistics' from the OECD. All data is seasonally adjusted and converted from a quarterly to a weekly frequency through interpolation.

either allowing the intercept to switch between two states or by making the beta an affine function of a lagged term spread variable. For the global beta, we use the US term spread, defined as the difference between the yield on 10-year government bonds and 1-year treasury bills. We employ the German term spread - calculated in a similar fashion - for the regional European betas.

Finally, for the contagion tests, we consider the following crisis periods: the crash of '87, the Mexican Peso crisis at the end of 1994, the Asian crisis of the second half of 1997 and the beginning of 1998, the Russian cold in August 1998 (including the LTCM crisis), the Nasdaq Rash in April of 2000 and the 9/11/2001 terrorist attack. Using starting and ending dates which are commonly used in the contagion literature (see Table 1), we create dummies that take on the value of 1 in a particular crisis period and zero otherwise. In addition, we create a dummy that distinguishes between high and low volatility periods. We create this dummy based on estimates from our regime-switching Asymmetric GARCH model on global equity market returns, as explained in Section 2.1. The dummy has zeros except for times when the smoothed probability of being in the high global equity market volatility regime is larger than 50% (See Figure 1)[7]. We perform the formal contagion tests for each of the 7 dummies.

3.2 Factor Model Results

Section 2.1 outlined our most general specification for the two factor model. In practice, however, we may not need all the flexibility offered by this complex specification. We distinguish respectively between models with constant betas (Cst), instrumental betas (Inst), regime-switching betas (RS) and regime-switching instrumental betas (RSInst). For the time being, we include both structural instruments, namely the trade integration and industry alignment variables.

To differentiate between various restricted versions of this model, we use a number of likelihood ratio tests[8]. Unfortunately, standard asymptotic theory does not apply for tests of multiple regimes against the alternative of one regime because of the presence of nuisance parameters

[7]The selection of the 50% cut off point to classify the volatility regimes is not crucial as regimes are well defined (smoothed probabilities are either close to 0% or to 100%).

[8]When the compared models are not nested (like is the case comparing the regime-switching with the constant beta specification), we follow Pagan and Schwert (1990) and choose the model with the highest R^2 in a regression of the realized variance, proxied by the squared returns $r_{c,t}^2$ on the predicted total variance, i.e. $(\left(\beta_{c,t}^{w}\right)^2 \sigma_{w,t}^2 + \left(\beta_{c,t}^{reg}\right)^2 \sigma_{reg,t}^2 + \sigma_{c,t}^2)$.

under the null of one regime. Similar to Ang and Bekaert (2002), we use an empirical likelihood ratio test. In a first step, the likelihood ratio statistic of the regime-switching model against the null of one regime is calculated. Second, N series (of length T, the sample length) are generated based upon the model with no regime switches. For each of the N series, both the model with and without regime switches is estimated. The likelihood values are stored in respectively L_{RS} and L_{NRS}. For each simulated series, as well as for the sample data, the Likelihood Ratio (LR) test is calculated as $LR_{NRS \leftrightarrow RS} = -2 \log \left(L_{NRS} - L_{RS} \right)$. Finally, the significance of the LR test statistic is obtained by calculating how many of the LR test values on the simulated series are larger than the LR statistic for the actual data. Table 3 presents (empirical) likelihood ratio tests for Europe and the 14 European countries[9]. The first column reports the best performing model based on these tests. We find that models with both instruments and a latent regime variable in the specification of the global and regional market exposures outperform more restricted versions, notable constant beta specifications or specifications with either instruments or a regime variable. The only exception is Norway where a model with only regime-switching betas is preferred over a model also including structural instruments.

Table 3 further reports the estimation results for the best performing beta specification. The beta intercepts differ substantially between the two regimes for both the global and regional factor. According to a Wald test, the global and regional market betas are statistically different between regimes in respectively 10 and 12 of the 14 European countries. Moreover, also the global market beta of the region Europe varies substantially across regimes. The betas of many European countries (and the region Europe) are not only driven by a latent regime variable, but also by the structural variables. For nearly all European countries, exposures to both global and regional shocks are positively related to trade openness, and are so in a statistically and economically meaningful way. For the euro area countries, the trade variable has a positive and significant effect on the global beta for all countries except for Austria and Spain[10]. For Austria, France, Germany, and the Netherlands, trade has an additional positive and significant effect on the regional market beta. For the other European countries, we find a significant influence of the trade variables for Denmark, Sweden, and Switzerland, but not for Norway and the United Kingdom. The strong effect of trade on the betas of the European countries - and especially those now part of the euro area - indicates that the process of European economic and financial integration has lead to a more homogeneous valuation of European equities[11]. We do find,

[9] For detailed estimation results, we refer to Baele and Inghelbrecht (2006).

[10] For Ireland and Italy, the trade variable is significant at a 10 percent level only.

[11] The trade variable may not only proxy for economic, but also for monetary and financial integration. Indeed,

however, the effect of trade openness to be stronger for global than for regional market betas, suggesting that globalization may be at least as important in this respect as regional economic integration. Similar to the trade variable, the industry misalignment instrument is mainly related to the global market betas of European countries, however to a lesser extent. In 6 out of 14 cases this variable enters significantly with the expected negative sign, indicating that a more aligned industry structure leads to higher market betas and, ceteris paribus, higher cross-market correlations. Industry misalignment also has a significant impact on the global market beta of Europe.

Table 4 reports the evolution of the global and regional market betas over different subperiods, as implied by our optimal beta specification. The European market beta has increased substantially, from about 0.72 in the period 1973-1982 to about 0.91 in the period 1997-2004. In the euro area, both global and regional betas are more than 40 percent higher in the period 1997-2004 compared to the period 1973-1982. For the other European countries, large increases are observed in Denmark, Sweden, and Switzerland. While the betas have stayed relatively constant in Norway, the beta of the UK with respect to the regional European market has decreased by more than 30 percent.

To complete this section, Figure 2 plots the evolution of the average market-weighted conditional correlations across the 14 European countries, based on the results of the optimal factor model. The correlations are fundamental-implied, originating from the joint exposure to the same fundamental factors, and should be 'contagion-free'. They reflect the effect of both cyclical economic fluctuations as well as structural changes in the economy on global and regional betas. We notice a structurally-driven increase in cross-country correlations over time. Moreover, the correlations appear to be typically higher in times of economic downturn. Clearly, this correlation asymmetry should not be mistaken with contagion. Interestingly, as shown by Figure 3, restricted versions of the beta specifications lead to substantial mismeasurement of the cross-country correlations over time. While restricted versions, especially the constant beta specification, typically overestimate correlations before 1990, the opposite is the case thereafter. In the next section, we will investigate whether such correlation biases also lead to wrong conclusions about contagion.

---

we find a high correlation between our trade variable and the Quinn measure of capital account openess (see e.g. Quinn (1997)).

3.3 Results Contagion Tests for optimal model

In this section, we test for contagion for a set of 14 European countries based on estimates from our optimal two-factor model. First, we perform an informal contagion test by comparing unconditional correlations between crisis and non-crises periods. Second, we present estimates from the formal contagion test discussed in Section 2.2.

3.3.1 Preliminary Contagion Analysis

Table 5 reports correlations between the country-specific shocks and respectively the global, regional, and the other country-specific shocks, based on the optimal beta specification. We report correlations for the full sample as well as for tranquil and crisis times. The crisis period is identified as the periods where at least one crisis dummy equals one. The exact definitions of the crisis periods can be found in Table 2. The tranquil period corresponds to all non-crisis observations.

Generally, we do not find evidence of increasing correlation in the crisis period of local return shocks with both global and regional market shocks[12]. Only for Switzerland (with 10 percent) and The Netherlands (with 12 percent) we do find an increase in correlation of local market shocks with respectively global and regional market shocks. For both countries, however, we do not find evidence of excess within-region correlation. We do find positive excess correlation of local return shocks in Austria, Belgium, Denmark, and Norway with return shocks in the other markets, even though we only find a statistically significant increase in the crisis period for Austria. Overall, we do not find any evidence of contagion between European countries.

3.3.2 Formal Contagion Analysis

Table 6 reports results from the contagion test outlined in Section 2.2, more specifically the results from estimating equations (9), (10), and (11). Panel A tests whether the country-specific shocks exhibit excess correlation with respect to global market shocks. Similarly, Panel B considers the case of excess correlation with respect to the regional market shocks. We differentiate between different crisis periods, namely the 1987 crash, the Mexican Crisis, the Asian Crisis, the Russian/LTCM crisis, the Nasdaq Rash, and the 09/11 terrorist attacks. We also test for ex-

[12]We test for zero correlations over the different periods according to the following asymptotic distribution: $\sqrt{N}\hat{\rho} \overset{a}{\sim} N(0,1)$ with N the number of observations in the specific period and $\hat{\rho}$ the estimated correlation.

cess comovement in times of high market volatility. For exact definitions on the crises periods, we refer to Table 2.

Panel A of Table 6 provides little evidence in favour of contagion. First, the estimate of $v_{w,1}$, i.e. the increase in correlation between local markets and global markets in crisis periods, is economically small and statistically insignificant during the Mexican crisis, the Asian crisis, the Russian / LTCM crisis, and during the period directly after the 9/11 terrorist attacks. Second, we do not find a meaningful increase in global market exposures in times of high world market volatility. Third, we find a statistically significant *decrease* in global market exposure during the 1987 market crash and the more recent Nasdaq Rash. During these two crisis periods, European equity markets actually became less exposed to global market shocks, which is good news for both investors and policy makers.

Panel A of Table 6 also reports BHN's overall test for contagion, a test of whether both $v_{w,0}$ and $v_{w,1}$ are equal to zero. Similar to BHN, we find that the null hypothesis of no overall contagion is rejected for all crisis periods. The significance of the test for overall contagion is entirely driven by the significance of the intercept $v_{w,0}$. As argued before, one has to be careful interpreting this overall test for contagion. Suppose that market exposures are indeed higher in crisis periods (contagion) but that the beta specification does not take this into account. In this case, MLE will push beta estimates upwards to accommodate for higher betas in crises periods. As argued in Appendix A, the BHN contagion test allows the betas ex post to be different in tranquil and crisis periods. In this particular case of contagion, one expects a positive estimate for $v_{w,1}$ to reflect that market exposures are indeed higher during crisis periods. At the same time, we expect a negative value for $v_{w,0}$: After correcting for higher betas during crisis periods, there is no reason for 'normal' betas still to be biased upwards. Following the same argument, it is difficult to reconcile a *positive* intercept $v_{w,0}$ with contagion. Rather, it constitutes a systematic underestimation of betas during normal times, possibly due to measurement error in the global (regional) market shocks or a missing factor. As can be seen in Panel A of Table 6, the intercept $v_{w,0}$ is positive and significant for all crisis episodes, pointing towards misspecification of the underlying factor model rather than at contagion. While the intercepts are statistically significant, it is reassuring that the magnitude of the intercept is economically small ($v_{w,0}$ is between 0.017 and 0.021).

Similar results are found for the exposures with respect to regional market shocks (see Panel B of Table 6). We find no evidence in favour of contagion during the Mexican Crisis, the

Asian crisis, the Nasdaq rash, the Russian / LTCM crisis, and during periods of high market volatility. We do find strong contagion, though, directly after the 1987 market crash. While local European equity markets became less exposed to global shocks, especially those in the US, we observe a strong increase in the exposure to regional European shocks. Finally, while the regional intercept $v_{reg,0}$ is positive for all crisis periods, it is never statistically significant. Overall, we do not find evidence of important contagion effects in European equity markets during the last 20 years[13].

3.4 Contagion and Alternative Beta Specifications

In the previous section, we tested for contagion based on residuals generated from our preferred model, and found limited evidence for contagion. In this section, we test whether we would have reached the same conclusion for more restricted versions of our model. We distinguish respectively between specifications with constant, regime-switching, instrumental and regime-switching instrumental betas.

Panel A and B of Table 7 report results from the contagion tests for constant beta model (line 1), regime-switching beta model (line 2), and instrumental beta model (line 3), and compare them with the results from the most general regime-switching instrumental beta model (line 7), which is our optimal model (except for Norway). The instrumental beta specification contains two instruments, namely a trade integration and industry alignment measure. We find a number of interesting results. First, a contagion test based on constant global/regional market exposures indicates contagion from global markets during the Asian crisis, the 9/11 terrorist attacks, and during periods of high market volatility, while no contagion is found when country-specific shocks are generated with our optimal model. Similarly, constant beta models indicate regional contagion during the Asian crisis, the Russian / LTCM crisis, and during periods of high world market volatility, while our preferred model does not.

Second, models with time-varying factor exposures, either modeled by conditioning on a latent regime variable or on structural instruments, mostly yield the same conclusions as the preferred model. We observe though some discrepancies. The specification with only regime-switches does indicate contagion from global markets during the 9/11 and high world market volatility periods, while the other time-varying beta models do not. The results of the specification that

[13] As the UK behaves somehow differently from the other European countries, we have done the contagion analysis excluding the UK. Excluding the UK does however not affect the results.

only conditions market exposures on structural instruments are in line with the results of the optimal model[14]. This finding underlines the need to especially accommodate for structural changes in market interdependences in any test for contagion.

Notice that BHN make the global (regional) betas a function of one structural instrument only, namely the trade integration variable. In line 4 of Panel A and B of Table 7, we report contagion test results for specifications where the beta is conditioned only on the trade integration instrument. We find that the results for this specification are mostly in line with our preferred factor model. Nevertheless, the BHN model does indicate contagion in periods of high volatility, while our preferred model does not. Notice that all models except the optimal one indicate contagion in highly volatile periods, suggesting that one should accommodate for both structural changes and cyclical fluctuations in the market betas.

Above, we focused on the pure contagion test, namely on the sign and significance of $v_{w,1}$ and $v_{reg,1}$. Table 7 contains, however, also a number of interesting findings with respect to the intercept coefficients $v_{w,0}$ and $v_{reg,0}$. First, the global intercept $v_{w,0}$ is positive and significant for most of the beta specifications. While this suggest that the factor models are all misspecified, the coefficients are all economically small and never higher than 0.021. Second, we find substantial differences across the various beta specifications for the regional intercept $v_{reg,0}$. While the intercept is both economically and statistically insignificant for the optimal model, we observe relatively large and statistically significant values for other beta specifications. Especially the constant beta model performs badly with coefficients of up to 0.063, indicating that factor models with constant exposures are misspecified.

Our optimal model allows the global (regional) market exposures to vary with a latent regime variable. Despite that we limit the number of possible states to two, it is still possible that our regime variable does not (only) pick up cyclical movements in market betas, but also contagion episodes. If this would be the case, our tests would be biased against finding contagion. As a robustness check, we replace the latent regime variable by the lagged term spread, an often used instrument to predict cyclical movements. As can be seen from line 5 in Panel A and B of Table 7, the contagion test results of a model with structural instruments and the lagged term spread are similar to our preferred model, suggesting that our finding of 'no contagion' is robust to

[14]The only difference is that we observe a significant $v_{reg,1}$ during the 09/11 terrorists attack, but the coefficient is negative.

using observed cyclical instruments rather than a latent regime variable as a proxy for cyclical movements.

4 Conclusion

In a recent article, Bekaert et al. (2005a) define contagion as “correlation over and above what one would expect from economic fundamentals”. They developed a two-factor asset pricing specification to model fundamentally-driven linkages between markets. Conditional on the particular specification of the factor model, they define contagion as correlation among the model residuals, and develop a corresponding test procedure. By specifying a dynamic factor model to characterize cross-market interlinkages, BHN overcome a major disadvantage of the Forbes and Rigobon (2002) bias correction, namely that their test does not work well in the presence of common shocks. At the same time, though, the BHN contagion test requires a correct characterization of fundamental linkages between markets. In this respect, their null hypothesis is a joint test for no contagion and a correct factor specification.

The main aim of this paper is to investigate to what extent conclusions from the BHN contagion test depend on the actual specification and complexity of the dynamic factor model chosen. At the one hand, we follow Bekaert et al. (2005a) in their choice for a two-factor model, where the two factors are shocks to respectively global and regional European equity markets. Our paper differs from BHN, however, in how we model the exposures or ‘betas’ with respect to the factors. Our most general specification conditions the global and regional market betas on two structural instruments and a latent regime variable. The two structural instruments proxy for respectively trade openness and industry structure alignment. The latent regime variable accommodates for potential cyclicality in the market betas. We estimate this general specification as well as more restricted version on a set of 14 European equity markets.

We find a number of interesting results. First, our specification tests indicate that the model with both structural instruments and a latent regime variable is preferred over more restricted versions in all but one of the countries. Both global and regional market betas have increased substantially over the last three decades, reflecting increasing economic and financial integration. Second, conditional on our preferred model, we do not find evidence for contagion during any of the crisis periods we consider, namely the Mexican crisis, the Asian crisis, the Russian / LTCM crisis, the Nasdaq Rash, the 9/11 terrorist attacks, and periods of high market volatility. Third, specifications with constant global (regional) market exposures miscorrectly identify contagion during the Asian crisis, the 9/11 terrorist attacks, and periods of high volatility. On the hand, models with time-varying betas, either modeled by (a subset of) structural instruments or a latent regime variable, yield mostly the same conclusions with respect to contagion as our preferred model. Our results indicate that any test for contagion should take into account time-varying equity market interdependences.

From a methodological point of view, we provide for an alternative interpretation of the 'overall' contagion test of Bekaert et al. (2005a). More specifically, we distinguish between a contagion test and a misspecification test for the underlying factor model. We find considerable evidence that the various factor models are indeed misspecified. The degree of misspecification, however, decreases with model complexity. While even the more complex models are misspecified in a statistical sense, the biases on parameter estimates are generally small in economic terms.

Appendix A Contagion versus Model Misspecification

We have the following fundamental two factor model for countries:

$$r_{c,t} = \mu_{c,t-1} + \beta_{c,t}^{w} e_{w,t} + \beta_{c,t}^{reg} e_{reg,t} + e_{c,t} \tag{A-1}$$

where $r_{c,t}$ is the return for country c, $\mu_{c,t-1}$ the time $t-1$ expected return of country c, $e_{w,t}$ and $e_{reg,t}$ respectively the global and regional market shocks, $e_{c,t}$ the country-specific shock, and $\beta_{c,t}^{w}$ and $\beta_{c,t}^{reg}$ the time-varying exposures of country c's returns with respect to the global and regional market shocks. $\beta_{c,t}^{w}$ and $\beta_{c,t}^{reg}$ are assumed to capture fundamental and cyclical movements in the returns. The country residuals could however show excess correlation, whether or not related to crisis periods. To model this excess correlation, we use the following model:

$$\hat{e}_{c,t} = w_c + v_{w,t}\hat{e}_{w,t} + v_{reg,t}\hat{e}_{reg,t} + u_{c,t} \tag{A-2}$$

with

$$v_{w,t} = (v_{w,0} + v_{w,1} D_t) \tag{A-3}$$

$$v_{reg,t} = (v_{reg,0} + v_{reg,1} D_t). \tag{A-4}$$

After replacing the shocks in equation (A-1) by their estimated values and substituting in equations (A-2), (A-3) and (A-4), we obtain

$$r_{c,t} = (\mu_{c,t-1} + w_c) + (\beta_{c,t}^{w} + v_{w,0} + v_{w,1} D_t)\hat{e}_{w,t} + (\beta_{c,t}^{reg} + v_{reg,0} + v_{reg,1} D_t)\hat{e}_{reg,t} + u_{c,t}$$

or, more concise

$$r_{c,t} = \tilde{\mu}_{c,t-1} + \tilde{\beta}_{c,t}^{w}\hat{e}_{w,t} + \tilde{\beta}_{c,t}^{reg}\hat{e}_{reg,t} + C_t + u_{c,t}.$$

with

$$\tilde{\mu}_{c,t-1} = \mu_{c,t-1} + w_c \tag{A-5}$$

$$\tilde{\beta}_{c,t}^{w} = \beta_{c,t}^{w} + v_{w,0} \tag{A-6}$$

$$\tilde{\beta}_{c,t}^{reg} = \beta_{c,t}^{reg} + v_{reg,0} \tag{A-7}$$

$$C_t = (v_{w,1}\hat{e}_{w,t} + v_{reg,1}\hat{e}_{reg,t}) D_t.$$

C_t can be labelled as the contagion component, i.e. the excess return in times of crisis which is common to all countries. The bias in the global and regional market betas are captured by respectively $v_{w,0}$ and $v_{reg,0}$. This bias can be caused by a number of things. First, in case $v_{w,0}$

and $v_{reg,0}$ are negative, the bias is caused by contagion. Basically when contagion is important and the model is not able to capture it, the betas $\beta^{w}_{c,t}$ and $\beta^{reg}_{c,t}$ will be biased upwards. Adding contagion dummies to the specifcation, the negative values for $v_{w,0}$ and $v_{reg,0}$ will bring the betas down in no-contagion periods, i.e. will account for the bias. The resulting $\tilde{\beta}^{w}_{c,t}$ and $\tilde{\beta}^{reg}_{c,t}$ will be unbiased. The excess correlation due to contagion, will be captured by a positive $v_{w,1}$ and $v_{reg,1}$[15].

Second, model misspecification will cause $v_{w,0}$ and $v_{reg,0}$ to be positive. A positive $v_{w,0}$ and $v_{reg,0}$ imply that respectively the global market betas $\beta^{w}_{c,t}$ and the regional market betas $\beta^{reg}_{c,t}$ are systematically underestimated. This underestimation can be explained by measurement errors. As the actual global market shock $e_{w,t}$ and regional market shock $e_{reg,t}$ are not know, they must be replaced by estimates. The resulting measurement error will bias the estimates for $\beta^{w}_{c,t}$ and $\beta^{reg}_{c,t}$ downward. This is typically called the attenuation bias. Baele and Inghelbrecht (2006) have shown that the global market betas and the regional market betas do not sum to one[16]. They are slighly below one. The attenuation bias may well account for that.

Finally, note that there may also be excess correlation between the residuals $u_{c,t}$ of each country. This could signal that there is a missing factor. This is however not the focus of the paper.

[15]As the country return is in fact a part of the global and regional market portfolio return, we may have a simultaneity problem. This could also cause the estimates of the betas to be upward biased, resulting in negative values for $v_{w,0}$ and $v_{reg,0}$.

[16]When the factor model is correctly specified, betas should sum to one.

References

Ang, Andrew, and Geert Bekaert, 2002, International asset allocation with regime shifts, *Review of Financial Studies* 15, 1137–1187.

Ang, Andrew, Monika Piazzesi, and Min Wei, 2006, What does the yield curve tell us about gdp growth?, *Journal of Econometrics* 131, 359–403.

Aydemir, A. Cevdet, 2004, Risk sharing and counter-cyclical variation in market correlations, *Working Paper,* Tepper School of Business, Carnegie Mellon University.

Baele, Lieven, 2005, Volatility spillover effects in European equity markets, *Journal of Financial and Quantitative Analysis* 40, 373–402.

Baele, Lieven, and Koen Inghelbrecht, 2006, Structural versus temporary drivers of country and industry risk, *Working Paper* .

Bekaert, Geert, and Campbell R. Harvey, 1995, Time-varying world integration, *Journal of Finance* 50, 403–444.

Bekaert, Geert, and Campbell R. Harvey, 1997, Emerging equity market volatility, *Journal of Financial Economics* 43, 29–77.

Bekaert, Geert, Campbell R. Harvey, and Angela Ng, 2005a, Market integration and contagion, *Journal of Business* 78, 39–69.

Bekaert, Geert, Robert J. Hodrick, and Xiaoyan Zhang, 2005b, International stock return comovement, *NBER Working Paper* 11906.

Billio, Monica, Marco Lo Duca, and Loriana Pelizzon, 2003, The dcc test: powerless evidence of no contagion, *Working Paper,* GRETA, Venice.

Billio, Monica, Marco Lo Duca, and Loriana Pelizzon, 2005, Contagion detection with switching regime models: a short and long run analysis., *Working Paper,* GRETA, Venice.

Billio, Monica, and Loriana Pelizzon, 2003, Contagion and interdependence in stock markets: Have they been misdiagnosed?, *Journal of Economics and Business* 55, 405–426.

Boyer, Brian H., Michael S. Gibson, and Mico Loretan, 1999, Pitfalls in tests for changes in correlations, *Board of Governors of the Federal Reserve System International Finance Discussion Paper* 597.

Carrieri, Francesca, Vihang Errunza, and Sergei Sarkissian, 2004, The dynamics of geographic versus sectoral diversification: Is there a link to the real economy?, *Working Paper,* McGill Univeristy.

Chen, Nai-Fu, and Feng Zhang, 1997, Correlations, trades and stock returns of the Pacific-Basin markets, *Pacific-Basin Finance Journal* 7, 559–577.

Christiansen, Charlotte, Forthcoming, Volatility-spillover effects in european bond markets, *European Financial Management* .

Ciccarelli, Matteo, and Alessandro Rebucci, 2003, Measuring contagion with a bayesian time-varying coefficient model, *IMF Working Paper* No. 03/171.

Corsetti, G., M. Pericoli, and M. Sbracia, 2005, 'some contagion, some interdependence': More pitfalls in tests of financial contagion, *Journal of International Money and Finance* 24, 1177–1199.

Das, Sanjiv R., and Raman Uppal, 2004, Systemic risk and international portfolio choice, *Journal of Finance* 59, 2809–2834.

De Santis, Giorgio, and Bruno Gerard, 1997, International asset pricing and portfolio diversification with time-varying risk, *Journal of Finance* 52, 1881–1912.

Forbes, Kristin J., and Roberto Rigobon, 2002, No contagion, only interdependence: Measuring stock market comovements, *Journal of Finance* 57, 2223–2261.

Fratzscher, M., 2002, Financial market integration in europe: On the effects of emu on stock markets, *International Journal of Finance and Economics* 7, 165–193.

Hartmann, Philipp, Stefan Straetmans, and Casper G. de Vries, 2004, Asset market linkages in crisis periods, *Review of Economics and Statistics* 86, 313–326.

Karolyi, G. Andrew, 2003, Does international financial contagion really exist?, *International Finance* 6, 179–199.

Kodres, L. E., and M. Pritsker, 2002, A rational expectations model of financial contagion, *Journal of Finance* 57, 769–799.

Longin, Francois, and Bruno Solnik, 2001, Extreme correlation of international equity markets, *Journal of Finance* 56, 649–676.

Ng, Angela, 2000, Volatility spillover effects from Japan and the US to the Pacific-Basin, *Journal of international money and finance* 19, 207–233.

Pagan, Adrian R., and G. William Schwert, 1990, Alternative models for conditional stock volatility, *Journal of Econometrics* 45, 267–290.

Phylaktis, Kate, and Lichuan Xia, 2006, Equity market comovement and contagion: A sectoral perspective, *Working Paper,* Cass Business School.

Quinn, Dennis, 1997, The correlates of changes in international financial regulation, *American Political Science Review* 91, 531–551.

Ribeiro, Ruy, and Pietro Veronesi, 2002, The excess co-movement of international stock markets in bad times: A rational expectations equilibrium model, *Working Paper,* University of Chicago.

Rigobon, R., 2003, On the measurement of the international propagation of shocks: is the transmission stable?, *Journal of International Economics* 61, 261–283.

Rodriguez, Juan-Carlos, Forthcoming, Measuring financial contagion: A copula approach, *Journal of Empirical Finance* .

Sola, M., F. Spagnolo, and N. Spagnolo, 2002, A test for volatility spillovers, *Economics Letters* 76, 77–84.

Wongswan, Jon, 2003, Contagion: An empirical test, *Board of Governors of the Federal Reserve System International Finance Discussion Paper* 775.

Figure 1: Smoothed Probabilities of the Global Market Volatility Regimes

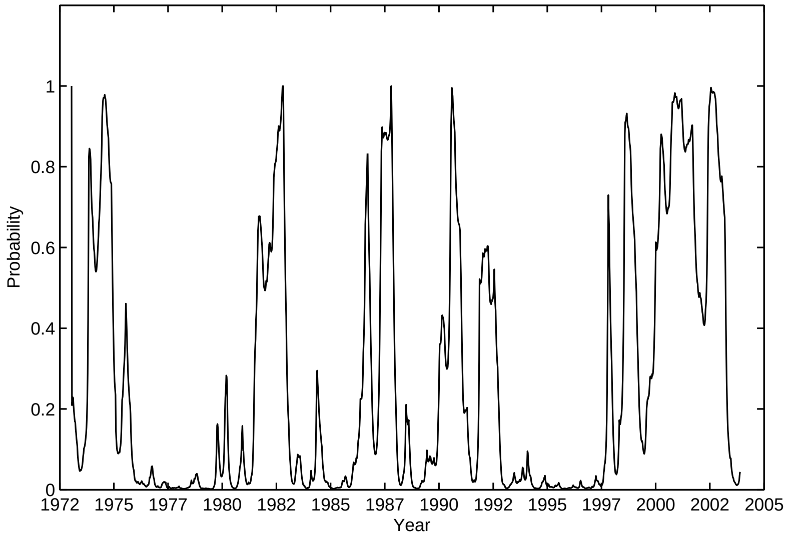

Figure 1 plots the smoothed probabilities that the global market equity returns are in the high volatility state. The probabilities are obtained from estimating the regime-switching Asymmetric GARCH model outlined in Section 2.1.

Figure 2: Average Fundamental Model-Implied Correlations between European countries

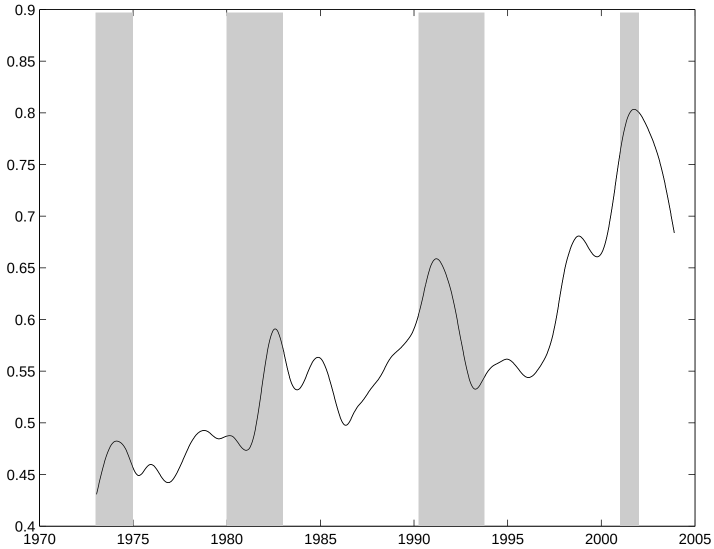

Figure 2 reports the average fundamental model-implied cross-country correlations over time for 14 European countries. The implied correlations are computed using the optimal models as reported in Table 3. World recessions are shaded in gray to illustrate cyclical movements in correlations. The recessions are identified as the periods from the peaks to the throughs of the detrented world GDP.

Figure 3: Average Mismeasurement in Correlations Due to Restrictive Beta Specifications

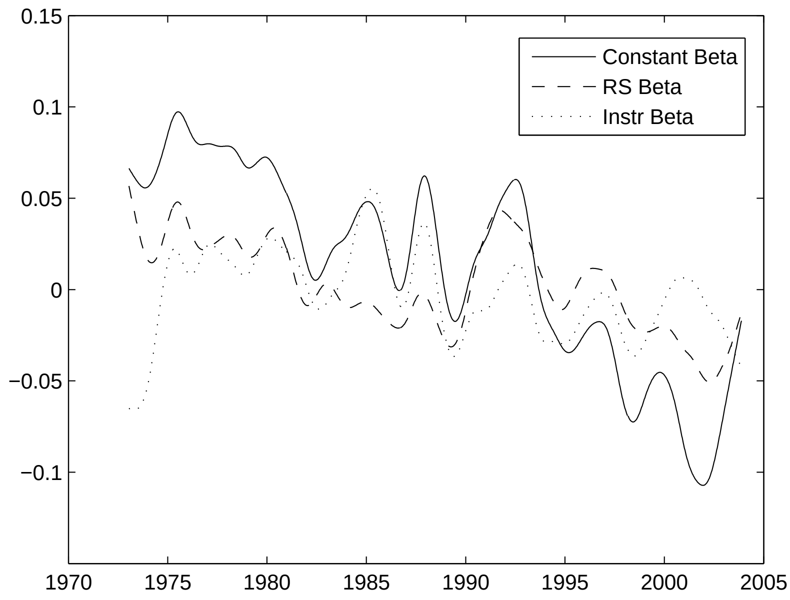

Figure 3 reports the average mismeasurement in correlations due to using the wrong beta specification for 14 European countries. We differentiate between mismeasurement based on constant beta model (Constant Beta), regime-switching beta model (RS Beta) and instrumental beta model (Instr Beta). The instrumental beta model concerns the model including both trade integration and industry alignment measure.

Table 1: Structural Instruments for Europe and 14 European Countries over Different Periods

This table displays subperiod averages of the structural instruments for Europe and 14 European countries. The trade integration measure is calculated as the ratio of imports plus exports over GDP. Data is obtained from the OECD. We make a distinction between trade with the world (W) (excluding the region Europe) and trade with the region Europe (R). The misalignment measure for Europe is computed as the square root of the mean squared errors between the industry weights of the region Europe and the industry weights of the world. For the countries, we make a distinction between the errors relative to the weights of the world (W) and the errors relative to the weights of the region Europe (R).

Country	**W/R**	**Trade Integration**				**Misalignment**			
		1970s	**1980s**	**1990s**	**90s v 70s**	**1970s**	**1980s**	**1990s**	**90s v 70s**
					(% diff.)				(% diff.)
Europe	**W**	8.1%	9.2%	8.9%	10.4%	14.8%	12.0%	7.4%	-49.7%
Austria	**W**	5.1%	7.0%	6.7%	31.4%	31.5%	36.9%	29.9%	-5.3%
	R	31.1%	34.3%	38.6%	24.0%	22.1%	28.5%	26.2%	18.8%
Belgium	**W**	12.3%	13.3%	16.2%	32.4%	40.7%	29.8%	33.1%	-18.7%
	R	62.6%	78.1%	77.6%	24.0%	37.1%	30.2%	29.9%	-19.5%
Denmark	**W**	6.7%	8.3%	7.7%	14.1%	30.4%	30.9%	25.4%	-16.5%
	R	31.4%	33.9%	34.1%	8.9%	30.8%	32.2%	25.5%	-17.3%
Finland	**W**	11.1%	14.5%	12.7%	14.5%	-	15.0%	34.4%	-
	R	25.4%	24.6%	27.9%	9.7%	-	15.7%	40.0%	-
France	**W**	5.9%	6.9%	6.8%	15.7%	22.4%	19.8%	12.1%	-45.7%
	R	17.0%	19.3%	21.8%	27.8%	28.0%	22.3%	14.6%	-47.9%
Germany	**W**	7.1%	9.2%	9.0%	25.9%	25.2%	26.2%	25.9%	2.8%
	R	22.2%	27.7%	26.0%	17.2%	26.8%	26.7%	27.0%	0.7%
Ireland	**W**	11.1%	15.3%	24.0%	115.9%	44.0%	40.9%	33.1%	-24.7%
	R	54.3%	59.3%	65.5%	20.5%	35.5%	36.1%	28.8%	-18.9%
Italy	**W**	7.6%	7.7%	6.4%	-15.5%	47.7%	47.4%	37.4%	-21.5%
	R	18.2%	18.9%	20.5%	12.3%	38.4%	43.2%	35.0%	-8.8%
Netherlands	**W**	11.6%	13.9%	14.3%	22.9%	31.6%	36.5%	27.9%	-11.5%
	R	46.4%	54.7%	55.4%	19.3%	30.8%	35.1%	23.9%	-22.6%
Norway	**W**	7.8%	6.8%	8.4%	8.0%	-	48.3%	38.2%	-
	R	32.2%	34.4%	32.7%	1.5%	-	47.5%	36.0%	-
Spain	**W**	6.0%	7.3%	5.4%	-9.9%	-	29.3%	30.7%	-
	R	8.9%	12.2%	20.6%	132.5%	-	8.9%	29.1%	-
Sweden	**W**	7.1%	10.1%	12.1%	70.5%	-	25.9%	26.4%	-
	R	25.2%	32.6%	37.4%	48.1%	-	20.9%	31.9%	-
Switzerland	**W**	9.2%	10.1%	9.3%	1.0%	47.6%	37.5%	45.6%	-4.2%
	R	37.4%	33.4%	30.8%	-17.7%	49.0%	35.1%	46.1%	-6.0%
UK	**W**	12.7%	11.2%	11.3%	-10.8%	21.5%	17.3%	16.5%	-22.9%
	R	20.0%	21.7%	22.1%	10.5%	20.8%	21.1%	19.6%	-5.6%

Table 2: The Different Event Windows for Constructing the Dummies

This table reports the different dummies used in the contagion analysis. The dates are based on the ones which are traditionally used in the literature. They are also consistent with the chronology of economic and market events provided by Macro-Dev through their website 'hhttp://www.macro-dev.com'. Macro-Dev has established itself as a leading web provider of economic forecasts and market analysis. The 'high world volatility state' event concerns a dummy which takes on the value one if the smoothed probability of being in the high world volatility state is higher than 0.5. The probabilities are retrieved from our regime-switching Asymmetric GARCH model, estimated on global equity market returns. The smoothed probability of being in the high volatility state is presented in Figure 1.

Event	**Begin**	**End**
Crash '87	19/10/1987	26/10/1987
Mexican Crisis	19/12/1994	31/01/1995
Asian Crisis	01/04/1997	30/10/1998
Russian Crisis + LTCM	01/08/1998	30/09/1998
Nasdaq Rash	01/04/2000	30/04/2000
Attack 09/11	11/09/2001	11/10/2001
High World Volatility State	see Figure 1	

Table 3: Specification Tests and Estimation Results for Beta Specifications

This table reports the specification tests and estimation results of the beta specification for the region Europe and 14 European countries. The first column reports the optimal specification codes for the different countries. The three-digit model code is defined as follows: the first number represents the assumptions about the beta (1 = unit, 2 = constant, 3 = time-varying); the second number denotes whether instruments are added to the beta specification (0 = no instruments, 1 = instruments), the third number represents whether regimes are allowed in the beta specification (0 = no regimes, 1 = regimes). The next three columns report the likelihood ratio tests comparing the different beta specifications. 'Inst>Cst' tests the significance of adding structural instruments to the constant beta specification. 'RS>Cst' tests whether regimes should be added to the beta specification using an empirical likelihood ratio test. Bold p-values indicate that our R^2 measure favours the regime-switching beta specification over the instrumental beta specification (see Baele and Inghelbrecht (2006)). 'RSInst>RS' tests the significance of adding instruments to the regime-switching beta specification. P-values are reported between brackets. The remaining columns report the results for the beta specification of the selected model for respecively the global market and the regional market factor. The columns 'β_1' and 'β_2' show the betas over the two different regimes. The p-value of the (Wald) test whether betas are significantly different across regimes is reported between brackets. The columns 'Trade' and 'Align' show the coefficients of the two structural instruments in the beta specification (if applicable). P-values are reported between brackets. Finally, the last two columns show the transition probabilities of the regimes with the p-values between brackets.

Geographical	**Model**	**Likelihood Ratio Tests**			**Global Factor**				**Regional Factor**				**Probabilities**	
		Inst>Cst	RS>Cst	RSInst>RS	β_1	β_2	**Trade**	**Align**	β_1	β_2	**Trade**	**Align**	**P**	**Q**
Europe	311	32.028	62.093	18.848	0.641	1.076	0.095	-0.034	-	-	-	-	0.920	0.959
		(0.000)	**(0.000)**	(0.000)	(0.000)		(0.000)	(0.097)	-	-	-	-	(0.000)	(0.000)
Austria	311	38.663	70.566	15.728	0.178	0.546	0.002	-0.040	0.507	0.712	0.134	0.104	0.994	0.995
		(0.000)	**(0.000)**	(0.000)	(0.000)		(0.398)	(0.214)	(0.025)		(0.001)	(0.061)	(0.000)	(0.000)
Belgium	311	36.576	94.872	22.897	0.435	0.752	0.105	-0.069	0.507	0.992	0.049	-0.019	0.976	0.972
		(0.000)	**(0.000)**	(0.000)	(0.000)		(0.009)	(0.029)	(0.000)		(0.260)	(0.368)	(0.000)	(0.000)
Denmark	311	19.403	24.774	37.430	0.505	0.578	0.085	0.055	0.314	0.902	0.019	0.056	0.997	0.996
		(0.000)	**(0.009)**	(0.000)	(0.434)		(0.026)	(0.180)	(0.000)		(0.391)	(0.200)	(0.000)	(0.000)
Finland	311	61.761	40.589	56.277	1.044	1.419	0.258	0.188	0.768	4.369	0.201	-0.107	0.989	0.525
		(0.000)	**(0.004)**	(0.000)	(0.640)		(0.003)	(0.002)	(0.000)		(0.168)	(0.220)	(0.000)	(0.398)
France	311	56.920	79.448	21.127	0.695	0.951	0.093	-0.004	0.738	1.071	0.104	-0.009	0.976	0.986
		(0.000)	**(0.000)**	(0.000)	(0.000)		(0.000)	(0.396)	(0.000)		(0.017)	(0.390)	(0.000)	(0.000)
Germany	311	139.247	172.637	71.681	0.528	0.855	0.195	-0.062	0.612	1.081	0.083	-0.016	0.980	0.969
		(0.000)	**(0.000)**	(0.000)	(0.000)		(0.000)	(0.017)	(0.000)		(0.009)	(0.322)	(0.000)	(0.000)
Ireland	311	15.091	41.149	14.440	0.623	0.708	0.051	-0.061	0.769	2.411	-0.100	0.068	0.935	0.000
		(0.001)	**(0.003)**	(0.001)	(0.698)		(0.087)	(0.049)	(0.004)		(0.070)	(0.125)	(0.015)	(0.049)
Italy	311	35.687	46.429	10.392	0.588	0.823	0.062	-0.128	0.744	1.153	-0.013	-0.092	0.995	0.998
		(0.000)	**(0.003)**	(0.006)	(0.000)		(0.071)	(0.000)	(0.003)		(0.387)	(0.112)	(0.000)	(0.000)
Netherlands	311	109.415	139.617	65.147	0.672	1.032	0.126	-0.058	0.725	0.882	0.094	-0.156	0.978	0.989
		(0.000)	**(0.000)**	(0.000)	(0.000)		(0.000)	(0.045)	(0.100)		(0.000)	(0.000)	(0.000)	(0.000)
Norway	301	0.781	26.002	1.695	0.611	1.177	-	-	0.535	0.888	-	-	0.975	0.938
		(0.677)	**(0.004)**	(0.428)	(0.000)		-	-	(0.338)		-	-	(0.000)	(0.000)
Spain	311	17.047	16.614	13.867	0.783	1.024	0.129	-0.026	0.864	1.294	0.167	-0.049	0.995	0.984
		(0.000)	**(0.042)**	(0.001)	(0.012)		(0.176)	(0.389)	(0.006)		(0.361)	(0.394)	(0.000)	(0.000)
Sweden	311	91.192	67.431	90.837	0.731	1.009	0.335	0.047	0.781	4.445	0.284	0.060	0.460	0.986
		(0.000)	**(0.002)**	(0.000)	(0.471)		(0.002)	(0.363)	(0.000)		(0.005)	(0.337)	(0.392)	(0.000)
Switzerland	311	37.515	81.631	17.113	0.544	0.800	0.032	0.000	0.464	0.966	-0.124	0.061	0.982	0.981
		(0.000)	**(0.000)**	(0.000)	(0.003)		(0.204)	(0.399)	(0.000)		(0.042)	(0.155)	(0.000)	(0.000)
UK	311	26.247	109.527	31.551	0.797	0.901	0.016	-0.014	0.905	1.385	-0.028	0.143	0.988	0.993
		(0.000)	**(0.000)**	(0.000)	(0.008)		(0.264)	(0.261)	(0.000)		(0.283)	(0.000)	(0.000)	(0.000)

Table 4: Full-Period and Subperiod Average Implied Betas for Optimal Factor Model

This table reports fullperiod and subperiod average implied betas based on the beta specification of the optimal model. The p-values of the t-test whether subperiod betas are equal to the fullperiod betas are reported between brackets. We make a distinction between the global market beta and the regional market beta of the country.

	Global Factor						Regional Factor					
	73-04	**73-82**	**83-87**	**88-92**	**93-96**	**97-04**	**73-04**	**73-82**	**83-87**	**88-92**	**93-96**	**97-04**
Europe	0.793	0.717	0.791	0.784	0.796	0.909	-	-	-	-	-	-
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-	-	-	-	-	-
Austria	0.371	0.292	0.326	0.475	0.520	0.358	0.615	0.420	0.689	0.746	0.620	0.744
		(0.000)	(0.000)	(0.000)	(0.000)	(0.198)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Belgium	0.563	0.419	0.619	0.602	0.561	0.701	0.703	0.612	0.684	0.762	0.697	0.807
		(0.000)	(0.000)	(0.000)	(0.050)	(0.000)		(0.000)	(0.032)	(0.000)	(0.358)	(0.000)
Denmark	0.548	0.511	0.626	0.533	0.501	0.582	0.658	0.512	0.550	0.750	0.784	0.807
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Finland	1.053	-	-	0.569	1.018	1.401	0.856	-	-	0.644	0.946	0.947
		-	-	(0.000)	(0.003)	(0.000)		-	-	(0.000)	(0.000)	(0.000)
France	0.857	0.814	0.820	0.830	0.842	0.975	0.949	0.830	0.880	1.004	0.985	1.110
		(0.000)	(0.000)	(0.000)	(0.000)	(0.002)		(0.000)	(0.000)	(0.010)	(0.000)	(0.000)
Germany	0.721	0.525	0.684	0.749	0.673	1.035	0.889	0.746	0.865	1.002	0.876	1.036
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.036)	(0.000)	(0.257)	(0.000)
Ireland	0.703	0.619	0.652	0.766	0.794	0.762	0.869	0.970	0.969	0.820	0.757	0.749
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Italy	0.687	0.548	0.620	0.606	0.820	0.917	0.915	0.784	0.808	0.915	1.064	1.097
		(0.000)	(0.000)	(0.000)	(0.277)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Netherlands	0.794	0.755	0.776	0.667	0.743	0.985	0.778	0.673	0.657	0.690	0.825	1.055
		(0.000)	(0.001)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Norway	0.768	0.810	0.760	0.752	0.793	0.754	0.790	0.764	0.795	0.800	0.775	0.799
		(0.000)	(0.000)	(0.000)	(0.000)	(0.001)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Spain	0.856	-	0.774	0.781	0.831	0.935	0.996	-	0.633	0.785	0.982	1.195
		-	(0.000)	(0.000)	(0.000)	(0.000)		-	(0.000)	(0.000)	(0.188)	(0.000)
Sweden	1.002	0.789	0.797	0.756	1.092	1.305	0.867	0.554	0.685	0.682	1.022	1.084
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Switzerland	0.670	0.640	0.668	0.671	0.607	0.752	0.712	0.586	0.627	0.785	0.873	0.808
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
UK	0.850	0.881	0.864	0.802	0.845	0.833	1.149	1.303	1.297	1.153	1.025	0.888
		(0.000)	(0.000)	(0.000)	(0.471)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 5: Correlation of Country Residuals for Full-time Period, Tranquil Period and Crisis Period

This table reports average unconditional correlations between country residuals and respectively world residuals, regional residuals, and country residuals of the region where the country belongs to. Market residuals are computed as outlined in Section 2. The correlations of residuals across different European countries are computed over the longest possible overlapping sample period between the markets. We differentiate between three different periods: full time period, tranquil period and crisis period. The latter is the period of crisis events as shown in Table 2. The tranquil period corresponds to all non-crisis observations. The * symbol indicates 5 percent significance level for a test of zero correlation according to the following asymptotic distribution: $\sqrt{T}\hat{\rho} \overset{a}{\sim} N(0,1)$ with T the number of observations in the specific period. This implies the following critical values for respectively the full time period, tranquil period and crisis period: 0.049, 0.059 and 0.087.

	World Residuals			**Regional Residuals**			**Within Region Residuals**		
Geographical	**Full**	**Tranquil**	**Crisis**	**Full**	**Tranquil**	**Crisis**	**Full**	**Tranquil**	**Crisis**
Europe	0.023	0.031	0.004	1.000	1.000	1.000	1.000	1.000	1.000
Austria	0.073*	0.075*	0.068	0.040	0.079	-0.048	0.073*	0.061*	0.091*
Belgium	0.008	-0.024	0.042	-0.003	-0.034	0.052	0.057*	0.051	0.075
Denmark	-0.016	-0.032	-0.003	-0.030	-0.029	-0.037	0.055*	0.056	0.056
Finland	0.013	0.024	0.000	0.013	0.036	-0.015	-0.034	0.003	-0.081
France	0.000	0.000	-0.009	0.002	-0.007	0.019	0.012	0.005	0.025
Germany	0.027	0.019	0.037	0.011	0.017	-0.002	0.022	-0.002	0.066
Ireland	0.036	0.036	0.034	0.002	0.029	-0.058	0.017	0.002	0.049
Italy	0.017	0.028	0.000	0.011	0.016	-0.001	-0.035	-0.050	0.004
Netherlands	0.020	0.034	0.001	0.022	-0.027	0.122*	0.003	0.011	-0.015
Norway	0.015	0.016	0.007	0.017	0.039	-0.023	0.065*	0.060*	0.071
Spain	0.021	0.050	0.005	-0.002	0.002	-0.003	0.021	0.000	0.050
Sweden	-0.005	0.007	-0.023	-0.018	-0.028	-0.004	0.039	0.039	0.044
Switzerland	0.042	-0.013	0.101*	0.001	-0.016	0.028	0.052	0.041	0.073
UK	0.034	0.031	0.036	0.047	0.065*	0.009	-0.236*	-0.239*	-0.232*

Table 6: Cross-section Analysis of Country Residuals for Optimal Factor Model

The time-series-cross-section regression model is estimated as outlined in Section 2 for all European countries in our sample, accommodating group-wise heteroskedasticity. We use the residuals based on the optimal factor model as discussed in Section 3.2. We make a distinction between world residuals (Panel A) and regional residuals (Panel B) affecting the country residuals. The model is estimated for each of the 7 crisis dummies as shown in Table 2. P-values are reported between brackets.

	v_0		v_1		**Wald:** $v_0 = v_1 = 0$	
Dummy	**estimate**	**p-value**	**estimate**	**p-value**	**estimate**	**p-value**
Panel A: World Residuals						
Crash '87	0.017	*(0.016)*	-0.332	*(0.041)*	9.549	*(0.008)*
Mexican Crisis	0.020	*(0.003)*	-0.063	*(0.579)*	8.714	*(0.013)*
Asian Crisis	0.021	*(0.004)*	-0.005	*(0.844)*	8.631	*(0.013)*
Russian Crisis + LTCM	0.020	*(0.004)*	0.012	*(0.832)*	8.714	*(0.013)*
Nasdaq Rash	0.021	*(0.002)*	-0.195	*(0.021)*	13.731	*(0.001)*
09/11	0.019	*(0.006)*	0.065	*(0.328)*	9.090	*(0.011)*
High World Volatility State	0.019	*(0.040)*	0.003	*(0.846)*	8.724	*(0.013)*
Panel B: Regional Residuals						
Crash '87	0.008	*(0.398)*	0.933	*(0.003)*	9.493	*(0.009)*
Mexican Crisis	0.013	*(0.164)*	-0.192	*(0.454)*	2.419	*(0.298)*
Asian Crisis	0.013	*(0.201)*	0.018	*(0.701)*	2.086	*(0.352)*
Russian Crisis + LTCM	0.012	*(0.214)*	0.102	*(0.265)*	3.109	*(0.211)*
Nasdaq Rash	0.014	*(0.148)*	-0.089	*(0.590)*	2.299	*(0.317)*
09/11	0.015	*(0.128)*	-0.146	*(0.232)*	3.475	*(0.176)*
High World Volatility State	0.011	*(0.344)*	0.008	*(0.708)*	1.976	*(0.372)*

Table 7: Cross-section Analysis of Country Residuals for Alternative Beta Specifications

The time-series-cross-section regression model is estimated as outlined in Section 2 for all European countries in our sample. We make a distinction between world residuals (Panel A) and region residuals (Panel B) affecting the country residuals. The model is estimated using the 7 dummies as shown in Table 2. Moreover the model is estimated for different sets of residuals. We use residuals based on respectively contant beta model, regime-swiching beta model, instrumental beta model and regime-switching instrumental beta model. For the instrumental beta model we differentiate between an instrumental beta model with trade integration (TI) and industry alignment (IA) as structural variables, an instrumental beta model with only trade integration (TI) as structural variable and a instrumental beta model including the term spread as additional instrument. The regime-switching instrumental beta model includes trade integration (TI) and industry alignment (IA) as structural variables. The panel model is estimated accommodating group-wise heteroskedasticity. P-values are reported between brackets.

Panel A: World Residuals

	World Residual					
	v_0		v_1		**Wald:** $v_0 = v_1 = 0$	
Dummy/Model	**estimate**	**p-value**	**estimate**	**p-value**	**estimate**	**p-value**
Part A: Crash '87						
Constant	0.017	*(0.024)*	-0.251	*(0.003)*	12.992	*(0.002)*
Regime-Switching	0.015	*(0.036)*	-0.448	*(0.001)*	14.381	*(0.001)*
Instrumental: TI + IA	0.019	*(0.008)*	-0.204	*(0.014)*	12.045	*(0.002)*
Instrumental: TI	0.014	*(0.053)*	-0.187	*(0.025)*	8.088	*(0.018)*
Instrumental: TI + IA + Term	0.019	*(0.008)*	-0.222	*(0.010)*	12.536	*(0.002)*
Regime-Switching Instrumenal (TI + IA)	0.017	*(0.016)*	-0.332	*(0.041)*	9.549	*(0.008)*
Part B: Mexican Crisis						
Constant	0.014	*(0.072)*	-0.068	*(0.536)*	3.487	*(0.175)*
Regime-Switching	0.016	*(0.031)*	-0.085	*(0.464)*	5.025	*(0.081)*
Instrumental: TI + IA	0.019	*(0.009)*	-0.026	*(0.816)*	6.762	*(0.034)*
Instrumental: TI	0.015	*(0.043)*	-0.015	*(0.879)*	4.115	*(0.128)*
Instrumental: TI + IA + Term	0.019	*(0.009)*	-0.026	*(0.805)*	6.804	*(0.033)*
Regime-Switching Instrumenal (TI + IA)	0.020	*(0.003)*	-0.063	*(0.579)*	8.714	*(0.013)*
Part C: Asian Crisis						
Constant	0.009	*(0.284)*	0.084	*(0.001)*	15.103	*(0.001)*
Regime-Switching	0.015	*(0.052)*	0.016	*(0.540)*	5.296	*(0.071)*
Instrumental: TI + IA	0.017	*(0.026)*	0.037	*(0.156)*	9.581	*(0.008)*
Instrumental: TI	0.012	*(0.102)*	0.040	*(0.124)*	7.123	*(0.028)*
Instrumental: TI + IA + Term	0.017	*(0.025)*	0.035	*(0.172)*	9.486	*(0.009)*
Regime-Switching Instrumenal (TI + IA)	0.021	*(0.004)*	-0.005	*(0.844)*	8.631	*(0.013)*
Part D: Russian Crisis + LTCM						
Constant	0.013	*(0.105)*	0.084	*(0.163)*	5.252	*(0.072)*
Regime-Switching	0.015	*(0.032)*	0.006	*(0.914)*	4.718	*(0.095)*
Instrumental: TI + IA	0.018	*(0.012)*	0.044	*(0.455)*	7.441	*(0.024)*
Instrumental: TI	0.014	*(0.052)*	0.043	*(0.476)*	4.683	*(0.096)*
Instrumental: TI + IA + Term	0.018	*(0.012)*	0.045	*(0.432)*	7.535	*(0.023)*
Regime-Switching Instrumenal (TI + IA)	0.020	*(0.004)*	0.012	*(0.832)*	8.714	*(0.013)*
Part E: Nasdaq Rash						
Constant	0.015	*(0.057)*	-0.156	*(0.068)*	6.362	*(0.042)*
Regime-Switching	0.017	*(0.022)*	-0.188	*(0.028)*	9.289	*(0.010)*
Instrumental: TI + IA	0.020	*(0.006)*	-0.198	*(0.018)*	12.143	*(0.002)*
Instrumental: TI	0.016	*(0.027)*	-0.243	*(0.006)*	11.633	*(0.003)*
Instrumental: TI + IA + Term	0.020	*(0.006)*	-0.206	*(0.014)*	12.591	*(0.002)*
Regime-Switching Instrumenal (TI + IA)	0.021	*(0.002)*	-0.195	*(0.021)*	13.731	*(0.001)*
Part F: 09/11						
Constant	0.011	*(0.176)*	0.267	*(0.000)*	20.809	*(0.000)*
Regime-Switching	0.013	*(0.075)*	0.200	*(0.001)*	15.542	*(0.000)*
Instrumental: TI + IA	0.018	*(0.015)*	0.080	*(0.194)*	8.508	*(0.014)*
Instrumental: TI	0.014	*(0.065)*	0.103	*(0.102)*	6.867	*(0.032)*
Instrumental: TI + IA + Term	0.018	*(0.014)*	0.079	*(0.194)*	8.547	*(0.014)*
Regime-Switching Instrumenal (TI + IA)	0.019	*(0.006)*	0.065	*(0.328)*	9.090	*(0.011)*
Part G: High World Volatility State						
Constant	-0.024	*(0.014)*	0.067	*(0.000)*	19.492	*(0.000)*
Regime-Switching	-0.007	*(0.458)*	0.040	*(0.005)*	10.366	*(0.006)*
Instrumental: TI + IA	0.018	*(0.055)*	0.001	*(0.954)*	6.956	*(0.031)*
Instrumental: TI	0.010	*(0.283)*	0.008	*(0.581)*	4.083	*(0.130)*
Instrumental: TI + IA + Term	0.019	*(0.051)*	0.000	*(0.978)*	7.081	*(0.029)*
Regime-Switching Instrumenal (TI + IA)	0.019	*(0.040)*	0.003	*(0.846)*	8.724	*(0.013)*

Panel B: Regional Residuals

Dummy/Model	Regional Residual					
	v_0		v_1		**Wald:** $v_0 = v_1 = 0$	
	estimate	**p-value**	**estimate**	**p-value**	**estimate**	**p-value**
Part A: Crash '87						
Constant	0.062	*(0.000)*	0.463	*(0.005)*	47.298	*(0.000)*
Regime-Switching	0.032	*(0.001)*	1.037	*(0.000)*	25.749	*(0.000)*
Instrumental: TI + IA	0.038	*(0.000)*	0.463	*(0.002)*	25.836	*(0.000)*
Instrumental: TI	0.041	*(0.000)*	0.466	*(0.002)*	28.172	*(0.000)*
Instrumental: TI + IA + Term	0.036	*(0.000)*	0.459	*(0.001)*	25.810	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.008	*(0.398)*	0.933	*(0.003)*	9.493	*(0.009)*
Part B: Mexican Crisis						
Constant	0.063	*(0.000)*	-0.176	*(0.507)*	38.763	*(0.000)*
Regime-Switching	0.035	*(0.000)*	-0.180	*(0.486)*	12.775	*(0.002)*
Instrumental: TI + IA	0.041	*(0.000)*	-0.180	*(0.493)*	17.325	*(0.000)*
Instrumental: TI	0.045	*(0.000)*	-0.157	*(0.552)*	20.316	*(0.000)*
Instrumental: TI + IA + Term	0.039	*(0.000)*	-0.170	*(0.525)*	16.298	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.013	*(0.164)*	-0.192	*(0.454)*	2.419	*(0.298)*
Part C: Asian Crisis						
Constant	0.013	*(0.201)*	0.018	*(0.701)*	2.086	*(0.352)*
Regime-Switching	0.060	*(0.000)*	0.102	*(0.035)*	44.808	*(0.000)*
Instrumental: TI + IA	0.033	*(0.001)*	0.041	*(0.390)*	13.503	*(0.001)*
Instrumental: TI	0.039	*(0.000)*	0.048	*(0.307)*	18.855	*(0.000)*
Instrumental: TI + IA + Term	0.043	*(0.000)*	0.053	*(0.266)*	22.092	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.013	*(0.201)*	0.018	*(0.701)*	2.086	*(0.352)*
Part D: Russian Crisis + LTCM						
Constant	0.061	*(0.000)*	0.192	*(0.078)*	41.265	*(0.000)*
Regime-Switching	0.033	*(0.001)*	0.104	*(0.305)*	13.346	*(0.001)*
Instrumental: TI + IA	0.039	*(0.000)*	0.130	*(0.210)*	18.436	*(0.000)*
Instrumental: TI	0.043	*(0.000)*	0.138	*(0.199)*	21.507	*(0.000)*
Instrumental: TI + IA + Term	0.038	*(0.000)*	0.122	*(0.229)*	17.365	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.012	*(0.214)*	0.102	*(0.265)*	3.109	*(0.211)*
Part E: Nasdaq Rash						
Constant	0.063	*(0.000)*	-0.082	*(0.674)*	39.030	*(0.000)*
Regime-Switching	0.035	*(0.000)*	-0.083	*(0.631)*	12.949	*(0.002)*
Instrumental: TI + IA	0.041	*(0.000)*	-0.138	*(0.424)*	17.783	*(0.000)*
Instrumental: TI	0.045	*(0.000)*	-0.127	*(0.477)*	20.724	*(0.000)*
Instrumental: TI + IA + Term	0.040	*(0.000)*	-0.132	*(0.446)*	16.769	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.014	*(0.148)*	-0.089	*(0.590)*	2.299	*(0.317)*
Part F: 09/11						
Constant	0.063	*(0.000)*	-0.133	*(0.304)*	38.184	*(0.000)*
Regime-Switching	0.036	*(0.000)*	-0.196	*(0.127)*	14.631	*(0.001)*
Instrumental: TI + IA	0.042	*(0.000)*	-0.237	*(0.061)*	20.515	*(0.000)*
Instrumental: TI	0.046	*(0.000)*	-0.247	*(0.058)*	23.665	*(0.000)*
Instrumental: TI + IA + Term	0.041	*(0.000)*	-0.237	*(0.060)*	19.536	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.015	*(0.128)*	-0.146	*(0.232)*	3.475	*(0.176)*
Part G: High World Volatility State						
Constant	0.028	*(0.017)*	0.099	*(0.000)*	51.651	*(0.000)*
Regime-Switching	0.026	*(0.022)*	0.023	*(0.283)*	12.548	*(0.002)*
Instrumental: TI + IA	0.032	*(0.007)*	0.027	*(0.207)*	17.861	*(0.000)*
Instrumental: TI	0.031	*(0.007)*	0.040	*(0.071)*	21.970	*(0.000)*
Instrumental: TI + IA + Term	0.030	*(0.010)*	0.029	*(0.185)*	16.950	*(0.000)*
Regime-Switching Instrumenal (TI + IA)	0.011	*(0.344)*	0.008	*(0.708)*	1.976	*(0.372)*