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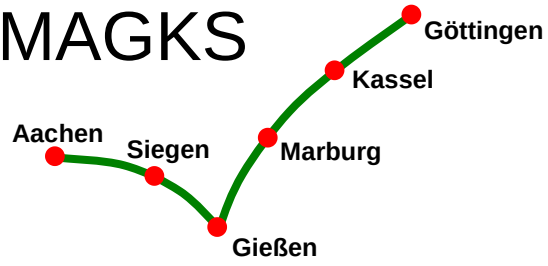

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Daily CDS pricing in emerging markets before and during the global financial crisis

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Daily CDS pricing in emerging markets before and during the global financial crisis

Abstract: In this paper, we study the determinants of daily spreads for emerging market sovereign credit default swaps (CDS) over the period April 2002–December 2011. Using GARCH models, we find, first, that daily CDS spreads for emerging market sovereigns are more related to global and regional risk premia than to country-specific risk factors. This result is particularly evident during the second subsample (August 2007–December 2011), where neither macroeconomic variables nor country ratings significantly explain CDS spread changes. Second, measures of US bond, equity, and CDX High Yield returns as well as emerging market credit returns turn out to be the most dominant drivers of CDS spread changes. Finally, our analysis suggests that CDS spreads are more strongly influenced by international spillover effects during periods of market stress.

Keywords: Credit default swaps, emerging markets, financial crisis, spillovers.

JEL classification numbers: G14, G15.

1. Introduction

Walter Wriston, then Chairman of Citibank, once famously remarked that 'countries don't go bust' (Guill (2009)). Yet, by October 1983, and only a few months after that statement had been made, 27 countries owing about $240 billion in debt had rescheduled these obligations or were in the process of doing so—in what is now commonly known as the 'LDC debt crisis'. Indeed, countries *do* go bust, in the sense of refusing or being unable to meet their financial obligations. Recent developments surrounding the restructuring of Greek government debt are a stark reminder of this fact, even though such events remain a relatively rare occurrence. Historical data reveal a number of important patterns: sovereign defaults often occur in waves and have tended to be heavily concentrated in periods of extreme stress, with the largest wave of defaults coming during the Great Depression and World War II. Historically, the majority of defaults are on countries' external debt, while defaults on domestic debt are less common. Defaults have included both emerging market and industrialised country issuers, but are dominated by the former. Specifically, based on the frequency with which a country has moved into default, emerging market borrowers are about 10 times more likely to default than their peers from developed markets.[1] Thus, country risk is an important factor in the pricing of sovereign debt, especially—though not only—for emerging market borrowers.

Assuming rational investors, we would expect that credit spreads on sovereign debt instruments reflect such risks. Surprisingly, the evidence on the importance of country-specific risks in the pricing of sovereign debt is rather mixed. Longstaff et al (2011), for example, show—using monthly data—that returns on sovereign credit default swaps (CDS), a common measure of credit risk, are substantially more correlated across countries than corresponding stock index returns. They find that these spreads are more related to US stock and high-yield credit markets, proxies of global risk premia, and international liquidity patterns, than they are to local financial measures. Thus, the country-specific risk premium—after adjusting for global and, in particular, US risk factors—appears to be almost negligible. This suggests a potentially important role for international and, in particular, US financial variables in the determination of non-US sovereign CDS spreads—and thus a channel for spillovers into those countries' funding costs in international debt markets.

Our approach is also related to the literature on the determinants of corporate credit spreads and the pricing of individual firms' CDS, which includes Collin-Dufresne et al (2001), Campbell and Taksler (2003), and Ericsson et al (2008). Longstaff and Rajan (2008), Bhansali et al (2008), and Fender and Scheicher (2009) apply similar methodologies to multi-name CDS contracts (ie, contracts based on portfolios of underlying credits). A standard finding of these studies is that broad factors, such as measures of risk appetite and market liquidity, play an important role in the determination of observed CDS spreads. Fontana and Scheicher (2010) study the relative pricing of euro area sovereign CDS and underlying government bonds and find that repricing of sovereign credit risk in the CDS market seems mainly due to common factors.

We aim to explore these spillovers by building on the extant literature on the impact of US financial variables on foreign asset returns. While previous studies of policy spillovers have typically focused on equity and bond markets, our analysis employs daily CDS spread data for twelve emerging market borrowers.[2] Sovereign CDS are traded in relatively liquid markets and

[1] Reinhart and Rogoff (2008) and Moody's (2009).

[2] For instance, Andritzky et al (2007) show that global bond spreads respond to rating actions and changes in US interest rates rather than domestic data and policy announcements. Examining country sub-samples, they discover

provide a direct indicator of the credit risk premium demanded by investors. As such, CDS premia are close proxies of the excess funding costs of sovereign borrowers relative to benchmark US Treasury yields. They also often serve as a lower bound measure for the wholesale funding costs of banks and corporate issuers from the same countries. Expanding on the analysis by Longstaff et al. (2011), our methodology differs from theirs in a number of ways. First, we employ daily instead of end-month data to measure spillover effects on sovereign CDS returns. Low-frequency data tends to exhibit higher correlations, and, hence, an empirical analysis using monthly financial market data could potentially overestimate the importance of spillover effects. In contrast, daily data measures the direct impact of US financial markets on CDS spreads, thereby also incorporating the high degree of volatility typical for financial market data (see also Figure A.2 in the Appendix). Second, in our analysis we quantify the economic relevance of such spillover effects, as we provide point estimates and their significances instead of presenting only *t*-statistics. Third, in addition to financial factors, we also incorporate several macroeconomic variables, such as economic growth, debt/GDP levels, fiscal deficits, net foreign assets and country ratings. As a consequence, we are able to directly and systematically compare the effects of international financial variables with domestic financial variables *and* macroeconomic factors. Furthermore, we also control for target rate movements by the European Central Bank (ECB) and the Federal Reserve (Fed). Fourth, we split our sample to examine potential differences in the reaction of CDS spreads to the various factors before and during the recent financial crisis.[3] Finally, we use a panel framework to estimate the influence of the factors more efficiently and to illustrate the most relevant drivers of emerging market CDS spreads at a glance in one model.

We investigate the determinants of daily spreads for emerging market sovereign CDS spreads by addressing three closely related research questions. First, are there common factors that cause daily sovereign CDS spread changes across emerging financial markets? Second, what is the impact of (i) domestic financial and macroeconomic variables and country ratings compared to (ii) US and international financial variables on daily sovereign CDS spread changes? Third, are there noticeable differences in the reaction of CDS spreads before and during the recent financial crisis?

Our findings suggest that (i) common factors play a role for daily sovereign CDS spread changes across emerging financial markets, (ii) daily CDS spreads for emerging market sovereigns are more related to global and regional risk premia than to country-specific risk factors. This result is particularly evident during the second subsample (August 2007–December 2011), where neither macroeconomics variables nor country ratings significantly explain CDS changes. Finally, (iii) the amplified reaction to international financial variables in the second subsample suggests that CDS spreads are more strongly influenced by spillover effects during the financial crisis.

The remainder of this paper is organised as follows. Section 2 presents a brief introduction to the mechanics of sovereign CDS. Section 3 describes the CDS data and our sample selection process and introduces the explanatory variables used in the empirical analysis. Section 4

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that US news matter less to countries with more transparent policies and higher credit ratings. Arora and Cerisola (2001) explore how country risk—proxied by sovereign bond spreads—is influenced by US monetary policy, country-specific fundamentals, and conditions in global capital markets. They conclude that the stance and predictability of US monetary policy are important for stabilising capital flows and capital market conditions in emerging markets.

[3] Longstaff et al. (2011) use a sample break in their principal component analysis but not in their regression analysis.

presents the econometric methodology, illustrates the results and reports a number of robustness tests. Section 5 concludes.

2. Sovereign credit default swaps (CDS)

Sovereign CDS are financial contracts offering insurance against losses from credit events on outstanding debt issued by sovereign entities. Standard contracts have two legs. The protection buyer pays a premium (the premium leg), expressed in basis points per notional amount of the contract, in exchange for a contingent payment (the contingent leg) if any of the contractually pre-specified credit events occurs. Settlement for these contracts has typically been by physical delivery of admissible bonds, in return for payment of the original face value.[4] As such, CDS for both sovereign and corporate reference entities are defined by five separate contractual features: (1) the debt issuer (reference entity), (2) a set of reference obligations, (3) the contract term (eg, 5 years), (4) a notional principal amount and (5) a list of events triggering protection payments (Markit (2008b)).

Standard International Swaps and Derivatives Association (ISDA) documentation defines six different credit events, some or all of which may be selected for individual CDS contracts: (1) bankruptcy of the reference entity, (2) failure to pay (the reference entity fails to make interest or principal payments when due; a grace period and materiality threshold may apply), (3) debt restructuring (the configuration of debt obligations is changed in an unfavourable way for the creditor, eg maturity extension, coupon or par amount reduction, postponement in coupon dates or change in currency), (4) obligation default, (5) obligation acceleration, (6) repudiation/moratorium. The range of restructuring events included in the CDS contract will depend on the chosen restructuring clause. In our sample, the clause most commonly found in sovereign CDS is the so-called complete (or cum-) restructuring (CR) clause, which allows for any form of restructuring and delivery of any bond of maturity up to 30 years.[5] This stands in contrast to CDS for corporate issuers, which tend to limit the range of qualifying events as well as the allowable maturity of deliverable obligations.[6]

Pricing of such contracts results in a CDS premium (spread) equating the present value of both payment legs over the (expected) lifetime of the deal. Holding the annual probability of default (conditional on earlier non-default) constant over time, pricing can be interpreted in terms of a constant hazard rate (Duffie and Singleton (2003)). Making further assumptions, such as the absence of counterparty default risk and continuous premium payments, the CDS spread at origination (ie, with market value of zero) can then be shown to equal $(1-\rho)\lambda$, where ρ is the recovery rate and $(1-\rho)$ denotes loss given default (LGD). The hazard rate λ corresponds to a risk neutral loss probability that reflects the risk preferences of investors. Using actual probabilities of default (PD) instead, this yields the term $(1-\rho)PD + RP$ for the annual CDS spread, where a risk premium (RP) accounts for the difference between λ and PD, which is typically positive. In other words, observed CDS spreads tend to represent a combination of

[4] The first ever credit event auction for sovereign CDS was held on 14 January 2009, enabling cash settlement of contracts for Ecuador.

[5] See Markit (2008b). Given the lack of maturity limitations, protection buyers can technically deliver long-maturity obligations (cheapest-to-deliver option) in case of a credit event, as long as the bond is pari passu or senior to the reference obligation on the contract.

[6] The complete restructuring (CR) clause dates back to the original 1999 ISDA credit derivatives definitions, with the modified (MR) and modified-modified (MM) restructuring clauses introduced in 2001 and 2003, respectively.

expected loss ($EL = (1–\rho)PD$) and an extra premium to compensate investors for risks in addition to *EL*.

Note that full-scale default is only one type of event that sovereign CDS insure against. In particular, relevant standard documentation tends to be based only on restructuring, repudiation/moratorium, and failure to pay (allowing for pre-defined grace periods). Thus, the bankruptcy credit event is generally not covered in sovereign CDS. Instead, the contingent CDS payment might be triggered when, for example, amendments are made to the legal codes governing the issuance of sovereign debt[7] or when interest or principal payments (subject to minimum threshold amounts) on individual obligations are made with (even relatively short) delays, which would give the protection buyer the right to deliver (subject to any deliverability requirements) any discounted bonds at face value—an event that would tend to generate relatively high recovery rates. As a result, and abstracting from other factors, such as liquidity premia, observed increases in sovereign CDS spreads may reflect rising probabilities of such a scenario of 'technical default'—along with the transition risk of a sovereign rating downgrade—as much as genuine concerns about principal losses on outstanding debt.

One advantage of working with sovereign CDS data is that these contracts are among the most actively traded instruments in global credit markets. Depository Trust and Clearing Corporation (DTCC) data for end-December 2009 indicate that, among the top-100 reference names (by US dollar-equivalent gross notional amounts outstanding) in the CDS market, 19 were sovereign entities (of which, 11 were emerging market sovereigns), including all of the top-6 names. In volume terms, at $1.46 trillion, these sovereigns accounted for almost 30% of the aggregate notional amount of the top-100 reference names taken together. By the first quarter of 2012, this ratio had risen to 40%, with gross notional amounts outstanding for the 25 sovereign issuers among the top-100 at $2.24 trillion. Detailed volume data for the full period covered in this study (see below) is unavailable, but other studies suggest that the overall market for sovereign CDS has been active enough even during these earlier years to support our analysis (see Longstaff et al (2011)).

3. Sample selection and data

Our sample period extends from April 2002 to December 2011.[8] We split the sample with the aim of comparing the influence of domestic and international variables during 'normal' times and during major financial turbulences.[9] In total, we have 1391 daily observations for the pre-crisis sub-sample (April 2002–July 2007) and 1153 daily observations for the financial-crisis sub-sample (August 2007–December 2011). The data set used in this paper is described in more detail below.[10]

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[7] This is was the case in March 2012, when ISDA determined that the use of 'collective action clauses' to amend the terms of Greek law-governed bonds issued by the Hellenic Republic reduced the right of all holders of these bonds to receive payments, thus constituting a restructuring event under the CR clause.

[8] April 2002 marks the first month in our sample for which data is available systematically across the countries and on a daily basis.

[9] See, for example, Fender and Hoerdahl (2007) and chapter VI in BIS (2008). Figure A.1 in the Appendix indicates an increasing importance in the common component of CDS spreads. With the inception of the financial crisis in August 2007, the explanatory power of the first common factor for sovereign CDS spreads increases.

[10] We also considered a second split point in the data to examine 'post-crisis' effects. However, it is unclear if the financial crisis actually ended during our sample period, particularly in the mature economies, where our spillover effects originate.

Creating a sample of sovereign CDS

The CDS data used in this paper are provided by Markit, one of the largest suppliers of CDS quotes and related services. Our sample is restricted to the most active market segment, namely contracts denominated in US dollars with a 5 year maturity. To enhance the reliability of the observed daily price quotes, we construct a sample of CR-equivalent spreads (ie, spread observations that correspond to contracts with complete restructuring). We start with the quotes available for CR contracts, which are the majority of the quotes in our sample. In those cases where CR quotes are not available, we fill the remaining gaps by finding any other quotes (ie, for contracts with zero restructuring (XR), modified restructuring (MR) or modified-modified restructuring (MM)) and then convert observed spreads into CR-equivalents using a set of 'factors' provided by Markit (Markit (2008a)). The available CR-equivalents are then averaged into implied CR quotes using arithmetic means.

This methodology provides us with a sample of daily CDS spreads for a total of 80 reference countries, which includes both mature and emerging market sovereigns. In the majority of cases, CDS spreads do not move over prolonged periods of time (in particular before the financial crisis and for mature countries), which raises doubts about the true market liquidity of these particular contracts. Therefore, we keep only those countries for which spread changes are observed for at least 90 percent of the days in either sub-sample period. We then end up with a sample of 12 emerging market borrowers from four geographical regions: Bulgaria (BGR), Russia (RUS), and Turkey (TUR) from Central and Eastern Europe; Brazil (BRA), Colombia (COL), Peru (PER), and Venezuela (VEN) from Latin America; China (CHN), Malaysia (MYS), the Philippines (PHI), and Thailand (THA) from Asia, and South Africa (ZAR).

Explanatory variables

Our analysis incorporates several domestic and international factors potentially determining sovereign CDS spreads. First, we explore the influence of several macroeconomic indicators in our setup. Our conjecture is that higher real GDP growth lowers CDS spreads, whereas a higher debt-to-GDP-ratio and/or deficit-to-GDP-ratio should increase sovereign borrowing costs. This is based on the assumption that a rise in the former (latter) ratio decreases (increases) the likelihood of a debt crisis. We also include the annual change in the Aggregate Effective Currency Mismatch (AECM) indicator of Goldstein and Turner (2004) into our analysis. It is defined as the ratio of net foreign currency assets available for repayment of foreign currency debt relative to exports of goods and services times the foreign currency share in total debt. Defined this way, the AECM indicator captures the fact that currency movements can translate into credit risk if borrowing is in foreign currency and borrowers do not have matched foreign currency income.

Second, we take into account country-specific effects and insert eleven country dummies, using Bulgaria as the reference country. Another dummy variable captures the impact of exchange rate pegs on CDS spreads, which allows us to control for modifications in a country's exchange rate regime on a year-to-year basis.[11] In addition, adjustments in country risk and, hence, borrowing conditions for sovereign issuers are approximated using data on sovereign bond rating actions by Moody's as well as Standard & Poor's. For this purpose, one dummy variable covers improvements in either one of the two rating agencies' credit opinions on countries in our sample on the respective announcement dates, and another dummy indicates worsening opinions. Interest rate changes by the ECB and the Fed are included for comparison.

[11] Exchange rate regimes are coded according to the IMF's Exchange Arrangements and Exchange Restrictions data.

Third, several US financial market variables are incorporated, either in terms of growth rates or first differences (see Table A.2 in the Appendix for an overview), to capture the effect of various continuous pricing factors in the determination of sovereign CDS spreads. Specifically, S&P 500 index returns and the Chicago Board Options Exchange Volatility Index (VIX Index) are used to proxy US stock market conditions. The latter index, a popular gauge of investor risk appetite in equity markets, measures the implied volatility of S&P 500 index options and is included as credit-risky products are known to compensate investors for more than pure expected losses from default (see section 2 above). US bond market conditions are covered by the US 3-month Treasury bill rate, the US yield curve slope (which is expressed as the difference between the 10-year Treasury bond rate and the 3-month Treasury bill rate) as well as the Merrill Lynch MOVE volatility index (which is a yield curve-weighted index of the normalised implied volatility on 1-month Treasury options and expected to capture risk preferences in fixed income markets). The CDX North American High Yield index spread, a measure of the cost of default protection on a portfolio of 100 corporate borrowers, serves as a benchmark of market sentiment in CDS markets for reference entities of broadly similar credit quality as the sovereign borrowers in our sample. Similarly, total returns on overall as well as regional EMBIG indices are used to control for conditions in the (cash) markets for traded external debt instruments by emerging market borrowers. Market liquidity conditions more generally are proxied by the Refco spread, which compares ten-year yields on bonds issued by Resolution Funding Corporation with those on US Treasury bonds.[12] Bilateral exchange rates for the currencies of our sample countries vis-à-vis the US dollar and returns on those countries' major domestic stock market indices are included to analyse the effect of changes in country-specific conditions. Finally, we control for day of the week effects using four dummy variables, with Monday as reference day.

4. Econometric methodology and results

Our econometric approach proceeds as follows. First, we conduct a principle components analysis to reveal systematic patterns in our sovereign CDS data and to illustrate broad relationships between the common factors extracted from these CDS spreads and the behaviour of other financial market variables. Second, we explain movements in CDS spread changes and their volatility using a variety of explanatory variables ('pricing factors') in the framework of a GARCH(1,1) model (Bollerslev (1986)). Note that such a procedure is consistent with a Bayesian updating process (Engle (2001)). In principle, the explanatory variables help decompose CDS spread changes into components related to expected loss (EL) and a variety of risk premia. However, given our focus on financial market spillovers, we do not disentangle the drivers of these two components thoroughly. Finally, we explore the robustness of our findings using a variety of tests.

Exploratory principal components analysis

Principal components analysis can shed some light on the importance of different factors in the determination of sovereign CDS spreads. For this purpose, our sample of 12 emerging market sovereigns is analysed using daily CDS spread data (absolute basis point changes) for the periods April 2002–July 2007 and August 2007–December 2011, respectively. The decomposition is based on maximum likelihood estimation and determines the overall number of

[12] Resolution Funding Corporation (Refco) is a US Treasury agency that was created to help resolving the bank failures that occurred during the US savings and loan crisis and whose debt carries an explicit guarantee by the US government.

factors on the basis of their shares in total observed variance. The common factors identified this way account for relatively high percentages of the observed correlations across the various CDS spread variables (Table 1).

[Table 1 about here].

Focussing on the first principal component indicates that, in the pre-crisis period, 32% of common variation of CDS spreads relate to the first factor. During the second subsample, the explanatory power of the first factor increases up to 69%. In contrast, the influence of the two other factors is marginally lower during the crisis period. Studying correlations of the first principal component with various financial market variables (Table 2) suggests that it is best interpreted as a broad 'credit' or 'financial market' factor—it correlates significantly positively with measures of equity (S&P 500) and emerging credit market returns (EMBIG) and negatively with proxies for risk appetite (VIX, MOVE) and US CDX High Yield returns (CDX HY), though not that much with broad indicators of market liquidity (Refco spread). Another noteworthy finding is that the correlations of the first principal component with the global financial market variables increase significantly during the financial crisis. Thus, our results suggest that daily CDS spreads are related more to global and regional risk premia than country-specific risk factors. Nevertheless, idiosyncratic risk can play an important role for individual countries, but less so in periods of market stress or reduced risk appetite. Similar patterns are observed for equity returns, although, with about 26% (pre-crisis) and 43% (crisis), the predominance of the first factor in explaining observed variance is much less pronounced than for CDS spread changes.

[Table 2 about here].

Our results are broadly in line with earlier studies of sovereign CDS spreads, such as Longstaff et al (2011), who find—using monthly data—first, that sovereign credit is more correlated across countries than are equity returns. Second, the explanatory power of their first common factor also increases during the financial crisis period. In their sample of monthly CDS quotes, the first principal component accounts for about 43% (2000–2006) and 75% (2007–2010) of the variation in sovereign spreads, and there is little evidence of a country-specific risk premium once global risk factors are taken into account. Our findings suggest that common factors are slightly less important at the higher daily frequency.

Explaining CDS returns with a GARCH model

Descriptive statistics show that the emerging market CDS series exhibit excess kurtosis, but almost no skewness (see Tables A.1a and A.1b in the Appendix), which indicates volatility clustering (Engle (1982); see Figure A.2 in the Appendix for an example). This implies that (i) the amplitude of financial returns varies over time, (ii) some time periods are more volatile, and therefore more risky, than others and these periods are not scattered randomly, and (iii) there is a noticeable degree of autocorrelation in the riskiness of financial returns. The models are specified in terms of a panel framework (ie, using a stacked sample with country-specific fixed effects). The panel framework helps assessing the most relevant drivers of emerging market CDS spreads consistently in one model. Furthermore, we obtain a larger number of observations for each type of news event, which is particularly relevant for rating changes and the slow moving macroeconomic variables. Finally, the increase in estimation efficiency allows reducing

the Type I inference error by systematically testing at a conservative one percent level of significance.

To validate the homogeneity assumption underlying the panel framework, we conduct country-specific analyses and use statistical testing to check for significant differences in the country-specific reactions. Tables A.3a and A.3b in the Appendix show that in only a very few cases do we detect a reaction that is statically different from the reference country, Bulgaria. To further confirm the impression of homogeneity, we conduct robustness tests for the final models in Table 3, where we include the significant country-specific variables from Tables A.3a and A.3b in the Appendix. Our results and their interpretation remain unchanged.[13] Hence, our pooling approach is not invalidated by heterogeneity across countries. Put differently, the sample countries are generally affected in a very similar way, regardless of the degree of trade or financial integration with the United States.

Since preliminary OLS estimations show significant ARCH effects in both sub-samples (with F(1,16690) = 2214* and F(1,13834) = 579* , respectively), we employ GARCH models for both periods. We start with a general GARCH(1,1) specification (Bollerslev (1986)) as follows:

$$
\begin{aligned}
(1)\ CDS\ changes_t \\
&= \gamma + \delta\ day\ of\ the\ week\ effects_t + \zeta\ country\ dummies_t + \eta\ FX\ regime\ dummy_t \\
&+ \theta\ macroeconomic\ variables_t + \iota\ country\ ratings_t \\
&+ \nu\ ECB\ and\ Fed\ target\ rate\ changes_t + o\ financial\ variables_{t-1} + \mu_t,
\end{aligned}
$$

$$
\mu_t = \epsilon_t h_t^{1/2},
$$

$$
h_t = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \beta_1 h_{t-1},
$$

where α_0, α_1, β_1, μ, κ_1, κ_2, γ, δ, ζ, η, θ, ι, ν, and o are parameters or vectors of parameters, and $\varepsilon_t|\Gamma_{t-1}$ = t(v), with Γ_{t-1} capturing all the information up to t-1, and t(v) a t-distribution with v degrees of freedom. The residuals μ_t are not assumed to be independent and identically distributed (i.i.d.). Instead, μ_t is the product of the i.i.d. error component ε_t and the square root of an explicitly modelled variance equation. The latter consists of a constant term α_0, the ARCH term $\alpha_1 \mu_{t-1}^2$, which captures the impact of lagged residuals on today's variance, and the GARCH term $\beta_1 h_{t-1}$, which measures the persistence in the variance equation.

Country-specific effects and day of the week effects are captured by (step) dummies and another dummy variable is created for countries with pegged exchange rates.[14] Macroeconomic variables enter equation (1) as yearly measures. Changes in country ratings (split into improvements and degradations), ECB and US target rate changes (split into hikes and cuts) enter the equation on the day the news actually reaches the respective market. The vector of financial variables in equation (1) contains past CDS spread changes and the financial variables described in section 4 above. The contemporaneous financial market returns are omitted to avoid simultaneity problems. Finally, student-t distributed errors (Bollerslev (1987)) are assumed; these provide a better approximation to residuals that are not normally distributed (even after using a GARCH model specification).

[13] To conserve space, we do not report these regressions in detail. All the omitted results are available upon request.

[14] The IMF data used to code the exchange rate regimes for the countries in our sample distinguishes ten different exchange rate regimes (of which eight amount to some sort of a peg).

Starting from this comprehensive GARCH(1,1) model, we exclude all insignificant variables in a consistent general-to-specific testing-down approach ($Chi^2(19) = 34.4$ and $Chi^2(27) = 46.1$, respectively) at a one percent significance level. The simplified GARCH(1,1) models fully remove the ARCH effects in the residuals ($F(2,16675) = 0.1$ and $F(2,13817) = 0.9$, respectively). Finally, we can rule out an integrated GARCH process (Nelson, 1990) in either case ($Chi^2(1) = 204^*$ and $Chi^2(1) = 64.6^*$, respectively). Table 3 reports the results.

[Table 3 about here].

Country-specific factors: In the pre-crisis sub-sample and after controlling for the other factors, Colombian, Peruvian, Turkish, and Venezuelan spread changes are, respectively, 0.25/0.25/0.37/0.50 bps lower on average than those of Bulgaria, Brazil, the Philippines, Russia, and South Africa.[15] CDS spread changes for China (0.11 bps), Malaysia (0.14 bps), and Thailand (0.07 bps) are found to be, on average, higher than those for the five countries mentioned above. In contrast, country dummies do not significantly explain spread changes in the financial crisis period (exclusion test: $Chi^2(11) = 2.6$).

We discover strong evidence that macroeconomic variables exert a significant impact on CDS spreads only before the financial crisis. Interpreting our results for the pre-crisis period suggests the following effects: Lax fiscal policy worsens credit conditions, as a higher budget deficit (in percentage of GDP) increases CDS spreads (0.02 bps). Surpluses of foreign currency income, as measured by changes in the AECM indicator, are found to improve a country's credit conditions. A one unit change in the indicator reduces the observed average spread by 0.01 bps. Credit ratings, our third measure of country risk, also affect CDS spreads.[16] On average, each one notch improvement in sovereign ratings by either Moody's or Standard & Poor's decreases observed spreads by 0.43 bps. The corresponding effect of a one notch downgrade increases spreads by around 1.21 bps. Statistical tests confirm the asymmetric reaction to good and bad news, as the latter effect is significantly larger ($Chi^2(1) = 16.3^*$). However, during the financial crisis, neither macroeconomic factors nor rating variables are found to have a significant impact on the sovereign CDS spreads (exclusion tests: $Chi^2(4) = 12.2$ and $Chi^2(2) = 2.7$, respectively) in the sample.

Monetary policy news: Turning to ECB and US monetary policy variables, we find that interest rate changes do not significantly affect daily CDS spreads in the first sub-sample. Before the crisis, changes in key interest rates are usually well-prepared by both central banks via central bank communication.[17] As a consequence, financial market expectations are altered before the interest rate decision, which causes the actual change to be insignificant. During the second sub-sample, there is primarily a downward trend of interest rates toward the zero lower

[15] For the first subsample, country-specific effects cannot be jointly excluded from the unrestricted model ($Chi^2(11) = 91.3^*$). However, average CDS spreads for Brazil, the Philippines, Russia, and South Africa are not significantly different from those for Bulgaria and can be excluded ($Chi^2(4) = 8.8$).

[16] In the literature, rating changes are typically found to lag market information. Hull et al (2004), for example, report that spread changes tend to anticipate negative rating announcements, especially when extreme deterioration in credit quality materialises within a short time period. Nevertheless, negative rating events (ie, downgrades and announcements of reviews for possible downgrade) are generally found to give rise to statistically significant contemporaneous price or spread movements. However, the changes are often economically insignificant and much smaller than would be suggested by the magnitude of the rating change itself; see Cantor (2004).

[17] For instance, Hayo and Neuenkirch (2010) show that in the case of the Fed, central bank communication helps predict changes in the Federal Funds rate. Jansen and de Haan (2009) provide similar evidence for the ECB's main refinancing rate.

bound. However, in contrast to the Fed, the ECB also implemented interest rate increases in the later sample period. These ECB interest rate hikes matter: a 25 bps increase in the main refinancing rate lowers the average sovereign CDS spread by 7.77 bps. Thus, for a given level of sovereign yields, an increase in the ECB's target rate reduces the spread between both rates underproportionally.

Financial factors: We find that past changes in CDS spreads can be used to predict today's returns in the pre-crisis subsample. This could be an indication that CDS markets were relatively thin during the first years of our sample, in spite of the fact that we concentrate on the most liquid contracts. A negative constant term indicates the declining trend in CDS spreads during that period (–0.09 bps). Positive US stock market returns are found to reduce CDS spreads. A one percentage point increase in the S&P 500 induces an average absolute CDS spread decline by 0.07 bps (pre-crisis) or by 0.71 bps (crisis). This is in line with Merton (1974)-type models, which propose that an improving US stock market environment should be associated with a higher 'distance to default' for US borrowers. Our result suggests that such a positive sentiment in US markets spills over into sovereign credit markets as well. Similarly, risk appetite, as proxied by the VIX implied stock market volatility index, significantly reduces CDS spreads after July 2007 (–0.04 bps). Higher yields in the US bond market also decrease average CDS spreads by 2.52 bps for each one percentage point increase in the 3 month yield in the financial crisis period and by 0.56 bps (pre-crisis) or by 1.39 bps (crisis) for the same increase in the yield curve slope. Thus, consistent with our expectations, for a given level of sovereign yields, an increase in the US reference rate lowers the spread between both rates (as proxied by the CDS premium), but not to the same extent.

Sentiment in high yield CDS and cash credit markets also plays a role. The spread on sovereign CDS increases on average by 0.77 (5.18) bps after a one percentage point hike in similarly-rated US corporates before (after) July 2007. Positive returns on the global EMBIG index tend to compress sovereign CDS spreads, by 0.19 and 1.37 bps, respectively.[18] Finally, domestic stock market returns are also found to have explanatory power, as higher returns lead to an increase in CDS spreads during the financial crisis (0.12 bps). This suggests that sovereign debt and equity market exposures are considered as (imperfect) substitutes in investors' portfolios.

In general, sovereign CDS are more sensitive to changes in a broader set of financial variables (most noteworthy, the VIX Index and US 3 month yield) during the financial crisis than before. Furthermore, the reaction to international financial variables is much stronger, by a factor ranging from 2.5 to 10 during the later period, as can be inferred from the estimated coefficients. Note that the dramatic rise in spillovers from other financial markets is not simply a result of more unconditional market volatility: the standard deviation of CDS spread changes is only marginally higher over the second sub-sample and the absolute mean of CDS changes even declined during the financial crisis (see Tables A.1a and A.1b in the Appendix). Thus, our results are consistent with a more general change in market participants' pricing of sovereign CDS during the crisis.

Discussion: Our findings suggest, first, that during the pre-crisis sub-sample (April 2002–July 2007), emerging market borrowing conditions are significantly influenced by both internal (domestic) as well as external (international) economic conditions, even as external factors appear to dominate. Second, this pattern changes in the financial crisis sub-sample (August

[18] Note that during the second subsample, the regional EMBIG index partially offsets this effect. However, the summing up global and regional EMBIG indices yield a statistically significant negative coefficient ($Chi^2(1) = 32.1$).

2007–December 2011), when ratings and domestic macroeconomic conditions in emerging markets do no longer significantly explain spread changes. Hence, in times of a market stress, investors appear to care less about country-specific conditions and adjust their portfolios mainly to global developments. In line with this interpretation, the explanatory power of the first common factor for CDS spread increases from 32% to 69% during the financial crisis, arguably reflecting the global financial environment, Third, additional international financial variables are found to significantly influence CDS spreads during the second sub-sample, which also suggests that spillover effects have a stronger impact on CDS spreads during crisis periods. Moreover, the estimated coefficients for international financial variables are 2.5 to 10 times larger than before July 2007, even though the volatility in CDS spread changes did not increase.

Robustness tests[19]

To explore the robustness of our findings, we, first, confirm that our selection of countries is appropriate. We calculate country-specific models for the emerging market countries that were left out of the sample due to concerns about illiquidity in their sovereign CDS spreads. We find that CDS spreads from these countries are not as systematically and symmetrically affected by the various pricing factors than those in our sample. Second, we extensively control for the influence of the exchange rate regime on the reaction of CDS spreads. For this purpose, we split our data set into one group of countries characterised by pegged exchange rate regimes and another group operating floating exchange rates. As we do not obtain further insights from this analysis, we confirm the superiority of our more parsimonious approach. Third, we proxy exchange rate risk using (i) the standard deviation of the respective bilateral exchange rates and (ii) a time-variant measure of risk provided by the conditional variance of the respective bilateral exchange rates. Again, this does not yield further insights. Forth, we include several variables to control for additional extraordinary events and measures undertaken by governments and central banks during the financial crisis. For that purpose, we rely on a list of major events compiled by the BIS (BIS, 2009). The explanatory variables in our model remain virtually unchanged. Finally, our results are robust to several variations in the GARCH specification.

In an extension to the analysis presented above, we include indicator variables for US monetary policy communications over the period April 2002 – December 2009.[20] We discover that US monetary policy communication significantly influences daily sovereign CDS spread changes during the financial crisis, but not before. This can be interpreted as evidence of international monetary policy spillovers on country risk premia for sovereign borrowers in emerging markets. Specifically, US interest rate cuts, coordinated liquidity actions by central banks and communications about the economic outlook and the future course of monetary policy are found to have a potentially meaningful economic influence on emerging market CDS spreads. Note that our main results, as presented above, are not affected by the inclusion of indicators for US monetary policy communication.

[19] All omitted results are available upon request.

[20] For more information on the US central bank communication data set, see Hayo et al (2008). Ehrmann and Fratzscher (2007) find qualitatively similar effects of Federal Reserve and ECB communication on financial markets in a sample ending in May 2004. This suggests that ECB communications are likely to generate spillovers comparable to those documented here for the United States, in particular since, in our analysis, CDS spreads are significantly affected by ECB monetary policy actions during the second subsample.

5. Conclusion

Credit default swaps, especially those referencing sovereign issuers, have become a hotly debated topic in both public and private circles, not least because of recent events involving Greece. Yet, even though these instruments have been around since the early 1990s, academic studies of CDS markets and of price determination in those markets still remain rather scarce—at least compared to the level of interest in those instruments outside the academic community. In an effort to fill some of the gaps in the current literature, this paper investigates the determinants of daily spreads for emerging market sovereign CDS, focusing in particular on the effects of financial market spillovers for CDS pricing. Specifically, we use GARCH models estimated over the periods April 2002–July 2007 and August 2007–December 2011 to establish the impact of a broad range of potential influences, particularly those exerted by international financial variables. Our study provides answers to three closely related questions regarding the importance of spillovers from broader financial markets for the determination of sovereign CDS spreads.

First, our results suggest that daily CDS spreads for emerging market sovereigns are related more to global and regional risk premia than country-specific risk factors, although idiosyncratic risk can play an important role for individual emerging market borrowers. This is in line with earlier findings that diversification opportunities from spreading fixed income investments across countries and regions might be more limited than expected (and more so for fixed income instruments than for equity market investments; see Longstaff et al (2011)). In particular, measures of US bond, equity, and CDX High Yield returns as well as emerging market credit returns turn out to be the most dominant drivers of CDS spreads.

Second, we detect noteworthy differences in the determination of CDS spreads over time. During the early years of our sample, emerging market CDS spreads react to country-specific factors. This pattern changes dramatically during the financial crisis, as country-specific factors no longer play a statistically significant role.

Finally, during the financial crisis, external (international) factors are more important for the determination of CDS spreads than are internal (domestic) factors, both in terms of statistical significance and economic importance. The impact of these variables increases by a factor of between 2.5 and 10 in the second subsample, which supports the conclusion that spillover effects play a much larger role during crisis periods than during more tranquil times.

Overall, these findings support the possibility of significant international spillovers from developments in international and, particularly, US financial markets to emerging market sovereign borrowers. More specifically, as CDS premia are close proxies for the excess funding costs of sovereign borrowers relative to benchmark US Treasury yields, movements in US and other major financial markets can exert a meaningful influence on the funding costs of sovereign issuers, banks and corporate borrowers from emerging market economies. By extension, policy measures taken in the major advanced economies can feed directly into the funding costs of their emerging market peers, at least temporarily.

Finally, our finding that monetary policy decisions and their communication (see the robustness tests described in section 4) can have an influence on sovereign borrowers raises important issues in the context of current discussions about exit strategies from historically low, crisis-induced monetary policy rates. Put differently, monetary policy-induced changes to these spreads, as a result of both policy actions and their communication, can have a potentially significant impact on the borrowing costs in emerging market economies. Country authorities may want to take these effects into account when devising their own policies.

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Table 1: Factor analysis[1]

Changes in CDS spreads versus stock market returns

	CDS Spread Changes		Stock Market Returns	
	% Expl.	Cum. % Expl.	% Expl.	Cum. % Expl.
Pre-Crisis (04/2002 – 07/2007)				
PC1	32.03	32.03	25.96	25.96
PC2	14.10	46.13	10.30	36.26
PC3	7.86	53.99	8.49	44.75
Financial Crisis (08/2007 – 12/2011)				
PC1	68.97	68.97	42.88	42.88
PC2	11.85	80.82	12.02	54.90
PC3	5.57	86.39	8.33	63.23

[1] First three factors; maximum likelihood estimation.

Table 2: PCA correlations[1]

Correlations of first CDS factor with various financial market variables

	Pre-Crisis (04/2002 – 07/2007)	**Financial Crisis (08/2007 – 12/2011)**	**Difference significant?**
S&P 500	0.11 *	0.44 *	*
VIX	–0.15 *	–0.37 *	*
US 3 month rate	0.02	0.15 *	*
Yield curve slope	0.00	0.10 *	
Move volatility index	–0.08 *	–0.23 *	*
CDX HY index spread	–0.26 *	–0.49 *	*
Refco spread	–0.02	0.12 *	*
Global EMBIG spread	0.60 *	0.85 *	*
Africa EMBIG spread	0.03	0.38 *	*
Asia EMBIG spread	0.28 *	0.73 *	*
Europe EMBIG spread	0.51 *	0.77 *	*
Latin EMBIG spread	0.57 *	0.76 *	*

[1] First factor, see Table 1. A * denotes significance at the 1 percent level.

Table 3: Explaining changes in sovereign CDS spreads[1]

Results of simplified GARCH regressions

Mean Equation	**Pre-Crisis (04/2002 – 07/2007)**	**Financial Crisis (08/2007 – 12/2011)**
Constant Term	–0.086	
Tuesday		0.129
Wednesday	–0.040	
Thursday	–0.037	0.119
China	0.109	
Colombia	–0.253	
Malaysia	0.135	
Peru	–0.253	
Thailand	0.070	
Turkey	–0.373	
Venezuela	–0.501	
Deficit/GDP	0.020	
Δ(AECM)	–0.014	
Improved Rating	–0.425	
Worse Rating	1.208	
ECB Interest Rate Hike		–7.770
CDS 1st lag	0.196	
S&P500 1st lag	–0.070	–0.711
VIX 1st		–0.043
US 3 Month Yield 1st lag		–2.526
US Yield Curve Slope 1st lag	–0.561	–1.391
CDX HY 1st lag	0.770	5.178
EMBIG Global 1st lag	–0.192	–1.371
EMBIG Regional 1st lag		0.466
Domestic Stock Returns 1st lag		0.123
Variance Equation	**Pre-Crisis (04/2002 – 07/2007)**	**Financial Crisis (08/2007 – 12/2011)**
α_0	0.007	0.293
α_1	0.147	0.171
β_1	0.853	0.829
Student-t d.o.f.	3.284	4.714

[1] The table shows all variables of the reduced model resulting from the testing-down process at the one percent significance level. Standard errors are heteroscedasticity-consistent (Bollerslev and Wooldridge (1992)).

Appendix

Figure A.1: Factor analysis – first factor per calendar year

Changes in CDS spreads versus stock market returns

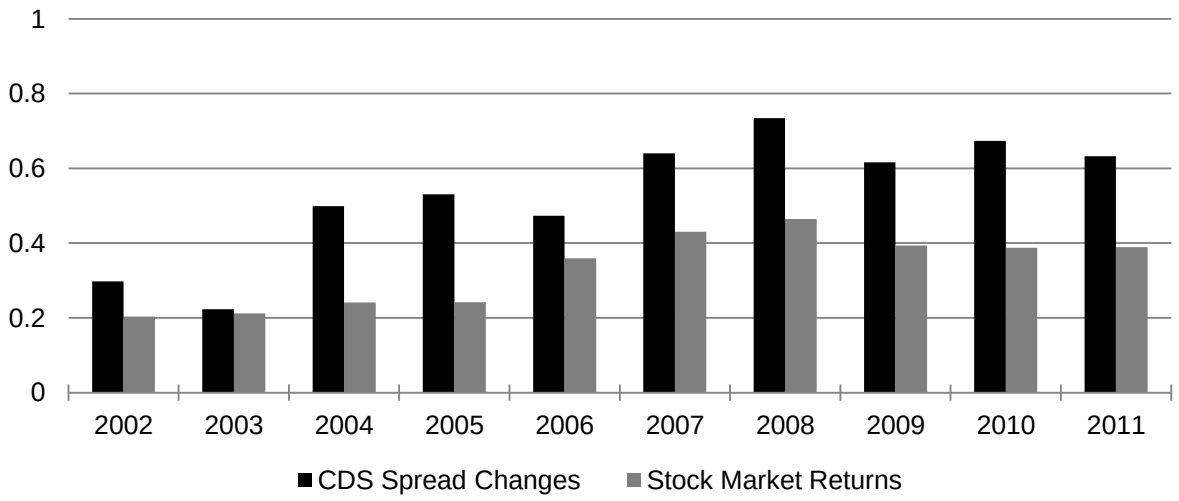
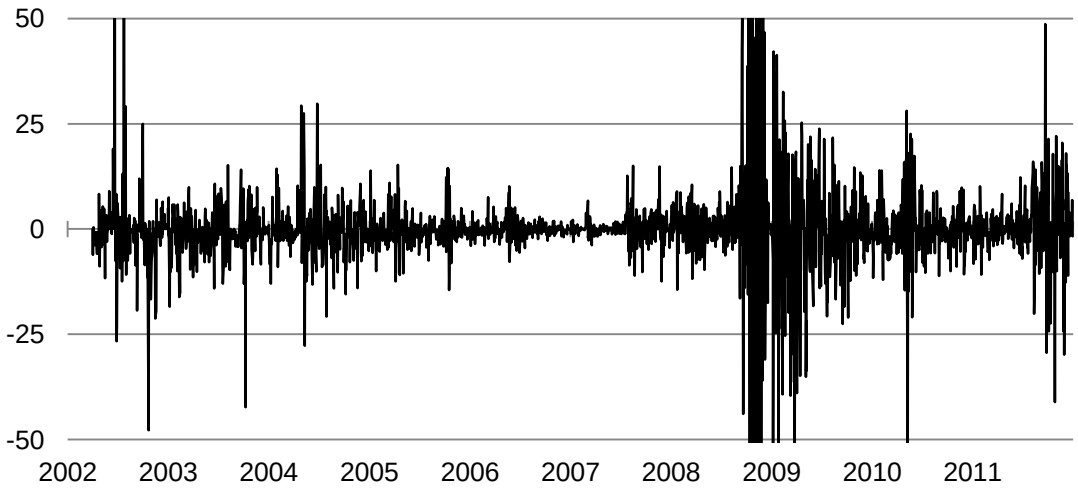


Figure A.2: Volatility clustering in daily CDS spread changes for Russia

April 2002 – December 2011



Sovereign CDS spreads, such as those for Russia (Figure A.2), display a pattern typical for financial time series. Whereas the early sample period from 2002 through 2005 is characterised by several bouts of extraordinarily high volatility, observed spreads are subject to a much lower degree of volatility in the years up to the end of our first sub-sample in July 2007. During the financial crisis, we observe further periods of increased volatility (in particular since September 2008), which slowly lessens towards the end of 2009. After another bout in mid-2010, volatility again increases strongly towards the end of the sample in December 2011. This phenomenon of changing amplitude of spread changes (returns) over time is commonly known as volatility clustering. GARCH models, which have been introduced by Bollerslev (1986), take these changes in volatility explicitly into account and thus increase estimation efficiency compared to OLS. Similar patterns of volatility clustering emerge for the other CDS spread series in our sample, which (expressed in daily, absolute basis point changes) exhibit excess kurtosis (the fourth central moment of the distribution, pointing to evidence of 'fat tails'), but only limited skewness (the third moment, with the positive sign suggesting a somewhat more pronounced right-hand tail for most series), as indicated by Tables A.1a and A.1b below. Table A.2 provides an overview of the other financial variables included in the analysis.

Table A.1a: Descriptive statistics – pre-crisis (04/2002 – 07/2007)[1]

Daily changes in sovereign CDS spreads (in basis points)

	Mean	Std. Dev.	Skewness	Kurtosis	Minimum	Maximum
World	**–0.21**	**15.43**	**5.91**	**268.82**	**–404.25**	**511.42**
BGR	–0.21	2.92	0.85	45.86	–27.50	36.88
BRA	–0.43	41.03	3.27	55.70	–404.25	511.42
CHN	–0.01	0.78	1.65	27.17	–5.10	9.59
COL	–0.34	12.37	2.25	30.12	–73.51	133.63
MYS	–0.05	1.90	1.01	43.35	–20.27	22.67
PER	–0.20	10.56	–0.78	37.96	–144.00	75.16
PHL	–0.11	6.10	0.38	13.11	–41.17	56.18
RUS	–0.24	6.19	5.48	115.98	–47.79	120.00
THA	–0.02	1.65	0.66	14.92	–10.21	11.45
TUR	–0.26	14.37	2.73	42.23	–102.05	185.56
VEN	–0.54	24.72	1.60	60.43	–272.00	371.00
ZAF	–0.10	2.00	2.20	30.96	–12.14	24.28

[1] Note: Number of observations: 1392 for each country, 12*1392 = 16704 for total sample.

Table A.1b: Descriptive Statistics – crisis (08/2007 – 12/2011)[1]

Daily changes in sovereign CDS spreads (in basis points)

	Mean	Std. Dev.	Skewness	Kurtosis	Minimum	Maximum
World	**0.13**	**15.74**	**2.84**	**95.24**	**–223.97**	**450.78**
BGR	0.33	12.36	0.27	15.66	–86.22	91.81
BRA	0.04	11.46	1.83	69.60	–124.68	174.70
CHN	0.10	5.63	0.07	33.40	–58.25	57.25
COL	0.00	11.63	1.58	60.86	–127.02	169.79
MYS	0.10	8.87	0.67	76.57	–110.61	130.64
PER	0.04	11.64	1.77	59.74	–123.64	168.34
PHL	–0.01	14.18	0.78	68.00	–163.42	180.10
RUS	0.18	19.39	1.90	44.16	–168.80	206.86
THA	0.11	9.15	0.13	61.28	–111.22	118.52
TUR	0.08	13.54	0.49	28.61	–119.49	133.92
VEN	0.49	36.45	2.15	31.04	–223.97	450.78
ZAF	0.12	11.63	0.74	31.48	–109.42	123.57

[1] Note: Number of observations: 1153 for each country, 12*632 = 13836 for total sample.

Table A.2: Explanatory financial variables	
Standard & Poor's S&P 500 index	Daily growth rates in percent
Chicago Board Options Exchange Volatility Index	Daily growth rates in percent
US 3-month Treasury bill rate	Daily absolute changes in percentage points
US yield curve slope	Daily absolute changes in percentage points
Merrill Lynch MOVE volatility index	Daily growth rates in percent
CDX North American High Yield index spread	Daily absolute changes in percentage points
Global and regional EMBIG indices	Daily growth rates in percent
Refco spread	Daily absolute changes in percentage points
Bilateral exchange rates vis-à-vis the US dollar	Daily growth rates in percent
Major domestic stock market indices	Daily growth rates in percent

Table A.3a: Test for differences in country-specific models – pre-crisis[1]											
BGR vs.	BRA	CHN	COL	MYS	PER	PHI	RUS	THA	TUR	VEN	ZAR
Constant Term											
Tuesday											
Wednesday										*	
Thursday											
Friday											
CDS 1st lag											
S&P500 1st lag											
VIX 1st						*					
US 3 Month Yield 1st lag											
US Yield Curve Slope 1st lag						*					
Move Index 1st lag											
CDX HY 1st lag											
Refco Spread 1st lag		*									
EMBIG Global 1st lag						*			*		
EMBIG Regional 1st lag						*					
Domestic Stock Returns 1st lag		*						*			
Domestic FX/USD Returns 1st lag											

Note: The table displays tests of differences in country-specific GARCH models using Bulgaria as the reference country. Fields marked * indicate a significant difference at the 1 percent level.

Table A.3b: Test for differences in country-specific models – crisis[1]											
BGR vs.	BRA	CHN	COL	MYS	PER	PHI	RUS	THA	TUR	VEN	ZAR
Constant Term											
Tuesday											
Wednesday											
Thursday											
Friday											
CDS 1st lag		*		*		*		*	*		
S&P500 1st lag			*								
VIX 1st											
US 3 Month Yield 1st lag											
US Yield Curve Slope 1st lag											
Move Index 1st lag											
CDX HY 1st lag											
Refco Spread 1st lag											
EMBIG Global 1st lag											
EMBIG Regional 1st lag			*								
Domestic Stock Returns 1st lag											
Domestic FX/USD Returns 1st lag				*							

Note: The table displays tests of differences in country-specific GARCH models using Bulgaria as the reference country. Fields marked * indicate a significant difference at the 1 percent level.