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Determinants of government bond spreads in the Euro area – in good times as in bad

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Abstract:
Despite the single currency, yields on government bonds in the Euro Area deviate from German bond yields. These bond spreads are usually attributed to differing default and liquidity risks. Recent research points out that time-varying global factors, approximated by risk measures or short term interest rates, play an important role for the evaluation of theses risks. In this paper, instead of proxy variables latent processes are assumed to model the aforementioned time variation. We find, that default risks measured via expected debt-to-GDP ratio explain a good stake of the variation of bond spreads in the Euro area at least between 2003 and the take-off of the financial crisis. During the financial crisis default risks or rather their evaluation increased but lost relative importance compared to liquidity risks.

Keywords: Euro Area; bond spreads; time-varying coefficients; liquidity risk; default risk

JEL classification: C32, G12, E43, E62

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1 Introduction

Due to the introduction of a single currency in 1999 spreads between bond yields of Germany and other members of the Euro area decreased significantly, but did not vanish. During the financial turmoil spreads have increased but without reaching the pre EMU levels. The importance of the introduction of the monetary union for bond markets has been stressed by Codogno et al. (2003) or Bernoth et al. (2004) among others. As risks concerning real exchange rate differences do not apply in a currency union, solely default and liquidity risks remain factors for differences between bond yields in the Euro area. Gomez-Puig (2006) points at the importance of liquidity, especially, the market size, as an explaining variable of bond yield differences, but also finds some impact of default risks. Jankowitsch et al. (2006), focussing on liquidity risks, come to the similar conclusion that liquidity matters, but not alone. Both studies cover just the early years of the EMU until 2001 and some years before the EMU came into effect .[1]

Besides the impact of country specific variables capturing differing default and liquidity risks several studies stress the impact of global factors for the variation of bond spreads in the Euro area over time. Codogno et al. (2003) assign a major role to US corporate bond spreads. This variable is assumed to reflect global risks as well as the level of risk aversion; see also Favero et al. (2009) and Bernoth et al. (2004). In contrast Magnelli and Wolswijk (2009) argue that short term interest rates of the ECB are better suited to capture variations over time, however, the situation during the current financial crisis contradicts their findings based on data spanning until 2008 which state a positive relation between short term interest rates and spreads. In early 2009, spreads peaked at the highest levels since 2001 while interest rates were at a very low level. Thus, a recent study of the Haugh et al. (2009) using quarterly data applies US corporate bond spreads for capturing aspects of global risks and thereby supports this view. However, a strict relation between the level of bond spreads in the EMU and US corporate bond spreads can be doubted, too. The US corporate bonds peaked in December 2008 while the highest bond spread was observed in Februar 2009 for Greece. Furthermore, many studies apply US corporate bond spreads for the assessment of global risks but at least quantitatively several differences appear among them.

This study focuses on the time-varying behavior (risk aversion, risk evaluation etc.) of market participants by applying a latent variable approach. Former studies like Codogno et al. (2003) or Bernoth et al. (2004) already incorporate time-varying aspects by considering global factors as well as cross terms based on these variables. Here, we chose a more flexible approach where inference on time-varying behavior is based on the observed spreads and not on a certain set of covariates.

[1] For further studies about pre EMU data see Lemmen and Goodhart (1999) or Lonning (2000).

This approach is implemented via a time-varying coefficient model where coefficients are assumed to follow a random walk. To enhance the flexibility in the light of the current financial turmoil GARCH processes are admitted for the errors of the model as well as for the processes governing the coefficients. Thus the model is a modification of the models of Harvey et al. (1992) and King et al. (1994). The time-varying coefficient model allows to monitor the impact of default and liquidity risks via the coefficients of the corresponding proxy variables over time as well as the global risk situation via a time-varying constant.

The time-varying coefficient approach can explain a good stack of variation during most of the sample and attributes explanatory power to both sources of risk in the early years of the sample 2001 and 2002. At the beginning of 2003 the weekly coefficient of determination suddenly drops but recovers. The recovery is attributed with the rise of the debt to GDP ratio as the single most important explaining variable. In this period the liquidity proxy was mostly insignificant. Whereas during the financial turmoil the role of liquidity recovered. Thus the model underlines the finding of Beber et al. (2009) that liquidity matters in times of stress.

The rest of the paper is organized as follows. Section 2 proposes the empirical model. Section 3 describes the data and gives some reasoning concerning the covariates considered. In Section 4 results are presented, while Section 5 concludes.

2 Model

The model shall capture frequent decisions about the pricing of 10-year bonds in the Euro area relative to German bond yields and therefore incorporates weekly data. It seems reasonable that prices reflect traders' beliefs about default and liquidity risks rather directly and immediately given the high level of integration of the Euro area bond market; see Pagano and von Thadden (2004) . Modelling within the cross-section dimension seems appropriate to capture this aspect. Therefore the model takes the following form:

$$y_{i,t} = \beta_t X_{i,t} + \varepsilon_{i,t}, \qquad \varepsilon_{i,t} \sim N(0, \sigma_t), \tag{1}$$

where $y_{i,t}$ denotes the return difference between country i's bonds and German government bonds. Note that in t Equation (1) represents a simple linear model. Its parameters can be estimated via OLS. The vector $X_{i,t}$ contains relevant variables for bond pricing of country i in period t and a constant. However, as the number of countries in this analysis is limited, the inclusion of the time dimension for the purpose of inference on the coefficients in t seems advisable. This is done by assuming that the parameters β_t follow a random walk

$$\beta_t = \beta_{t-1} + u_t, \qquad u_t \sim N(0, \Sigma_t). \tag{2}$$

Note that β_t is a vector and the coefficient for a particular variable is denoted as $\beta_{k,t}$ in the following ($k \in \{1, ..., K\}$). $K-1$ is the number of covariates as $\beta_{1,t}$ represents the constant. For simplicity we assume Σ_t to be diagonal. Thus, we assume a model with variance parameters only. These parameters can be estimated by regarding a considerable time dimension. Coefficients β_t reflecting the judgement of market participants can be estimated via the Kalman Smoother.

By considering a time-varying constant as well as a time-varying error variance the model implicitly captures the impact of time-varying global factors. This is important, as many studies stress the impact of global factors, like risk aversion often measured by the US corporate bond spreads, on differences in European bond yields. The methodology applied here thereby allows to differentiate between variation over time and the cross section variation. The variation over time is split into direct effects of global factors (time-varying constant) and their impact on the evaluation of different risks via the other time-varying β_t. Finally, monitoring of β_t at each point in time allows to directly assess the relative importance of different kinds of risks.

As it is one goal to follow the judgements of market participants even in rather volatile times like Winter 2008/09, the model assumes time-varying variances for both the errors as well as β_t. For both, GARCH-type specifications are considered. In case of the error variances it takes the following form

$$\sigma_t^2 = \alpha_0 + \alpha_1 \frac{1}{I} \sum_{i=1}^{I} \varepsilon_{i,t-1}^2 + \alpha_2 \sigma_{t-1}^2, \tag{3}$$

while the variance of each β_k is assumed to follow its own GARCH process

$$\sigma_{k,t}^2 = \gamma_{k,0} + \gamma_{k,1} u_{k,t-1}^2 + \gamma_{k,2} \sigma_{k,t-1}^2. \tag{4}$$

The inclusion of GARCH into the state-space model implies that the Kalman-Filter used for estimation has to be modified. Harvey et al. (1992) introduced ARCH modelling within the state-space frame work. A further extension is given by King et al. (1994). In their paper, a number of asset returns follow some unobservable dynamic factors, where the idiosyncratic errors as well as the innovations of the factors are modelled via GARCH. Thereby, they provide a modified Kalman Filter coping with GARCH type volatility. This modified Kalman Filter is adapted for the state space model used here. Details are given in the Appendix A.1.

3 Data description

The analysis is restricted to the 10 biggest and oldest members of the Euro area besides Germany to guarantee a relatively homogenous panel. Particularly, new member states are not taken into account, as their entry is mostly accompanied with adjustments processes of the markets which are not captured by the model here. Thus, we regard as a dependent variable the difference of the returns of government bonds with 10 years maturity between these 10 countries and Germany. Data is taken from Thomsen Datastream.

For the choice of explaining variables we consider budget balance relative to GDP as well as debt relative to GDP as variables reflecting the fiscal stance. Furthermore, we consider the current account balance relative to GDP as in Lonning (2000). The former variable is a proxy for two aspects. In the first place, it is a measure for the competitiveness of a country and therefore for its long run capabilities to fulfil foreign demands and secondly, this variable is a proxy for domestic savings. Countries with high current account surpluses (and a reasonable investment share) accumulate high additional savings. Both interpretations may play a role for the analysis of the long run financial conditions of a country by market participants.

As the model shall reflect the behavior of market participants and as these are assumed to be forward looking, we do not consider historic values, but forecasts of the aforementioned variables taken form the European Commission.[2] The consideration of forecasts as explaining variables follows Heppke-Falk and Hüfner (2004). The European Commission publishes their forecasts regularly twice a year and are related to yearly data. In recent years several interim forecasts have been published which are taken into account too. That forecasts for yearly data are monitored by market participants seems reasonable as short run variations are less important for the evaluation of the mid term fiscal stance of a government. With respect to the forecasting horizon we assume that current year figures are relevant given the spring projections, while figures for the following year are extracted from the autumn forecasts.[3]

The three variables, debt to GDP ratio, budget balance to GDP ratio and current account balance to GDP ratio, are taken into account as they are mainly assumed to drive the traders' beliefs about default risks. In addition, the outstanding amount of domestic debt securities of the public sector is considered as a proxy for market capitalization and thereby liquidity measure as proposed by Gomez-Puig (2006). Here, we do not take forecasts, but historical data of the Bank for International

[2]This study does not rely on other sources for forecasts as the European Commission provides consistently data for all variables and countries.

[3]Sensitivity checks show that results are rather robust against differing possibilities of consideration of forecasted data.

Settlement available via their quarterly reports .

Other variables like measures for global factors like US yield spreads or short term interest rates that have been used in previous studies, like Codogno et al. (2003) or Magnelli and Wolswijk (2009), are not considered as time-varying coefficients and variances should include the impact of processes that are approximated by these variables and so they are not needed to explain relative differences in default risk perception between countries in the Euro area.

We take weekly data as dependent variable to have a rather close monitoring of the behavior of the model in time. However, the explaining data has a much lower frequency, as e.g. data from the Bank for International Settlement is on a monthly basis and forecasts of the European Commission are updated twice a year. To cope with this mismatch explaining variables are linearly interpolated. Whereby this aspect is of minor impact as all explaining variables are rather persistent especially with respect to their country-to-country ordering. Accordingly the approximation error of the interpolation is relatively low. Finally, the explaining data is standardized for each week. This procedure allows a direct interpretation of the absolute level of β_t with respect to their relative importance and an absolute interpretation in terms of basis points. However, as the mean and variance of the explaining variables vary over time this interpretational convenience comes at some costs. The importance of the direct global factors measured via the time-varying constant cannot be distinguished from the aforementioned variation of the means and variances of the regressors. Thus, the estimation is also performed for data standardized with a general mean and variance stemming from the whole sample. The main results are not changed by the way of standardization. However, the second way makes interpretation of the time-varying constant easier.

4 Empirical Results

The model does explain the variation of the spreads relatively well as over most of the cases, the (smoothed) weekly coefficient of variation ranges between 0.6 and 0.9; see Figure (1).[4] There is one period in time where the model is obviously not able to capture the variation within the weekly data, namely several weeks during 2003. Interestingly, before this period, all four variables considered had a significant impact, whereas afterwards, only the debt to GDP ratio remained a suitable regressor; compare Figure (2).[5] Thus, the results for the early years 2001 and 2002 are in line with the findings of studies using data from theses periods, namely Gomez-Puig (2006) and Jankowitsch et

[4]Parameter estimates are given in Table 1.

[5]As all regressors are weekly standardized, the level of β_t can be compared with each other directly, while the comparison over time depends on the scale of the regressors. Thus, in addition approximate partial R^2 are given in Figure (3).

al. (2006), as both attribute explanatory power to both sources of risk. The early variation within model coefficients and model fit might stem to some degree from the relative youth of the Euro system, which is also reflected in sudden jumps within the bond returns of some countries. This had particular impact on the temporary breakdown of the explaining power of the model. The period between 2003 and 2007 was relatively calm. Several countries even experienced negative spreads in this period, while the debt to GDP ratio turned out to be the single most important variable capturing up to 90% of the variation. A hint, that the non-bail-out clause in the Maastricht treaty was taken seriously. In contrast, liquidity seemed to play a minor role in this period.

In autumn 2007, the financial crisis took off and had a climax in September 2008 with the breakdown of Lehman Brothers. At the end of 2008, a sudden rise in bond spreads relative to German bonds can be observed for many bonds. In October 2008, for the first time a spread was higher than 100 basis points within the whole sample. This turbulence is reflected by the model estimates in several dimensions. The error variance is multiplied, see Figure (5), however, the explaining power of the model stays relatively sound as the β coefficients rise in absolute terms, too, and this is true for all of them. All four variables become significant. The most pronounced change can be observed for the liquidity variable its coefficient turns significant in 2007 and rises in 2008/09 enormously. Thus, already the takeoff of the financial crisis led to an increased appreciation of liquidity. However, in 2008 its partial explaining power and thus its relative weight shrunk again but recovered in autumn 2008. At the end of the sample the absolute value of the coefficient is the highest compared to the other three and therefore is the most important determinant.

The model points at changes in absolute as well as in relative terms. Both risks, default as well as liquidity, got a higher valuation for determining the differences between bonds in the Euro area, where the liquidity risk obviously gained importance. Thus, the explaining power of the level of debts for the total variation shrank. Interestingly, the budget balance earned more attention. For this pattern two explanations are possible. Firstly, the default risks might be evaluated by different aspects than before and the projected budget balances are regarded as an indicator for the future fiscal stance simply due to the sheer size of the current deficit dynamics. Alternatively, the importance of the deficit forecasts have to be interpreted in relation with liquidity arguments, eventually coefficients of both variables seem to be in lock-step in 2009. According to this interpretation, the deficit forecast is a proxy for current and future supply of government bonds. If supply is enormously increased based on a rather illiquid market this might have an impact.

Figure (5) shows the mean as well as the variance of the constant over time. The constant can be interpreted as the direct impact of global factors, as global risks, or the level of aversion. Due to the standardization of the explaining variables for each single week, the time-varying mean might however also capture the variation of the means of the explanatory data. To illustrate the impact of these effects, the estimation is done again without weekly but overall standardized data. Results stay qualitatively the same, but the amplitude of the time-varying constant is lowered by roughly 25 per cent. The remaining part of β_1 is accordingly still high and represents a good stake of the variation of the data over time. Not just a higher appreciation of the default and liquidity risks is found within the data (represented by the increase of the absolute values of the other β_t coefficients) but also a substantial change in the attitude towards the relative position against Germany.

5 Conclusion

This paper applies a time-varying coefficient model to assess the spreads of government bonds on 10 countries of the Euro area in relation to Germany. This modelling approach is flexible enough to monitor the evolvement of the relative importance of liquidity and default risks.

Due to the single currency, spreads should reflect solely default and liquidity risks. The default risk is considered by inclusion of forecasts of the debt to GDP ratio, the budget balance relative to GDP as well as the current account relative to GDP. The liquidity aspect is approximated via the outstanding amount of domestic debt securities of the public sector. The analysis considers weekly spread data spanning from January 2001 until March 2009. During most of the time the debt to GDP ratio is the single most powerful explaining variable apart from a short episode in 2003 and the last months of the sample during the financial turmoil. Over long periods, mainly between 2003 and 2007, the budget balance and the liquidity variable were insignificant. With the start of the stress at the financial market liquidity gained importance and as the highest spreads rose up to nearly 300 bp in early 2009 the liquidity proxy and the budget balance projections got jointly more explaining power than the debt to GDP ratio. However, the coefficient of this variable increased remarkably, too. Thus, the default risk got a higher appreciation during the crisis as well as the liquidity risk where the liquidity risk appreciation rose faster.

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A Appendix

A.1 Modified Kalman Filter

The model in Equations (1) through (4) can be directly interpreted as a state space model. The modified Kalman Filter needed to calculate the likelihood as well as for estimating β_t is given as follows.

The predicted β_t equals the filtered one due to the random walk assumption:

$$\beta_{t|t-1} = \beta_{t-1|t-1}.$$

Thus the corresponding variance of the prediction is given as the filtered one plus the variance of the innovations:

$$P_{t|t-1} = P_{t-1|t-1} + \Sigma_{t|t-1}.$$

If one assumed time invariant variances, $\Sigma_{t|t-1}$ would be constant over all t. However, the GARCH process has to be taken into account. Therefore the diagonal elements of $\Sigma_{t|t-1}$ follow

$$\sigma^2_{k,t|t-1} = \gamma_{k,0} + \gamma_{k,1}\sigma^2_{k,t-1|t-2} + \gamma_{k,2}u^2_{k,t-1|t-1},$$

where $u^2_{k,t-1|t-1}$ is calculated via the filtered expectation and variance as

$$u^2_{k,t-1|t-1} = (u_{k,t-1|t-1})^2 + P_{k,t-1|t-1},$$

where filtered values are calculated as follows

$$P_{t|t} = P_{t|t-1} - P'_{t|t-1} * X'_t \left(s^2_{t|t-1}\mathcal{I}\right)^{-1} X_t P_{t|t-1},$$

$$u_{t|t} = P'_{t|t-1} * X'_t \left(s^2_{t|t-1}\mathcal{I}\right)^{-1} \varepsilon_{t|t-1}.$$

Note that the filtered β_t simply applies by adding the predicted $\beta_{t|t-1}$ and $u_{t|t}$. The GARCH process of the ideosyncratic errors is modelled as follows:[6]

$$s^2_{t|t-1} = \alpha_0 + \alpha_1 s^2_{t-1|t-1} + \alpha_2 \frac{1}{I}\sum_{i=1}^{I} \varepsilon^2_{i,t-1|t-1},$$

[6] $\mathcal{I}$ denotes the unity matrix.

where

$$\varepsilon^2_{t-1|t-1} = Q_{t-|t-1} + (\varepsilon_{t-1|t-1})^2$$

and

$$Q_{t|t} = X_t' P_{t|t} X_t + s^2_{t|t-1}$$

denotes the filtered variance of the filtered errors and

$$\varepsilon_{t|t} = y_t - X_t \beta_{t|t}$$

represents the corresponding mean expectations.

A.2 Approximate Partial R^2

The time-varying coefficient of determination is defined as follows:

$$R_t^2 = 1 - \frac{Var(\widehat{Y}_t)}{Var(Y_t)},$$

whereby $\widehat{Y}_t$ denotes the estimated vector of spreads based on the smoothed values of β_t, thus, $\widehat{y}_{i,t} = X_{i,t}\beta_{t|T}$.

The approximate partial R_t^2 of different variables is calculated as the squared coefficient of correlation of some auxiliary variables. In all cases the cross sectionally demeaned spreads are employed, $y^*_{i,t} = y_{i,t} - \frac{1}{n}\sum_i y_{i,t}$. Further, for each regressor variable a cross sectionally demeaned variable is constructed, too, $x^*_{k,i,t} = x_{k,i,t} - \frac{1}{n}\sum_i x_{k,i,t}$. Note that index k runs from 2 to K as $k = 1$ represents the constant in Model 1. Correspondingly, a cross sectionally demeaned variable is constructed representing the "rest" of the model: $z^*_{k,i,t} = z_{k,i,t} - \frac{1}{n}\sum_i z_{k,i,t}$, whereby $z_{k,i,t}$ is given as $X^k_{i,t}\beta^k_{t|T}$ and $X^k_{i,t}$ represents all regressors of $X_{i,t}$ without the constant and the variable k.

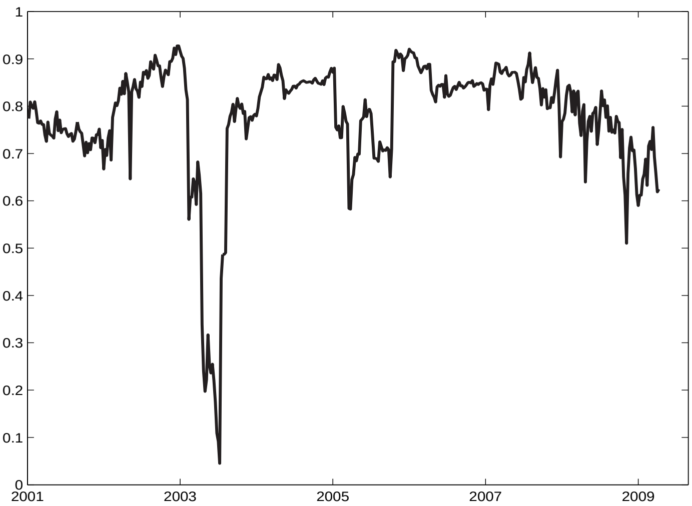
Afterwards, for each $k : 2 \to K$, the demeaned spreads $y^*_{i,t}$ are regressed on $z^*_{k,i,t}$, and $x^*_{k,i,t}$ are also regressed on $x^*_{k,i,t}$. The squared coefficient of correlation between the resulting residual series is used as approximate partial R^2.

Table 1: Estimation results

	ML-estimate	std. of estimation
α_0	6,82150	9,99960
α_1	0,14095	0,08897
$\gamma_{1,0}$	0,00910	0,02139
$\gamma_{1,1}$	0,39894	0,58230
$\gamma_{2,0}$	0,00216	0,01243
$\gamma_{2,1}$	0,10331	0,12297
$\gamma_{3,0}$	0,01821	0,02366
$\gamma_{3,1}$	0,06915	0,08502
$\gamma_{4,0}$	0,00204	0,01327
$\gamma_{4,1}$	0,11694	0,18778
$\gamma_{5,0}$	0,00028	0,04534
$\gamma_{5,1}$	0,13480	0,41927

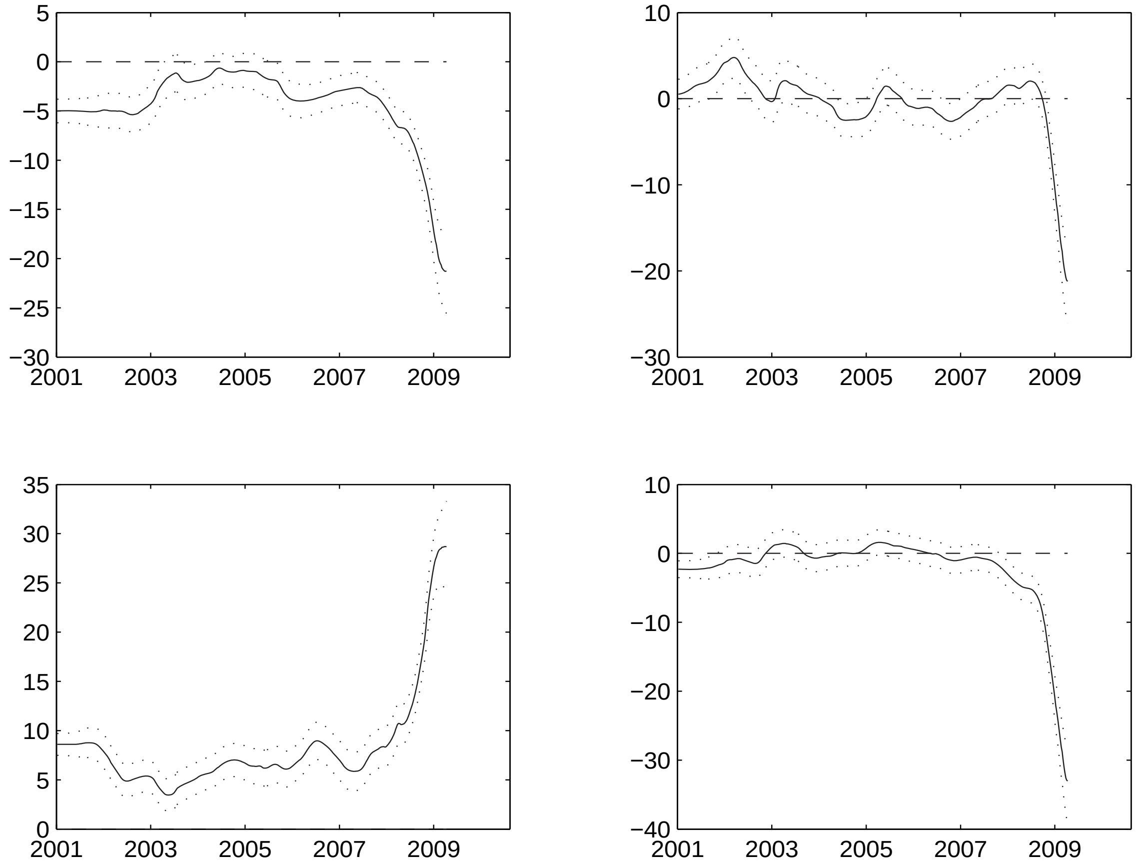
Note: Maximum likelihood estimates gained via numerical optimization for the model with weekly standardized covariates. Only ARCH parameters play a role. Persistence parameters of all GARCH equations are estimated to zero.

Figure 1: Coefficient of Determination



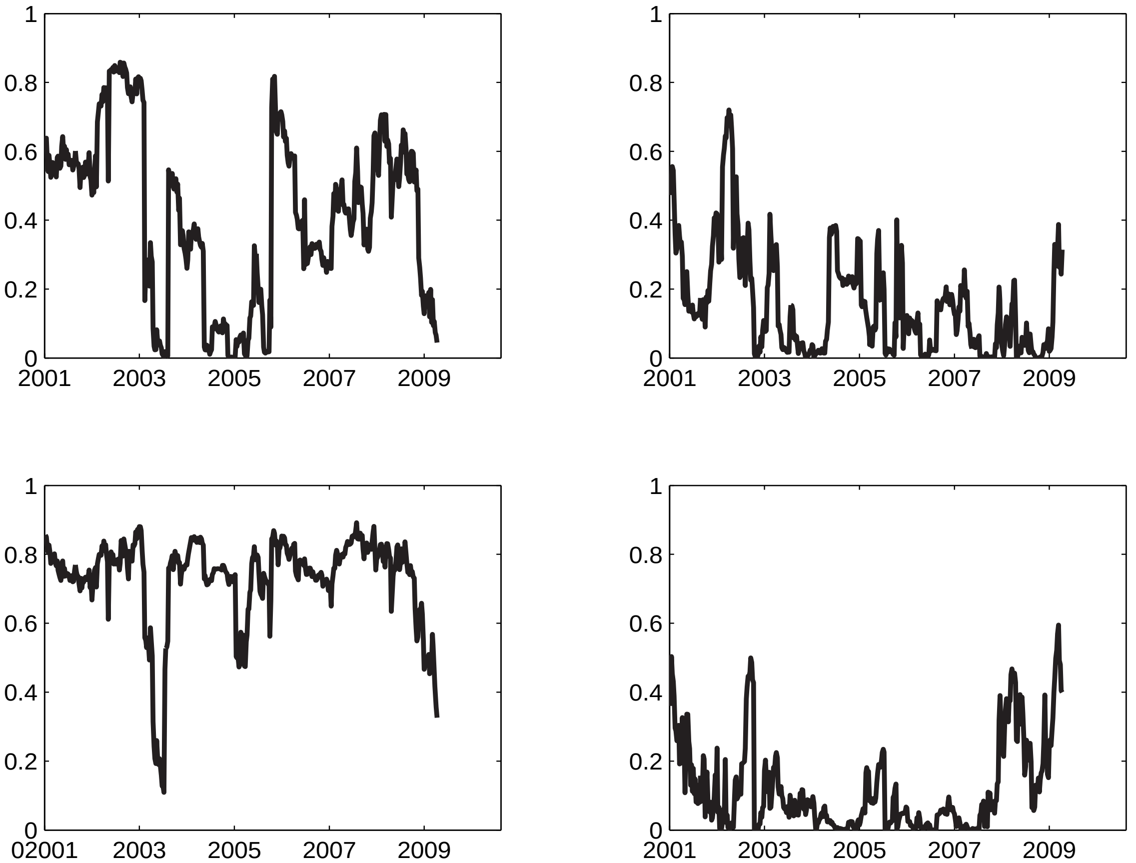
Note: For details see Appendix A.2.

Figure 2: Mean of time-varying coefficients of explaining variables



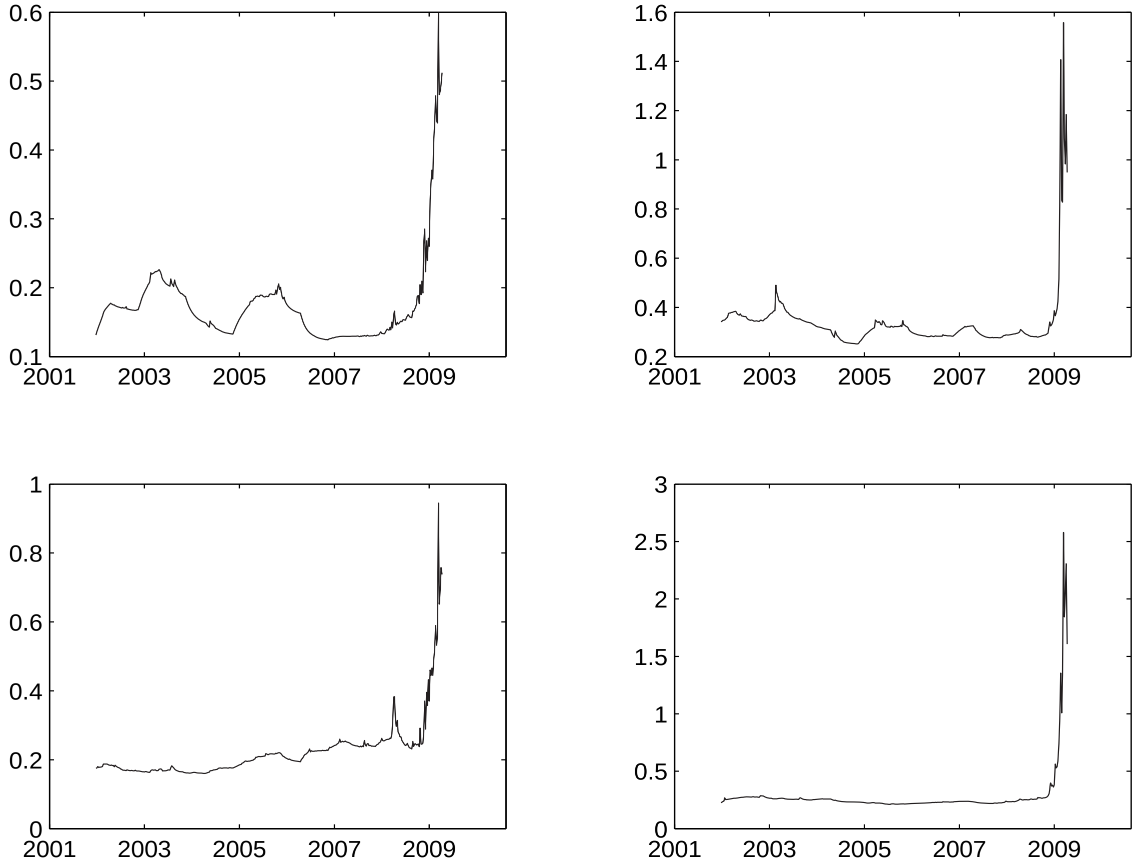
Note: Smoothed β_t: straight line; dashed lines: 2 σ confidence bands. Upper left panel: current account; upper right panel: deficit/GDP; lower left panel: debt/GDP; lower right panel: liquidity proxy.

Figure 3: Partial R^2



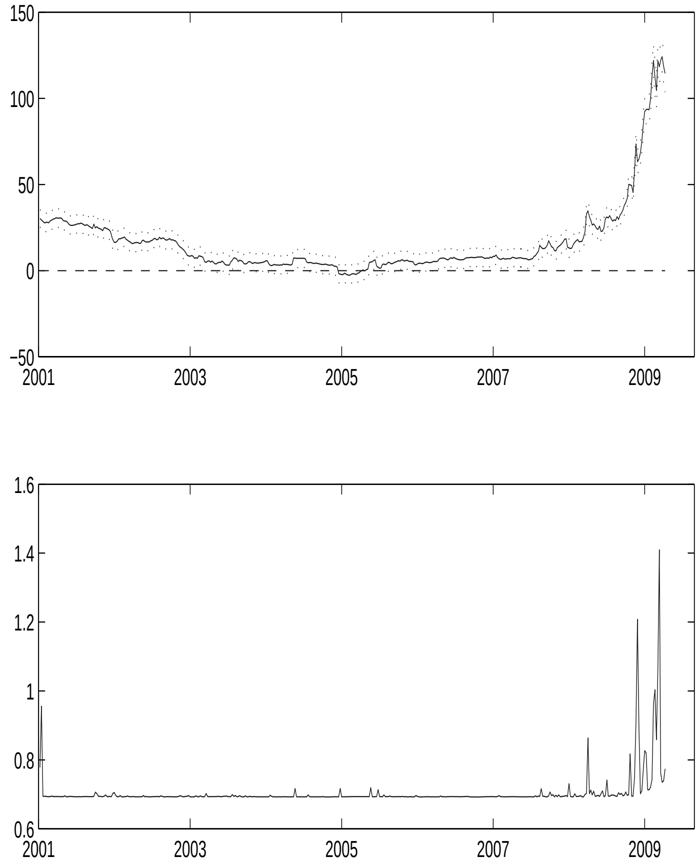
Note: Partial R^2 is calculated as described in Appendix A.2. Upper left panel: current account; upper right panel: deficit/GDP; lower left panel: debt/GDP; lower right panel: liquidity proxy.

Figure 4: Variance of time-varying coefficients of explaining variables



Note: Upper left panel: current account; upper right panel: deficit/GDP; lower left panel: debt/GDP; lower right panel: liquidity proxy.

Figure 5: Time-varying constant



Note: Upper panel: Smoothed mean (straight line) and 2 σ confidence bands (dashed lines); lower panel: variance of constant. Estimates for the model with overall standardized covariates.