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Abstract:
We study the impact of news embedded in scheduled macroeconomic announcements on the government bond market in Poland and the Czech Republic. We conduct an event study on intraday data and time-series regressions using daily data over an eight-year period, distinguishing between effects under different stages of the business cycle. We find that the Polish government bonds prices respond to several domestic indicators in a manner consistent with research from mature markets: inflation considerations appear to dominate credit risk considerations. For the most part, impact of news is incorporated in prices during the first hour since the release time. We could find much fewer systematic patterns for the Czech government bond market where any response was delayed. In both countries, the impact of GDP was found to vary between different stages of the business cycle.

Keywords: macroeconomic news, government bond market, intraday data, event study, GARCH, CEE
JEL: C22, C82, G12

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1 Introduction

The majority of economic fundamental data is released on a pre-scheduled calendar. Such data are continually analyzed by market participants. If the released value differs from market expectations, new information is triggered which we call a macroeconomic surprise. These unanticipated announcements are frequently cited as driving factors of market movements (e.g. Bloomberg 2012, Reuters 2012, Reuters 2014). De Goeij and Marquering (2006) conclude the macroeconomic news is “the most important source of news” for the US bond market.

The role of macroeconomic surprises in government bond market is interesting for several reasons. First, they provide information for portfolio management: Institutional investors can learn about risks of holding bonds around announcement days. Second, traders that do not agree with market consensus on an upcoming release can take a position enabling them to speculate on the release. Third, any findings may serve as verification of economic theory. Fourth, they are reflective of the creditworthiness of respective sovereigns. Fifth, movements in interest rates and especially their spreads are considered as important indicators of future economic activity (Estrella and Mishkin 1996). Last, to the extent that the degree of responsiveness to a particular indicator should be reflective of the relevance of the indicator for the long run borrowing costs, findings may be useful for governments.

This paper aims to provide such information for two of the largest Central and Eastern Europe (CEE) government bond markets - the Polish and the Czech ones. There are multiple reasons why government bond prices and yields should respond to macroeconomic news. First, macroeconomic fundamentals are important long-term determinants of sovereign risk (e. g. Hilscher and Nosbusch 2010). An underperformance with respect to analysts’ expectations is for the most part assumed to be interpreted by market participants as bad news, worsening the sovereign’s capability to repay, thus increasing its credit risk premium, and *vice versa*. This would suggest yields should rise facing an underperforming in a pro-cyclical indicator, such as retail sales. Second, bonds are fixed-income instruments whose payoff is strongly affected by inflation throughout their life. Releases that indicate increase of near-term inflation should lead to prices’ decline and thus yields to rise. If we consider that long-run inflation is uncertain, pro-cyclical indicators should be even more negatively related to prices of long-term bonds. Third, one may consider the effects of time-varying risk premia and alternatives faced by institutional investors. For instance, Dicke and Hess (2012) conclude that growth news influence stocks more strongly than bonds and that bad growth news may lead to reallocation of portfolios to bonds which are relatively less influenced by that bad news than stocks, which drives their prices up. Altogether, the relationship is theoretically unclear which makes it a perfect candidate for an empirical examination.

We conduct an intraday event study that enables us to look at a narrow window around the time of release and thus filter out most of other pricing factors. Secondly we look at the problem from a different perspective and model the time series of daily yield changes using GARCH models. We include both domestic indicators and German indicators that represent foreign news. Our findings suggest the impact of news embedded in regular macroeconomic announcements on the Polish and Czech bond market is generally relatively modest. For the Polish market, intraday event study analysis resulted in consistent patterns than our GARCH regressions. We find that the Polish government bonds react to several domestic indicators in a way consistent with research from mature markets (e.g. Ramchander et al. 2005). In particular, inflation considerations appear to play a more important role than domestic credit risk – bond prices react negatively to positive surprises in Retail Sales, Industrial Production, Wages and especially Consumer Price Index (CPI). GDP news appears to have the same effect during expansions but the opposite one during recessions – with unexpected positive GDP news, bond prices are predicted to rise and *vice versa*. This suggests credit risk may start to matter for investors in recessions. This effect is observed for the Czech bonds as well. Intraday analysis suggests the Czech government market is generally much less responsive. Our median regression results suggest that *more often than not* no reaction takes place. We were nonetheless able to observe some evidence of delayed responses. This finding could be reflective of low market liquidity of the Czech government bonds as compared to the Polish market. Limited evidence for bond prices' decline response to negative news suggests investors perceive macroeconomic fundamentals as sound.

The remainder of the paper is structured as follows. Section 2 provides an overview of related literature. Section 3 describes the data and their processing while Section 4 introduces our empirical methodology. Section 5 presents the results and Section 6 concludes.

2 Literature Review

One way to classify empirical studies of fundamental determinants of government bond yields and sovereign credit risk premia is according to the data frequency they use. The starting point of the search for fundamental variables was to inspect the relationship from the long-term point of view, using monthly or quarterly macroeconomic and financial data. A seminal paper for this strand of sovereign risk literature is that of Edwards (1985) who uses panel data estimation and finds that key drivers of bond spreads are country-level fiscal variables, for example external debt. Recent examples of this strand include Caggiano and Greco (2012), Aizenman et al. (2013) and Beirne and Fratzscher (2013) who examine the relationship for Eurozone, a panel of 50 and 31 countries, respectively. They quantify the effects of fiscal space (e.g. debt-to-GDP) and other macroeconomic variables on sovereign risk premia, finding them significant and economically important.

This study belongs to the other strand of literature that examines the immediate reaction of government bond market to macroeconomic news. Some researchers investigate whether the presence of an announcement *per se* affects markets. They maintain that announcement days are connected to a higher risk of holding risky financial assets, thus in equilibrium investors should receive higher risk premium because a part of risk-averse investors shift their portfolios to risk-free assets. According to Arshanapalli et al. (2006), higher risk stems simply from higher probability of information revelation on announcement day; they connect this to higher anticipated volatility. Savor and Wilson (2013) find the announcement-day return significantly higher than other-day return, with return differential of 3.4 basis points for 10 year T-bonds. Similarly, Dicke and Hess (2012) report the return for long-term bonds return is roughly 2.7 times higher on announcement days.

Most studies that consider the impact of *unexpected component* of the announcement have focused on either the US Treasury bonds or global emerging markets. Gürkaynak et al. (2005) study the effect of macroeconomic news on Treasury to challenge the assumption of many macroeconomic models that long-run levels of inflation and the real interest rate are constant over time and perfectly known. They demonstrate that both short-term rate and long-term forward interest rates respond to various macroeconomic surprises, which suggests that long run inflation expectations are not strongly anchored. Ramchander et al. (2005) examine the impact of US macroeconomic surprises on daily Treasury yields and other debt market instruments. They conclude yields are especially positively influenced by "inflation-related surprises" – CPI, non-farm payroll figures and wages. Evidence of growing inflation appeared to raise inflation expectations, consistent with Fisher hypothesis and efficient markets hypothesis. Effect on the term spread was likewise positive. Andritzky et al. (2007) investigate the effect of US macroeconomic news on emerging markets dollar-denominated bonds. Although they find no significant effect on the level of the spread, they conclude that the news influence and mostly reduce the conditional volatility, which they attribute to uncertainty reduction resulting from an announcement. Nowak et al. (2011) studied impact of US news on global emerging bond markets using high-frequency data. They found that volatility effects were stronger than effects on the mean and moreover they were measurable for hours rather than minutes.

Several papers consider the conditionality of the information brought by macroeconomic surprises on the stage of the business cycle. Fang et al. (2008) identify the turning points of the sample path of Australian GDP, divide their sample into expansions and contractions and find that while bond returns are very responsive to unexpected inflation (-0.114% return as a reaction to one standard deviation in unanticipated change in CPI), there is no significant impact during contractions. Özatay et al. (2009) argue that under inflation dominance, investors are likely to interpret positive news as overheating of the economy. In their study of emerging market bonds, they verify that the bond yield response to US macroeconomic news is significantly different under positive inflation gap – the effect of decreased spreads following positive news is mostly offset or even reversed. In their study of US T-bond futures market, Beber and Brandt (2010) measure the stage of business cycle using an experimental recession index called XRI-C (superseded by "CFNAI" Index). It is a monthly estimate of the probability of recession in the given month, constructed from various leading indicators. XRI-C only uses information available as of the month it refers to. This is considered an important advantage as what should matter are the *real-time* perceptions of economic agents rather than ex-post classifications. Beber and Brandt assume market reaction is a mix between two extreme reactions, one expansionary and the other recessionary. They document, for instance, that pro-cyclical positive news that increase the yield do so more in expansions than in recessions. This is consistent with overheating perceptions suggested by Özatay et al. (2009).

So far there have been only a handful of studies on the topic that concerned European bond markets. Andersson et al. (2009) study the futures markets for German long-term bonds and conclude US macroeconomic releases are more influential than domestic ones. There are several reasons for this, one of them being that US data are generally released with a smaller delay than equivalent euro area data. Arru et al. (2013) examine the sovereign spreads of six Eurozone countries. They use weekly aggregated surprises of US news and euro area news and find that in several countries, positive US news decrease the sovereign spreads and *vice versa* whereas euro area bad news increase conditional volatility. However one disadvantage to aggregating surprises is that one assumes that all aggregated indicators point in the same direction though some indicators may not contain information or may point to the other direction. Paiardini (2014) studies impact of a broad set of announcements on the Italian government bond market using intraday data over a three-year period. U.S. announcements again played a principal role whereas only CPI was the only significant domestic variable. One possible reason for this is that actual release times often differ from the scheduled times. Most of the news incorporated into prices within 20 minutes.

We focus on the region of Central and Eastern Europe (CEE). Most of related research focuses on the stock and foreign exchange markets (Hanousek and Kočenda 2012, Brzeszczynski et al. 2014). To our knowledge, so far only one paper – Büttner and Hayo (2012) – has included evidence of short-term impact of macroeconomic news on government bonds in this region. Büttner and Hayo use 2004-2006 daily data to examine the impact of various types of news on financial markets of the Czech Republic, Poland and Hungary. However the focus of that paper was somewhat different so they used few macroeconomic surprises and arguably quite short data that made it challenging to grab systematic patterns as such data contained only 36 opportunities for a monthly indicator to result in an unexpected release. CPI news was significant in each country though we notice that positive news sometimes move the market in the same direction as negative news and moreover, the effects are inconsistent between the three countries. In view of the above, we believe there is substantial space to be examined in this region.

3 Data

3.1 Macroeconomic Announcements

The source for macroeconomic surprises was Bloomberg. For each release, we use the date and time, the event (type of indicator), the actual value of release and the median of survey expectations by economic analysts. The latter is the key variable that enables us to construct surprises. Analyst responses are collected through an e-mail survey that usually starts about a week before the release. Vrugt (2010) notes that the procedure is transparent, as the analyst's name and company are visible to all users of Bloomberg system, thus motivating the forecasters to provide their best estimates. They may revise their estimates until three days prior to the release, which is a relatively short time, and restrains the amount of information not reflected in the estimates. The Bloomberg median survey is referred to by traders as the "market consensus" (Vrugt 2010). We included all regularly announced macroeconomic variables that had survey expectations available. German macroeconomic announcements were selected to represent foreign news. Germany, considered to be the European benchmark country, is by far the most important trading partner of the Czech Republic and Poland. Moreover, its announcements are more timely than their Eurozone counterparts (Vrugt 2010). Our macroeconomic announcements include prices (PPI and CPI indices, import price index for Germany), real economy variables (GDP, industrial production, retail sales, unemployment, employment), foreign trade related variables (current account, trade balance), a monetary aggregate (Polish M3) and forward-looking indicators. The latter were available only for Germany and included three indicators of the German IFO Institute, two indicators of economic sentiment of the ZEW Centre for European Economic Research, a purchasing managers' index of manufacturing firms conducted by Markit, and a consumer confidence survey. In case both month-on-month and year-on-year variables were available, we usually selected the year-on-year unless it had fewer surveys. Anyway the two indicator types are expected to contain similar informational content. We do not include central bank rates as we found that they scarcely contain an unexpected component. For the same reason we generally only include preliminary releases as the final figures are usually expected. Releases of unemployment are also frequently exactly predicted by median survey, but we keep them as still around 50% of releases result in nonzero surprise. Our sample spans between January 2007 and mid December 2014 so we usually have 95 to 96 releases per monthly series and about 32 for GDP series (the only quarterly indicators). In total, we include 8 Czech, 11 Polish and 16 German indicators. Their basic description is included in Table 10.

3.2 Dependent variables - Government bond prices

Unlike most of the existing research literature, our study employs both daily-frequency and intraday-frequency data of the dependent variables. For GARCH analysis we use daily *mid yields* of 10-year and 2-year government benchmark bond indices from Reuters Datastream. These indices are compiled by Reuters from plain vanilla fixed coupon domestic currency government bonds close to the reference maturity. The sample comprises all business days (different for the Czech Republic and Poland) between January 2007 and 15 December 2014. Second, we obtained 5-minute bar *bid* and *ask price* data for the same instruments from Reuters Tick History. These cover the same period except for Polish 2-year index where the data are available only since 2008.

The intraday data required extensive cleaning. First, we manually deleted some apparent error quotes and removed observations for which the bid-ask spread was higher than eight time the median spread on that day. Second, we noticed a number of large “spikes” characterized by massive change in price that subsequently dropped back to the original level. Therefore, we ran a procedure on all series that deleted observations for which the price was “too distant” from a certain statistic of surrounding observations. In particular, we ran a modification to the procedure suggested by Barndorff-Nielsen et al. (2009). We take as inputs quotes of one trading day. We deleted quotes deviating more than α median absolute deviations (over the day) from the closest of the three following statistics:

- Rolling centered median (excluding the observation under consideration)
- Rolling median of the following observations in a given $window$
- Rolling median of the previous observations in a given $window$

For every intraday series the above procedure was applied to every trading day in our sample using the *mid* prices (average of bid and ask prices). The parameter $window$ describes the number of quotes the function should take into account for computing the statistics to compare a given quote to (e.g. 180). In case the median absolute deviation is zero during a particular day, it is taken instead over a subsample with nonzero changes. We tried several values of $window$ and α parameters and finally selected those which then appeared to remove as many suspected “spikes” but kept normal price behavior. After this process, the deleted observations were replaced by the last observations carried forward.

4 Methodology

4.1 Preconditions and business cycles' measurement

Our variables of interest are macroeconomic surprises. For an indicator k, macroeconomic surprise on day t is defined as the deviation of actual release from the market expectations (median survey response), scaled by standard deviation of such deviations over the announcement days of the indicator:

$$S_{k,t} = \frac{A_{k,t} - E_{k,t}}{\sigma_k} \quad (4.1)$$

Standardization enables to compare the surprises' impact for indicators stated in different units while it does not affect statistical significance. We conducted three kinds of diagnostic tests of our macroeconomic indicators using a longer sample (generally 2003 – 2013 up to data availability) in order to inspect whether the surprise variables are sensible. Firstly, macroeconomic releases are subject to revisions. In case original releases are biased, i.e. revisions are tilted either upwards or downwards; informational value of such indicators is likely impaired. To test this one regresses the difference between the revised and the announced value on a constant, and tests its significance. This test suggested several variables actually had biased revisions (Czech industrial production and retail sales, Polish current account, trade balance and unemployment, German retail sales and current account). Secondly, it is reasonable to test whether the consensus estimates are unbiased estimators of the actual values. This was tested using the methodology by Joyce and Read (2001). One regresses indicator releases $x_{i,t}$ on the median survey response which proxies market expectations $x_{i,t}^{e}$:

$$x_{i,t} = c + \varphi x_{i,t}^{e} + \varepsilon_{i,t} \quad (4.2)$$

We expect $c = 0$ and $\varphi = 1$ and moreover the error term ε should be serially uncorrelated. Nonetheless, if it does not hold, the forecasts may still be unbiased (Holden and Peel 1990). For variables that fail the test we thus run an additional regression:

$$x_{i,t} - x_{i,t}^{e} = c + \varepsilon_{i,t} \quad (4.3)$$

In the above we test the significance of the constant c. This additional test indeed changed many results to a non-reject. We rejected the forecast unbiasedness for Czech trade balance, Polish unemployment and German retail sales, unemployment and trade balance. Thirdly, if forecasts are weakly efficient, past values of released indicators should not help to predict current forecast error. One possible way to inspect weak efficiency is to test for joint significance of $(\beta_1,..\beta_k)$ in the following regression:

$$x_{i,t}-x_{i,t}^{e} = c + \beta_1 x_{i,t-1} + \beta_2 x_{i,t-2} + \cdots + \beta_k x_{i,t-k} + \varepsilon_{i,t} \qquad (4.4)$$

We selected k equal to twelve for monthly-released variables and eight for quarterly ones. HAC covariance matrices were used where appropriate. The vast majority of survey forecasts were found weakly efficient. Overall, most of the surprise variables satisfy the requirements though there are several exceptions. We shall observe that these exceptions are generally not significant price drivers for the bond market.

Our basic hypothesis is that macroeconomic surprises are associated with repricing of bonds in a short window around the announcement. However as mentioned above, surprises in a given indicator may not have the same informational content across different stages of the business cycle. Given that none of the above mentioned related papers considered this possibility, we propose several methods to measure the business cycles and to allow the effects to be different in expansion versus recession phases. Therefore our econometric model will have the following specification:

$$y_t = \mu + \sum_{k=1}^{n} \delta_{k,exp}\,(1 - rec_t)S_{k,t} + \sum_{k=1}^{n} \delta_{k,rec}\, rec_t S_{k,t} + \varepsilon_t \qquad (4.5)$$

where rec_t is a given recession measurement at time t. This is based on the assumption that the market reaction is a convex combination of two extreme reactions – one under extreme expansion $(\delta_{k,exp})$ and another under extreme recession. For Poland and the Czech Republic, we use the following four methods for measuring the recession components:

- OECD based Recession Indicators (from the period following the peak through the trough), available from FRED

  This is a turning point analysis of OECD Composite Leading Indicators (OECD 2015) based on the "growth cycle" approach. Turning points are identified in the deviation-from-trend series. The main reference series is industrial production excluding construction. GDP is used to supplement it for identification of the final reference turning points in the growth cycle. This is the only method among the four selected that results in binary recession measurements. It is similar to the method used by Fang et al. (2007).

- Business cycle measurements stemming from our own output gap filtering analysis

  We took seasonally adjusted time series of Polish and Czech GDP (starting in mid-1990s) and estimated the output gap using the Hodrick-Prescott filter (lambda parameter equal to 1600) and two of the most basic state space models, local level model and local linear trend model, estimated by maximum likelihood and the Kalman filter. Periods of positive output gap correspond to expansions and vice versa.

- ZEW Indicators of Economic Expectations, Current Situation and Inflation

  The ZEW Institute conducts economic assessment surveys among financial market experts monthly since June 2007. We select three variables concerning the current economic situation, economic expectations and inflation that are available both for Poland and the Czech Republic. These reflect the difference between expectations of analysts who believe in an improvement and those who believe in a worsening, over the next six months. Compared to the above indicators, the ZEW survey data may have the advantage of representing real-time economic expectations data.

- Eurocoin index by Altissimo et al. (2010)

  The Eurocoin, available from eurocoin.cepr.org, is an Eurozone alternative to the real-time recession indicator used by Beber and Brandt (2010) for US. It is monthly estimate of the euro-area GDP growth computed each by the staff of the Banca d'Italia. It takes into account a large number of hard macroeconomic indicators, confidence surveys and financial data. It is likely the most sophisticated business cycle measurement among the four selected but on the other hand it does not directly refer to Poland or Czech Republic. Application of this indicator is thus based on the assumption of tight connection of business cycles in Eurozone and CEE countries.

The above methods all result in business cycle measurements on various scales. We transform these time series onto the [0, 1] range so that they are consistent with equation (4.5). For instance, the most positive output gap then corresponds to a value rec_t equal to zero. Secondly, we interpolate the measurements using cubic splines so that we have a value for every day used in our analysis. Examples of resulting business cycles measurements are depicted in Figure 1 in the Appendix. Given the distinct methodologies, the eight measurements are often quite different from each other. In this regard, if the impact of a given indicator truly varies over business cycle we expect this would often be captured by at least some measurement.

4.2 Intraday Event study

Intraday data enables us to inspect the reaction in a very short time frame around the announcements so that other impact of other factors that could affect bond prices is minimized. The idea of intraday event study is to group releases by their announcement time and thus eliminate the need for controlling for intraday volatility patterns. A similar method has been used e.g. by Reeves and Sawicki (2007) who examined the reaction to scheduled central bank communication. We take advantage of the fact that our indicators are released regularly at a certain precise time of the day. Where the release dates of more indicators coincide, there can be more than one nonzero surprise on a given day, so we always examine one whole group at once. It should be noted that prior to 2007, there have been several changes in release times for the Polish indicators which would make our analysis quite challenging. Since 2007, 8 out of 11 Polish indicators are released at 14:00 CEDT whereas GDP, Retail Sales and Unemployment are released at 10:00 CEDT. 7 out of 8 Czech variables are released at 9:00 Central European Daylight Time (CEDT) while current account is released at 10:00 CEDT. The situation is more complicated in Germany. The largest group is released already at 8:00 CEDT. Gfk consumer confidence is released at 8:10. We decided to act as if it was released at 8:00 as well and to focus on longer windows. CPI was released at irregular times before 2011. Several other indicators are released at the same intraday time (Unemployment at 9:55, IFO at 10:00, Factory Orders and Industrial Production at 12:00). However we decided not to run separate event studies for these and only include them in the daily analysis. Given various release times, there are only few German indicators that may interfere with the large Czech and Polish groups.

Firstly, we use a very simple method that tests whether the market activity around release times heightens on the announcement days. We proxy the market activity by mean absolute price change over a specific window and by mean absolute change in the bid-ask spread. We selected various windows – from the shortest possible [time of release, time of release + 5 min] (hereafter [0, 5] and so on) up to a very long window [-15 min, + 180 min]. The null hypothesis states that mean of absolute price changes over a given window on the sample of announcement days is the same as on the sample of other (non-announcement) days. The alternative hypothesis is that it is greater for the announcement days. For instance, in the total of 2010 Polish business days from January 2007 to 12th December 2014, there were 391 announcement days (of those indicators that get released at 14:00 and 1619 non-announcement days. We use the Welch's t-test for unequal variances. Any day with a release of an indicator (from the group of indicators released at the given intraday time) is considered an announcement day. In this preliminary step we do not take the magnitude of surprises into account.

Secondly, we conduct regression analysis using announcement days only that can take into account frequent cases where multiple indicators are released at once. The basic regression is as follows:

$$y_t = \mu + \sum_{k=1}^{n} \delta_k S_{k,t} + \varepsilon_t \tag{4.6}$$

where y_t is the change in price over a window around the announcement on day t and ε_t is a random error term. We also augment the specification by interacting the surprises with our business cycle indicators according to (4.5). In the above, y_t only considers information from the edges of a given window, so we also define a proxy for volatility as the mean 5-minute absolute price change within the window. Unlike in GARCH regressions, we keep all the variables (even the insignificant ones) for display.[1]

Intraday price changes are extremely long-tailed: most of the time there is little price change or even none at all, but many times the observations are extreme compared to the interquartile range. Our OLS estimates may be biased by the outliers especially in case some of them originate from remaining noise in the data. Therefore, we supplement our analysis with two other methods that impose require less strict distributional assumptions than OLS and are robust to outliers in the dependent variable. We use Huber's M-estimator (hereafter Huber's M) and Least Absolute Deviations (LAD). The latter is equivalent to *median* regression. These estimators minimize a specific function f of scaled residuals:

$$\sum_{i=1}^{n} f\left(\frac{y_i - \boldsymbol{x}_i^T \boldsymbol{\delta}}{\sigma}\right) \tag{4.7}$$

[1] Results with only significant variables are available on request. Though in a few cases certain variables became slightly more significant, the parameters have changed minimally and our conclusions have stayed the same.

with respect to β. There are various choices for the function f. $f(x) = x^2$ corresponds to OLS. Least Absolute Deviations sets $f(x) = |x|$. Huber (1964) suggested the following:

$$f(x) = \begin{cases} \frac{1}{2}x^2 , & |x| \leq c \\ c|x| - \frac{1}{2}c^2, & |x| > c \end{cases} \tag{4.8}$$

Parameter c equal to 1.345 was proposed by Huber which corresponds to 95% relative efficiency at the normal. The method essentially weights observations with "small" residuals with a weight of 1 whereas for observations surpassing the boundary the larger the residual the smaller the weight. It is a compromise between OLS and LAD. The normal equations are:

$$\sum_{i=1}^{n} f'\left(\frac{y_i - \sum_{j=1}^{k} x_{ij}\delta_j}{\sigma}\right) x_{ij} = 0, j = 1,2,..k \tag{4.9}$$

This will lead to a weighted least squares formula where the weights are functions of the residuals, which requires an iterative solution (re-weighted least squares for Huber's M). LAD is fitted using Frisch-Newton algorithm described in Portnoy and Koenker (1997). For LAD there are multiple methods available for standard errors – we use a kernel estimate of the sandwich covariance matrix as proposed by Powell (1991). By comparing the coefficients and significance of the various methods we will be able to infer whether the estimated relationship appears driven mostly by several extreme observations or by the bulk of observations.

4.3 Time series modeling

Our secondary method is a standard technique in the literature utilizing daily data (Andritzky et al. 2007, Büttner and Hayo 2012, Fang et al. 2007, Arru et al. 2013). Unlike in the event study where we only included announcement days in the regressions, we model the whole time series of Polish and Czech business days between January 2007 and mid-December 2014. In view of excess kurtosis and volatility clustering of financial markets we use GARCH-type models. This method has several advantages over the event study on intraday data. First, unlike our intraday data the daily data are the yield that is the preferred variable over the price variable in the setting of our econometric model. Impact on the "spread" (difference between prices) in the intraday data merely measures whether the 10-year bonds or

2-year bonds are influenced more. In absolute terms this would usually be the 10-year bond. However, the daily data are quoted as *mid yield*, and term spread compares yearly yields, which is easier to interpret. The term spread is a variable of great interest to policymakers (Rosenberg and Maurer 2008). Second, daily data do not suffer from noise in quotes and thus one avoids data quality issues. Third, *not focusing* on the very short window can serve as check for the robustness of the impact. As pointed out by Hayo et al. (2008), “effects of economic importance are characterized by some sort of persistence over time instead of just picking out short blips in the data”.

Our model specification is as follows. Macroeconomic news can enter both mean equation (4.8) and volatility equation (4.11). In addition to domestic surprises, we include the German ones to proxy the foreign macroeconomic news. The mean equation also contains autoregressive and moving average terms and control variables:

$$\Delta y_t = c + AR(r) + \sum_{k=1}^{l} \delta_k S_{k,t} + \sum_{j=1}^{m} \gamma_j control_{i,t} + e_t \qquad (4.10)$$

Δy_t is the daily spread change – all dependent variables are first differences in *mid yield* which ensures their stationarity. The error $e_t \sim t(0, \sigma_t^2)$ is t-distributed to address the non-normality of our dependent variables. Individual $S_{k,t}$ may further be split according to (4.5). We also include the possibility that the surprises have a lagged effect. $AR(r)$ denotes the autoregressive terms that are added to the mean equation if needed to avoid autocorrelation in residuals. We use a simple GARCH (p, q) specification for conditional variance (Engle 1982) augmented with explanatory variables:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i e_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2 + \sum_{i=1}^{n} \omega_i \, sur_{i,t} \qquad (4.11)$$

We tried unrestricted estimation and one that imposes stationarity $(\sum_i \alpha_i + \beta_i < 1)$. Unrestricted estimation usually led to much higher estimated effects of surprises in the variance equation, but it also violated the above stationarity condition by large margins. The interpretation would be that without any surprises the process of daily spread changes is explosive. This appears quite unrealistic so we imposed the stationarity. Unlike in intraday analysis where effect of other pricing factors is minimized, in a daily analysis it is useful to include control variables. We collected a broad set of financial indicators that drive risk appetite of the investors. When choosing our control variables we follow Ebner (2009), Büttner and Hayo (2012) and Fender et al. (2012). We take equity volatility indices on US and German equity VIX, VDAX-NEW and fixed income volatility index Merril Lynch MOVE. Second, we include equity indices (PX, VIG, S&P 500 and DAX) to account for possible stock-bond correlation. JP Morgan EMBI is assumed to control investor's general preferences towards emerging markets. Third, we include domestic exchange rates *vis-à-vis* the euro and the US dollar. The controls were transformed into first differences (interest rates and volatility indices) or simple returns (exchange rates and indices) which ensured their stationarity. Moreover, weekday dummies were included but their effects were generally insignificant.

We take a specific two-stage modeling strategy in line with the general-to-specific modelling approach. On the one hand, we believe GARCH is the correct specification. However, we have too many variables at hand to include them all in a GARCH model given it is difficult for the Maximum Likelihood Estimation to converge on high-dimensional function surfaces. However OLS should be consistent even in presence of strong ARCH effects. In the first stage, we thus use OLS-based model selection algorithm Autometrics of Doornik (2009). Autometrics procedure belongs to automatic selection procedures that follow the pioneering work of Hoover and Perez (1999). It starts the process at a general model and eliminates insignificant variables (less significant first). It also decides based on specific diagnostic tests. For comprehensive description of Autometrics and its advantages can be found in Doornik (2009). Hoover and Perez (1999) and Krolzig and Hendry (2001) use Monte Carlo experiments to show that despite extensive search used in general-to-specific modeling, the empirical size and power stay close to values from the true data-generating process. We run Autometrics three times for each model using Heteroskedasticity and Autocorrelation Consistent errors. Control variables stay the same. The first specification uses basic surprises. The other two specifications use surprises interacted with business cycle measurements ZEW Economic Expectations and OECD. The former appeared as one of the best performing measurement in intraday analyses and the latter is the only binary measurement.

Variables that survive the first stage enter the GARCH specification. We firstly finalize the mean equation and only model the variance equation afterwards. For every series, we choose at most one specification between the ZEW and OECD. During the second-stage modeling, we regularly test model assumptions. In particular, we test for residual autocorrelation of the first 20 lags using the Ljung-Box Q-statistic and for ARCH effects up to lag 5 using the Engle's ARCH LM test (Engle 1982). We assumed that only the absolute value of a surprise may have an effect in the variance equation, i.e. only the amount of information but not the direction is relevant for volatility. Asymmetric reaction is possible but we found it insignificant during preliminary trials.

5 Results

5.1 Event study results

The first part of the event studies was the Welch's two-sample t-test. We tested whether absolute price changes are higher on a specific intraday windows during announcement days for Polish 14:00 surprises, Polish 10:00 surprises, Czech 9:00 surprises and Czech Current Account which is released at 10:00, compared to the same intraday windows during non-announcement days. Results for Poland are in Table 1. The differences are highly significant in short windows especially for 14:00 surprises. The mean absolute price change is approximately double on the announcement days (0.037 per 100 nominal during the first 5 minutes). Changes in bid-ask spread are significantly higher in the [-5, 15] window but interestingly also in the [-30, 0] window – prior to the announcements being released. This suggests market makers adjust their spread awaiting the news. In general, the difference weakens with longer windows. This basic analysis suggests something happens around the announcement times. The same analysis for Czech bonds (available on request) suggests Czech bond price may be less responsive. Only mean absolute returns in the [0, 5], [-5, 30] and [5, 60] windows for the 10-year bonds and [0, 5] for the "spread" were found significant at 5%.

Secondly, we ran a large amount of regressions where we examined bid, ask and mid price behavior over various windows around the announcements. The dependent variables were (i) price change per 100 nominal over a given window (ii) mean absolute 5-minute price change per 100 nominal in a given window. We examined multiple "groups" (defined by the release time) and used multiple business cycle measurements, so in total we several hundred regressions. The appendix provides only several of the more interesting ones. Full results are available on request. Given the amount of output we cannot interpret all significant coefficients as true evidence of market reaction. Instead, we try to focus on consistent patterns that emerged in the output. Overall the results of Polish and Czech regressions is contrasting, reinforcing the indication of the Welch's tests: whereas various Polish surprises are significant both for the 10-year and the 2-year bond prices, and four of them have a significant influence already at the [0, 5] window, Czech surprises are rarely significant and when they are, the reaction is substantially delayed.

Results from Polish 14:00 surprises can be regarded as the most interesting. Their impact on the mid price over [-5, 60] is shown in Table 2. The effect of surprises in

CPI and Industrial production are measurable since the first 5-minute return. CPI appears to be the most influential indicator. One standard deviation corresponds to the mean effect of around -0.13 per 100 nominal for the 10-year bond. This magnitude was reached already after 15 minutes and stayed significant with almost exactly the same coefficient until our widest [-15, 180] window. This suggests CPI news is incorporated within the first 15 minutes from the release. CPI surprises were significant in OLS, Huber's M and LAD regressions, suggesting the effect is not merely driven by several large movements but also by the bulk of observations. The effects were also usually similar in magnitude across the three methods. The other two prevalently significant surprises were Industrial Production and Wages and they also had a negative effect: we interpret these indicators as drivers of inflation expectations. These results are consistent with the findings from Germany (Andersson et al. 2009) and US. The coefficients suggested maximum impact is generally reached until the end of first hour since the release time. PPI surprises appeared to impact the 2-year bond (suggested by OLS and Huber's M) but not the 10-year bond. Altogether macroeconomic surprises can be considered as influential. Adjusted R-squared reached around 20% for the middle length windows ([-5, 30], [-5, 60]) and slowly declined for the longer ones. Concerning the business cycle interactions, our results suggest that Polish 14:00 indicators have mostly similar effects under different stages of the business cycle. Of the eight measurement variants, none resulted in a clear separation pattern of any indicator. For instance, regressions using the binary OECD impact separation suggested CPI surprises' effect is very similar across expansions and recessions.

Effects on volatility (see Table 4 for the [-5, 30] window) were observable mostly for the three indicators above. For most windows, one standard deviation of the CPI surprise brought about as much volatility as is the "baseline" volatility measured by the intercept. Surprises in wages and industrial production mostly had about half of this effect. M3 money surprises were often found to decrease volatility, which is one counterintuitive effect.

Out of Polish 10:00 surprises (see Table 3 for the [-15, 180] window), retail sales surprises had the most consistent effect measured by OLS and Huber's M though only sometimes by LAD. The effect was comparable in both size and direction with wages and industrial production. Retail sales thus appear as another inflation-related indicator. GDP surprises were also found significant at many windows but did not have entirely consistent sign – for the 10-year bond the coefficient was positive and significant at various window lengths. Separation by ZEW Economic Expectations as well as Ecoin suggested that GDP surprises had a positive effect on the bond price in recessions and a negative effect in expansions. These effects were rather large (corresponding to a multiple of instance, the two significant coefficients were 0.4 and -0.41 for [-5,120] window which is about three times as high as the effect of CPI. We interpret this contrast as follows. A positive GDP surprise may signal overheating and subsequent inflation during expansions hence decreasing the prices of long-term bonds. On the other hand, in recessions, credit risk may become a consideration and institutional investors may fly to quality assets such as German bonds, hence decreasing the prices CEE bonds. GDP and Retail Sales surprises were found to influence especially the volatility of the 2-year bonds. The magnitude of GDP impact was about two times the baseline volatility per standard deviation.

Turning to Czech bond prices, we see quite a contrasting picture. Most interestingly the *median* effect as measured by LAD is essentially zero for most baseline window, suggesting that *more often than not*, Czech bond prices (benchmark bond yield indices by Reuters) do not move at all. Separation by business cycles revealed some interesting relationships. Even then it appears there is a large delay when reacting to macroeconomic news as our longest windows captured more effects. Table 5 shows reactions from the [-15, +180] window, separated by the measurement using the output gap from a local level model. GDP and industrial production surprises were negatively related to prices during expansions. The coefficient on the recession part was again positive and when using other kind of measurements (e.g. Ecoin, ZEW Economic Expectations) it was also significant. The coefficients at long windows were again about 0.4 / -0.4 range reinforcing the GDP interpretation somewhat. This was measurable only using OLS and Huber's M, LAD (traditionally for Czech surprises) showed no significant effects. Though CPI surprises did not have any measurable effect on the mean, they were found to have a smallish impact on the volatility during the first hour since the release. Our results for Czech current account surprises that are released unlike the rest at 10:00 are displayed in Table 6 and Table 7. It appears that a delayed reaction occurs in a manner relatively similar to GDP (positive relationship during recessions and *vice versa*). Yet corresponding LAD coefficients were again insignificant suggesting the effect is only driven by minority of observations. Some volatility is brought by current account news during recessions. Overall these effects are very small, which is also observable from tiny R-squareds. The above results may be reflective of low market liquidity of Czech government bonds or simply the quality of our data.[2]

[2] It should be noted that the data from the MTS platform used by Paiardini (2014) might be of higher quality. However, for the Czech Republic MTS data have been available only since mid 2011. This is

German surprises (8:00 group) were found almost universally insignificant for both Czech and Polish bond prices. One may attribute lack of significance to the early release time, release time prior to trading start in a given day yet if the German indicators were very influential, their effect would be measurable using our longer windows.

5.2 GARCH results

GARCH results are set forth in Table 8 and Table 9. Unlike for intraday regressions, the dependent variable is the implied mid yield so the signs of coefficients to a given surprise should be the opposite. It frequently occurred that the first-stage using OLS with Autometrics suggested a larger amount of significant surprises than actually remained in the final GARCH specification (that was free from autocorrelation and ARCH effects). In five out of six cases the GARCH (1,1), specification was sufficient to clear the ARCH effects. The student-t degrees of freedom were usually around 3 confirming the strong departure from normality. In order to better interpret the magnitude of coefficients we note that standard deviation of our dependent variables is about 5 basis points for the three Polish dependent variables and about 4 basis points for the three Czech ones.

Overall, fewer indicators stay significant from the daily data point of view, but several patterns from intraday event studies hold here as well. From Table 8, we can see that in the Polish case, surprises in CPI are again the most influential. One standard deviation in CPI implies a rise in yield of 1.8 basis points for the 10-year bond and about 3 basis points for the 2-year bond. How does that compare with the previous results? Intraday event studies suggested approximately -0.12 and -0.04 drop in price per 100 nominal per CPI standard deviation. If the duration of the 10-year bond was actually 10, change of yield by 1.8 basis points would imply approximately 0.18% drop in price whereas -0.12 means 0.12% drop in price assuming initial price equal to 100[3]. The duration is likely to be somewhat lower so the effects are roughly comparable. The effect on 2-year yield is considerably higher so that the coefficient on the term spread is positive. This means in some sense that CPI news do not fully translate into expectations in the long-term. During the modeling process, we noticed that separation by business cycles (we used ZEW Economic Expectations) indicated

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likely not enough to gauge the effect of our macroeconomic surprises as they occur at most once a month.

[3] PL10Y price almost always stayed between 90 and 110.

that the expansionary part of the CPI effect is much higher. However both coefficients were positive and thus we decided to use the baseline specification. Interestingly, the first lag of CPI surprises was significant for the 2-year bond as well (but only at 5% level). Retail sales and industrial production surprises had a significant positive effect for the 10-year bond, consistent with the intraday studies. Together with CPI, they appear as economically significant in the sense that the impact of surprises should be noticeable on announcement days. On the other hand, it does not seem that many *big shocks* in the bond market referred to by Goeij and Marquering (2006) should be explained by common macroeconomic surprises.

Volatility impacts in the variance equation need to be interpreted taking into account mean of conditional variance (around 35 for the Polish series, 20 for the Czech series). In this regard, most estimated significant effects appear quite small. One standard deviation in the CPI surprise is predicted to increase the conditional variance by about 12 for the 2-year bond. While in our intraday analyses one standard deviation in the CPI surprise was enough to match the “baseline volatility”, one needs a large shock for the match here. The lower effect might stem from the GARCH definition, where explanatory variables are assumed to impact even subsequent days through the β coefficients which may not be realistic.

Table 9 shows that in the Czech case, CPI surprises were only significant for the 2-year bond at 5% level. The size of that effect is also notably smaller than in the Polish case. PPI surprises were found to move the 2-year bond similarly to CPI. Retail sales surprises were significant for the 10-year bond. This time a few variables split by OECD or ZEW Economic Expectations turned out significant (we use at most one separation type per series). Positive coefficients on German CPI surprises suggest that market participants may interpret higher than expected German inflation as inflationary news for the Czech economy as well. Among the other significant indicators, we could find no clear and consistent effects. The same holds for the scarce and rather small effects on conditional variance. Results from the GARCH analysis support one of our main conclusions that the Czech bond price responses are weaker and with less consistent patterns.

6 Conclusion

This paper is among the first to provide systematic evidence of the short-term impact of macroeconomic news on bond markets in CEE. Unlike the vast majority of papers, we use both intraday and daily data as both have their advantages. Based on Polish and Czech government bond market data and data of scheduled macroeconomic announcements, our results suggest that the most important reason for bond repricing facing macroeconomic news is the revision of the real return and of inflation expectations. This is consistent with research from mature markets (Andersson et al. 2009, Ramchander et al. 2005). Essentially, the evidence is in line with the concept of investors associating country risk with GDP news during recessions. Otherwise, there were very few successful attempts to distinguish between effects during expansions and during recessions. Macroeconomic variables that were insignificant in the baseline specification usually stayed insignificant when we assumed the impact is a combination between an expansionary and a recessionary response.

Paiardini (2014) found that CPI was the only Italian indicator to move the Italian government bond market. Compared to that result, Polish government bond market appears more responsive. Consistent patterns were observed for surprises in Polish CPI, wages, industrial production and retail sales that are all negatively related to domestic bond prices. These effects were usually observable across various windows and confirmed by all three models. They were partly confirmed by our daily data analysis. However, volatility effects were notably smaller at daily data frequency. This is consistent with the results of our intraday event studies where volatility effects were found diminishing in the first couple of hours after the announcement.

The Czech government bonds appear much less responsive to macroeconomic news than the Polish ones. In the Czech case, even though the mean effect estimated by OLS was often found significant, Least Absolute Deviations estimate did not confirmed these results. Controlling for phase of business cycle appeared to play a role in case of GDP surprises, which moved the Czech and Polish bond prices in the same direction as inflation-related news during expansions but in the opposite direction during recessions. One reason for the lack of statistically strong evidence may simply be the illiquidity of the Czech underlying benchmark bonds. Another possible reason is the high noisiness of macroeconomic news and the issues associated with the measurement of the market expectations described by Rigobon and Sack (2008). The latter, however, does not explain the contrast to the Polish results.

We have found only limited evidence of German news' impact on the Polish and Czech government bond markets though some evidence was suggested by the daily data. We also note that surprises in macroeconomic indicators with biased revisions and/or biased consensus estimates (e.g. Polish foreign trade variables) were found generally insignificant.

One of the possible directions for follow-up research is to eliminate the implicit assumption of linear dependence of market price on the size of surprise. It is likely that only large surprises compel investors to rebalance their positions triggering bond repricing. Another possibility is to examine the effects on other markets such as the stock and forex markets that tend to be more liquid. It may be also beneficial to include other indicators than CEE fundamentals such as US macro news or non-fundamental news as in Mohl and Sondermann (2013) and Büchel (2013).

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7 Appendix

Table 1 Welch's t-test of Polish Bond Market: Announcement Days vs Non-announcement Days

Ann. Days = release dates of *Group 1*, around 14:00	PL10Y			PL2Y			Spread (10Y-2Y)		
	Mean Ann.Days	Mean Other	P-value	Mean Ann.Days	Mean Other	P-value	Mean Ann.Days	Mean Other	P-value
Abs(ΔP) 0 to 5	0.0368***	0.0183	0.0000	0.00938***	0.00363	0.0000	0.0373***	0.0188	0.0000
Abs(ΔP) -5 to 30	0.0968***	0.064	0.0000	0.0254***	0.0135	0.0000	0.0888**	0.0681	0.0040
Abs(ΔP) -5 to 60	0.108**	0.0898	0.0095	0.0309***	0.0194	0.0000	0.099	0.0951	0.3080
Abs(ΔP) -5 to 120	0.132	0.122	0.1320	0.0365**	0.0297	0.0051	0.121	0.124	0.6390
Abs(ΔP) -15 to 180	0.169	0.164	0.3310	0.0456*	0.0384	0.0106	0.157	0.167	0.8160
Abs(ΔBidAsk) 0 to 5	0.057***	0.0314	0.0000	0.0139**	0.00715	0.0015	0.0652***	0.0351	0.0000
Abs(ΔBidAsk) -5 to 15	0.0874*	0.0723	0.0299	0.0296***	0.0178	0.0005	0.103**	0.0815	0.0091
Abs(ΔBidAsk) -5 to 60	0.104	0.0977	0.2410	0.0368'	0.0305	0.0567	0.117	0.112	0.3130
Abs(ΔBidAsk) -15 to 120	0.11	0.108	0.4320	0.0407	0.0415	0.5900	0.123	0.125	0.5740
Abs(ΔBidAsk) -30 to 0	0.0887*	0.0739	0.0317	0.0307**	0.0206	0.0015	0.0988'	0.0847	0.0541
Ann. Days = release dates of *Group 2*, around 10:00	PL10Y			PL2Y			Spread (10Y-2Y)		
	Mean Ann.Days	Mean Other	P-value	Mean Ann.Days	Mean Other	P-value	Mean Ann.Days	Mean Other	P-value
Abs(ΔP) 0 to 5	0.0435*	0.0283	0.0277	0.0114*	0.00535	0.0175	0.05*	0.0303	0.014
Abs(ΔP) -5 to 30	0.0988*	0.0803	0.0480	0.0269'	0.0211	0.0685	0.103'	0.0851	0.0725
Abs(ΔP) -5 to 60	0.119*	0.0981	0.0499	0.0341*	0.0259	0.0152	0.117	0.102	0.117
Abs(ΔP) -5 to 120	0.14	0.126	0.1810	0.0409*	0.0321	0.0367	0.132	0.126	0.337
Abs(ΔP) -15 to 180	0.169	0.149	0.1240	0.0408	0.0376	0.24	0.166	0.146	0.125
Abs(ΔBidAsk) 0 to 5	0.0743*	0.0427	0.0203	0.0128	0.0102	0.224	0.0786'	0.0486	0.0505
Abs(ΔBidAsk) -5 to 15	0.0773	0.0815	0.6210	0.0368*	0.0246	0.0175	0.098	0.0938	0.395
Abs(ΔBidAsk) -5 to 60	0.112	0.0998	0.2190	0.0415	0.0353	0.143	0.131	0.116	0.184
Abs(ΔBidAsk) -15 to 120	0.132	0.111	0.1150	0.0406	0.0431	0.67	0.152	0.13	0.115
Abs(ΔBidAsk) -30 to 0	0.115	0.0939	0.1420	0.0326	0.0317	0.437	0.142'	0.108	0.0861

Notes: *, **, *** indicate significance at 5, 1 and 0.1% levels, respectively. There are two types of Polish indicators considered – *Group 1* are those usually released at 14:00 (CPI.YoY,Cur.Acc, Employ, Ind.Pro, M3.MoM, PPI.YoY, Trd.Bal, Wages.YoY). Indicators in *Group 2* are released at 10:00 (GDP.YoY, Ret.Sales, and Unemployment). Variable of interest are absolute changes in *mid* bond prices and absolute changes in the bid-ask spread, both measured per 100 nominal, over specific windows (see the left column) around respective intraday times (time of release is “time 0”). We test for mean using a simple Welch t-test for unequal variances using a one-sided alternative. We conducted the same test for Czech bonds and only Abs(ΔP) 0 to 5, -5 to 30 and -5 to 60 was significant at 5% for the large group of surprises released at 9:00. Full results are available on request.

Table 2 Response of Polish Bond Mid Prices to 14:00 Surprises over [-5, +60] Window

Y= ΔP 13:55 to 15:00	PL10Y		PL2Y		Spread(10Y – 2Y)	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.00141	(0.00808)	0.00528*	(0.00243)	-0.00169	(0.00837)
CPI.YoY	-0.118***	(0.0164)	-0.0379***	(0.00497)	-0.0586***	(0.0171)
Cur.Acc	0.0095	(0.0216)	0.00179	(0.00637)	0.00874	(0.0219)
Employ	-0.0161	(0.0171)	-0.0014	(0.00488)	-0.0169	(0.0168)
Ind.Pro	-0.0257	(0.0166)	-0.0215***	(0.00489)	-0.00481	(0.0168)
M3.MoM	0.00258	(0.0165)	0.00886	(0.00529)	0.000397	(0.0182)
PPI.YoY	-0.0304	(0.0166)	-0.00679	(0.00474)	-0.0295	(0.0163)
Trd.Bal	0.0157	(0.0218)	0.00568	(0.00671)	0.0204	(0.0231)
Wages.YoY	-0.0586***	(0.0164)	-0.0171***	(0.00497)	-0.0436*	(0.0171)
N; F-test	391	0.000***	342	0.000***	342	0.001***
AdjR^2; sigma	0.151	0.159	0.228	0.0447	0.055	0.154
BP test; SW test	0.998	0.000***	0.612	0.000***	0.998	0.000***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.00252	(0.00588)	0.00282	(0.0016)	0.00221	(0.00595)
CPI.YoY	-0.093***	(0.012)	-0.0339***	(0.00328)	-0.0357**	(0.0122)
Cur.Acc	0.021	(0.0158)	0.000659	(0.0042)	0.021	(0.0156)
Employ	-0.0152	(0.0124)	-0.00223	(0.00322)	-0.0152	(0.0119)
Ind.Pro	-0.0243*	(0.0121)	-0.0168***	(0.00322)	-0.00825	(0.012)
M3.MoM	0.000424	(0.012)	0.00273	(0.00348)	0.000628	(0.0129)
PPI.YoY	-0.0255*	(0.0121)	-0.00659*	(0.00312)	-0.0155	(0.0116)
Trd.Bal	0.0034	(0.0158)	0.00614	(0.00442)	0.00598	(0.0164)
Wages.YoY	-0.0363**	(0.0119)	-0.0107**	(0.00327)	-0.0266*	(0.0122)
F-test; sigma	0.000***	0.09562	0.000***	0.02308	0.004**	0.09513
BP test; SW test	0.998	0.000***	0.612	0.000***	0.998	0.000***
LAD	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	4.92E-13	(0.00766)	0.000722	(0.00202)	0.00035	(0.0081)
CPI.YoY	-0.0782**	(0.024)	-0.0321***	(0.00537)	-0.0241	(0.0244)
Cur.Acc	0.0143	(0.0185)	-0.00062	(0.00361)	0.0139	(0.019)
Employ	-0.00998	(0.0157)	-0.00281	(0.00635)	-0.00921	(0.0148)
Ind.Pro	-0.0252	(0.0185)	-0.0154*	(0.00647)	-0.0244	(0.0242)
M3.MoM	6.32E-14	(0.0129)	-0.00041	(0.00372)	-0.0002	(0.0144)
PPI.YoY	-0.0225	(0.0135)	-0.00746	(0.00419)	-0.0073	(0.0146)
Trd.Bal	0.00119	(0.0189)	0.00372	(0.00437)	-0.00443	(0.0229)
Wages.YoY	-0.0234	(0.0154)	-0.00658	(0.00385)	-0.0179	(0.0158)

Notes: *, **, *** indicate significance at 5, 1 and 0.1% levels, respectively. Sample is comprised by all announcement days of the macroeconomic variables in question between 2007 – 2014 for PL10Y and 2008 - 2014 for the rest. OLS stands for Ordinary Least Squares; Huber's M stands for Huber's M-estimator and LAD stands for Least Absolute Deviations (median regression). The dependent variables are intraday mid-price changes per 100 nominal of 10-year, 2-year benchmark bond indices and of the difference between them. Explanatory variables are deviations from median expected value by Bloomberg expressed in standard deviations. N is the number of observations. F-test is the p-value of the joint hypothesis that all coefficients except for the intercept are zero. Sigma is the estimated standard deviation of the error term. BP test is the p-value of Breusch-Pagan test for heteroskedasticity (For OLS and Huber's M, if significant at 5%, we use HC standard errors). SW test indicates the p-value of Shapiro-Wilk test of normality of the residuals.

Table 3 Response of Polish Bond Mid Prices to 10:00 Surprises over [-15, +180] Window

Y= ΔP 9:45 to 13:00	PL10Y		PL2Y		Spread(10Y-2Y)	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0261	(0.0227)	0.00917	(0.00581)	0.0229	(0.0226)
GDP.YoY	0.0796	(0.0431)	-0.0221*	(0.0111)	0.128**	(0.043)
Ret.Sales	-0.0638*	(0.0254)	-0.0143*	(0.00653)	-0.0534*	(0.0254)
Unem	0.0345	(0.0257)	0.0121	(0.0063)	0.0269	(0.0252)
N; F-test	126	0.014*	111	0.012*	110	0.004**
$AdjR^2$; sigma	0.061	0.245	0.072	0.0593	0.092	0.23
BP test; SW test	0.217	0.000***	0.59	0.000***	0.281	0.000***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0211	(0.0157)	0.00552	(0.00448)	0.0192	(0.0174)
GDP.YoY	0.13***	(0.0299)	-0.0186*	(0.00855)	0.171***	(0.0331)
Ret.Sales	-0.0481**	(0.0176)	-0.0147**	(0.00504)	-0.0344	(0.0196)
Unem	0.0278	(0.0178)	0.0084	(0.00486)	0.0191	(0.0194)
F-test;sigma	0.000***	0.12645	0.003**	0.03717	0.000***	0.15093
LAD	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0257	(0.0278)	0.00176	(0.00705)	0.02	(0.0266)
GDP.YoY	0.0835	(0.142)	-0.0104	(0.0124)	0.192***	(0.0463)
Ret.Sales	-0.0285	(0.0282)	-0.0172	(0.00876)	-0.0216	(0.0281)
Unem	0.0139	(0.0305)	0.0015	(0.00841)	0.0146	(0.0316)

Alternative Specification: Surprises interacted with Business Cycle Measurements

Y= ΔP 9:45 to 13:00	PL10Y		PL2Y		Spread(10Y-2Y)	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0342	(0.0232)	0.0119*	(0.00586)	0.0255	(0.0226)
GDP.YoY_Rec_ZEW_EcE	0.493**	(0.152)	0.0752*	(0.0378)	0.471**	(0.145)
GDP.YoY_Exp_ZEW_EcE	-0.381*	(0.169)	-0.129**	(0.0413)	-0.247	(0.158)
Ret.Sales_Rec_ZEW_EcE	-0.117	(0.0963)	-0.0138	(0.0239)	-0.0971	(0.0916)
Ret.Sales_Exp_ZEW_EcE	-0.00617	(0.0917)	-0.0143	(0.0225)	-0.0045	(0.0864)
Unem_Rec_ZEW_EcE	0.221*	(0.101)	0.019	(0.0223)	0.205*	(0.0965)
Unem_Exp_ZEW_EcE	-0.114	(0.0827)	0.00763	(0.0191)	-0.112	(0.0778)
N; F-test	121	0.001**	111	0.006**	110	0.001***
$AdjR^2$; sigma	0.127	0.239	0.108	0.0582	0.15	0.223
BP test; SW test	0.0651	0.001***	0.563	0.000***	0.286	0.001***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0308	(0.0174)	0.00637	(0.0048)	0.023	(0.0177)
GDP.YoY_Rec_ZEW_EcE	0.402***	(0.114)	0.031	(0.0309)	0.411***	(0.113)
GDP.YoY_Exp_ZEW_EcE	-0.196	(0.127)	-0.0755*	(0.0338)	-0.11	(0.124)
Rec_ZEW_EcE_Ret.Sales	-0.088	(0.0723)	-0.0185	(0.0196)	-0.0693	(0.0715)
Exp_ZEW_EcE_Ret.Sales	-0.007	(0.0688)	-0.0108	(0.0185)	0.000352	(0.0674)
Rec_ZEW_EcE_Unem	0.152*	(0.0755)	0.0246	(0.0182)	0.14	(0.0754)
Exp_ZEW_EcE_Unem	-0.0715	(0.0621)	-0.003	(0.0157)	-0.0741	(0.0608)
F-test;sigma	0.000***	0.14151	0.008**	0.0385	0.000***	0.14856
LAD	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0296	(0.027)	0.00162	(0.00761)	0.02	(0.0289)
GDP.YoY_Rec_ZEW_EcE	0.333*	(0.163)	0.019	(0.0444)	0.316	(0.166)
GDP.YoY_Exp_ZEW_EcE	-0.0574	(0.212)	-0.052	(0.0545)	-0.0152	(0.212)
Ret.Sales_ Rec_ZEW_EcE	-0.156	(0.171)	-0.0188	(0.0334)	-0.0833	(0.148)
Ret.Sales_ Exp_ZEW_EcE	0.0466	(0.141)	-0.013	(0.0289)	0.00792	(0.131)
Unem_ Rec_ZEW_EcE	0.115	(0.128)	0.0155	(0.0387)	0.123	(0.151)
Unem _Exp_ZEW_EcE	-0.0383	(0.107)	-	(0.0266)	-0.0672	(0.121)

Notes: See Table 2. Rec_ZEW_EcE and Exp_ZEW_EcE are measurements of the business cycle based on ZEW Econonomic. Expectations. Effect of a surprise is assumed to be a convex combination of 2 extremes, see 4.1.

Table 4 Response of Polish Bond Volatilities to 14:00 Surprises over [-5, +30] Window

Y = Average (5-minute) |ΔP| between 13:55 and 14:30	PL10Y		PL2Y		SPREAD	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0251***	(0.00332)	0.00519***	(0.000983)	0.0253***	(0.00387)
abs(CPI.YoY)	0.0367***	(0.00457)	0.00830***	(0.00134)	0.0353***	(0.0053)
abs(Cur.Acc)	-0.0136*	(0.00654)	4.41E-05	(0.00189)	-0.0144	(0.00744)
abs(Employ)	-0.00637	(0.0049)	-0.00058	(0.00138)	-0.00313	(0.00542)
abs(Ind.Pro)	0.00907	(0.00566)	0.00398*	(0.00165)	0.0101	(0.00649)
abs(M3.MoM)	-0.00701	(0.00471)	-0.00035	(0.00148)	-0.00675	(0.00585)
abs(PPI.YoY)	0.00413	(0.00552)	0.00236	(0.00157)	0.00458	(0.00619)
abs(Trd.Bal)	0.00877	(0.00663)	-0.00281	(0.002)	0.0125	(0.00787)
abs(Wages.YoY)	0.0167**	(0.00504)	0.00213	(0.00149)	0.0125*	(0.00589)
N; F-test	391	0.000***	342	0.000***	342	0.000***
$AdjR^2$; sigma	0.158	0.0406	0.122	0.0112	0.121	0.0439
BP test; SW test	0.963	0.000***	0.403	0.000***	0.991	0.000***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0182***	(0.00219)	0.00268***	(0.000489)	0.0176***	(0.00226)
abs(CPI.YoY)	0.0312***	(0.00301)	0.00877***	(0.000669)	0.0284***	(0.0031)
abs(Cur.Acc)	-0.00892*	(0.00431)	0.000214	(0.000939)	-0.00857*	(0.00435)
abs(Employ)	-0.00261	(0.00323)	-0.00027	(0.000684)	-0.00078	(0.00317)
abs(Ind.Pro)	0.00949*	(0.00372)	0.00304***	(0.00082)	0.0116**	(0.0038)
abs(M3.MoM)	-0.00429	(0.0031)	-4.8E-05	(0.000738)	-0.0038	(0.00342)
abs(PPI.YoY)	0.00703	(0.00363)	0.000776	(0.000782)	0.00565	(0.00362)
abs(Trd.Bal)	0.00836	(0.00436)	-0.00131	(0.000994)	0.0105*	(0.0046)
abs(Wages.YoY)	0.0146***	(0.00332)	0.00174*	(0.000743)	0.0112**	(0.00344)
F-test;sigma	0.000***	0.02542	0.000***	0.00428	0.000***	0.02391
BP test; SW test	0.963	0.000***	0.403	0.000***	0.991	0.000***
LAD	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.01***	(0.00301)	0.000833	(0.00065)	0.0107***	(0.00321)
abs(CPI.YoY)	0.0322***	(0.00723)	0.00974***	(0.00148)	0.0312***	(0.0058)
abs(Cur.Acc)	-0.00282	(0.00525)	-0.0001	(0.00139)	-0.00328	(0.00622)
abs(Employ)	-0.00126	(0.00397)	-8E-05	(0.000746)	-0.00072	(0.00379)
abs(Ind.Pro)	0.0162*	(0.00768)	0.00265	(0.00188)	0.012	(0.00788)
abs(M3.MoM)	-6.6E-05	(0.00333)	0.000521	(0.00107)	-0.00162	(0.00423)
abs(PPI.YoY)	0.00889	(0.00623)	0.00215	(0.00207)	0.0088	(0.00847)
abs(Trd.Bal)	0.00614	(0.00605)	-0.00043	(0.00137)	0.00838	(0.00708)
abs(Wages.YoY)	0.0159*	(0.00701)	0.00192	(0.000991)	0.0153*	(0.00598)

Notes: See Table 2. In this table, dependent variable is the average 5-minute absolute price change per 100 nominal over the window (-5 to 30).

Table 5 Response of Czech Bond Prices to 9:00 Surprises over [-15, +180] Window

Y= ∆P 8:45 to 12:00	CZ10Y		CZ2Y		Spread(10Y-2Y)	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0222	(0.0192)	-0.00732	(0.00874)	0.0283	(0.0191)
CPI.YoY_Rec_KFgap1	0.0252	(0.143)	-0.0199	(0.0651)	0.0448	(0.142)
CPI.YoY_Exp_KFgap1	-0.0496	(0.138)	-0.0135	(0.0629)	-0.0357	(0.137)
GDP.YoY_ Rec_KFgap1	0.264	(0.152)	-0.0228	(0.0695)	0.28	(0.152)
GDP.YoY_ Exp_KFgap1	-0.544**	(0.177)	-0.0227	(0.081)	-0.516**	(0.177)
Ind.Pro_ Rec_KFgap1	0.169	(0.12)	-0.0315	(0.0545)	0.209	(0.119)
Ind.Pro_ Exp_KFgap1	-0.333*	(0.14)	-0.0477	(0.0638)	-0.292*	(0.14)
Ret.Sales_ Rec_KFgap1	0.0386	(0.118)	0.034	(0.0541)	0.00279	(0.118)
Ret.Sales_ Exp_KFgap1	-0.184	(0.127)	-0.0757	(0.0578)	-0.107	(0.126)
PPI.YoY_ Rec_KFgap1	-0.174*	(0.0877)	0.0402	(0.0396)	-0.228**	(0.0876)
PPI.YoY_ Exp_KFgap1	0.00864	(0.104)	-0.105*	(0.0474)	0.105	(0.104)
Trd.Bal_Rec_KFgap1	0.213	(0.111)	0.0451	(0.0508)	0.168	(0.111)
Trd.Bal_Exp_KFgap1	-0.211	(0.125)	-0.0212	(0.0572)	-0.189	(0.125)
Unem_Rec_KFgap1	0.152	(0.164)	0.0366	(0.075)	0.116	(0.164)
Unem_Exp_KFgap1	-0.0813	(0.154)	-0.0319	(0.0703)	-0.0499	(0.154)
N; F-test	427	0.005**	428	0.442	427	0.022*
$AdjR^2$; sigma	0.04	0.383	0.00	0.175	0.03	0.383
BP test; SW test	0.946	0.000***	0.724	0.000***	0.853	0.000***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0154	(0.0148)	-0.00466	(0.00504)	0.0166	(0.0154)
CPI.YoY_Rec_KFgap1	0.046	(0.11)	-0.0333	(0.0376)	0.0761	(0.115)
CPI.YoY_Exp_KFgap1	-0.0842	(0.107)	-0.00699	(0.0363)	-0.0887	(0.111)
GDP.YoY_ Rec_KFgap1	0.127	(0.118)	0.00883	(0.0401)	0.205	(0.123)
GDP.YoY_ Exp_KFgap1	-0.359**	(0.137)	-0.0427	(0.0467)	-0.399**	(0.143)
Ind.Pro_ Rec_KFgap1	0.131	(0.0926)	-0.0367	(0.0314)	0.121	(0.0963)
Ind.Pro_ Exp_KFgap1	-0.232*	(0.108)	0.00563	(0.0368)	-0.178	(0.113)
Ret.Sales_ Rec_KFgap1	-0.0363	(0.0916)	0.018	(0.0312)	-0.0206	(0.0953)
Ret.Sales_ Exp_KFgap1	-0.0815	(0.098)	-0.034	(0.0333)	-0.0549	(0.102)
PPI.YoY_ Rec_KFgap1	-0.171*	(0.0679)	0.0229	(0.0228)	-0.248***	(0.0706)
PPI.YoY_ Exp_KFgap1	0.0584	(0.0805)	-0.0385	(0.0273)	0.129	(0.0837)
Trd.Bal_Rec_KFgap1	0.196*	(0.0861)	0.0347	(0.0293)	0.152	(0.0895)
Trd.Bal_Exp_KFgap1	-0.176	(0.0969)	-0.00893	(0.033)	-0.128	(0.101)
Unem_Rec_KFgap1	0.0941	(0.127)	-0.0156	(0.0432)	0.125	(0.132)
Unem_Exp_KFgap1	-0.0678	(0.119)	-0.00434	(0.0405)	-0.0517	(0.124)
F-test;sigma	0.012*	0.22328	0.525	0.07896	0.004**	0.24077
BP test; SW test	0.946	0.000***	0.724	0.000***	0.853	0.000***

Notes: See Table 2. The sample contains all announcement days of the macroeconomic variables in question between January 2007 – December 16, 2014. Rec_KFgap1 and Exp_KFgap1 are measurements of the business cycle based on output gap filtered by a local level model fitted by the Kalman Filter. Effect of a surprise is assumed to be a convex combination of two extremes.
LAD output omitted. For LAD the only significant variables were PPI.YoY and Trd.Bal for the Spread equation. Insignificance in LAD suggests that more often than not, there is no market reaction to these surprises during the specified interval -15, +180. For the Czech bonds, this finding held for all windows and all alternative business cycle interaction variables.

Table 6 Response of Czech Bond Prices to Current Account Surprises over [-15, +180] Window

Y= ∆P 9:45 to 13:00	CZ10Y		CZ2Y		Spread(10Y-2Y)	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0539	(0.0293)	0.00375	(0.0144)	0.0502	(0.0311)
Cur.Acc:Rec_ZEW_EcE	0.341**	(0.101)	0.1*	(0.0505)	0.241*	(0.109)
Cur.Acc:Exp_ZEW_EcE	-0.196*	(0.0757)	-0.0446	(0.0331)	-0.152*	(0.0718)
N; F-test	91	0.004**	91	0.143	91	0.075
AdjR^2; sigma	0.105	0.26613	0.021	0.13688	0.036	0.2968
BP test; SW test	0.0212	0.000***	0.863	0.000***	0.0836	0.000***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0538*	(0.0236)	0.000139	(0.00846)	0.0493	(0.0264)
Cur.Acc:Rec_ZEW_EcE	0.267**	(0.086)	0.0759*	(0.0298)	0.189*	(0.0927)
Cur.Acc:Exp_ZEW_EcE	-0.15***	(0.0391)	-0.0421*	(0.0195)	-0.0972	(0.0608)
F-test;sigma	0.005	0.19347	0.033	0.05722	0.121	0.20833
BP test; SW test	0.0212	0.000***	0.863	0.000***	0.0836	0.000***
LAD	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0539	(0.0391)	-0.00036	(0.0118)	0.0324	(0.0464)
Cur.Acc:Rec_ZEW_EcE	0.186	(0.143)	0.0237	(0.0406)	0.0927	(0.159)
Cur.Acc:Exp_ZEW_EcE	-0.106	(0.0807)	-0.0104	(0.0357)	-0.0582	(0.0966)

Notes: See Table 2. Rec_ZEW_EcE and Exp_ZEW_EcE are measurements of the business cycle based on ZEW Econ. Expectations. Effect of a surprise is assumed a convex combination of two extremes, see 4.1.

Table 7 Response of Czech Bond Volatilities to Current Account Surprises over [-5,+60] Window

Y = Average (5-minute) |∆P| between 9:55 and 11:00	CZ10Y		CZ2Y		Spread(10Y-2Y)	
OLS	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0255***	(0.00739)	0.00833**	(0.0031)	0.0288***	(0.00696)
abs(Cur.Acc)_Rec_ZEW_EcE	0.039*	(0.0189)	0.00221	(0.00794)	0.0398*	(0.0178)
abs(Cur.Acc)_Exp_ZEW_EcE	-0.011	(0.0113)	0.00548	(0.00473)	-0.0121	(0.0106)
N; F-test	91	0.126	91	0.324	91	0.089
AdjR^2; sigma	0.024	0.04472	0.003	0.01876	0.032	0.04214
BP test; SW test	0.977	0.000***	0.0756	0.000***	0.881	0.000***
Huber's M	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.0166***	(0.00475)	0.00589***	(0.00168)	0.022***	(0.00527)
abs(Cur.Acc)_Rec_ZEW_EcE	0.0367**	(0.0122)	0.00458	(0.00432)	0.0396**	(0.0135)
abs(Cur.Acc)_Exp_ZEW_EcE	-0.012'	(0.00724)	-0.00043	(0.00257)	-0.0102	(0.00803)
F-test;sigma	0.02	0.0246	0.508	0.00984	0.021	0.03219
BP test; SW test	0.977	0.000***	0.0756	0.000***	0.881	0.000***
LAD	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**	**Coef.**	**(S.e.)**
(Intercept)	0.00944	(0.00849)	0.00253	(0.00295)	0.013	(0.0107)
abs(Cur.Acc)_Rec_ZEW_EcE	0.04	(0.0286)	0.00436	(0.00805)	0.0357	(0.0327)
abs(Cur.Acc)_Exp_ZEW_EcE	-0.0137	(0.0121)	3.64E-05	(0.00446)	-0.0105	(0.0152)

Notes: See Table 2. Here, response variable is the average absolute price change per 100 nominal over a specified window (-5 to 60). Current account surprises appear to increase volatility of 10Y Treasuries during recessions, but again the median reaction (LAD) is not significant from zero. Rec_ZEW_EcE and Exp_ZEW_EcE are measurements of the business cycle based on ZEW Econ. Expectations. Effect of a surprise is assumed a convex combination of two extremes, see 4.1.

Table 8 GARCH Modeling – Polish government bonds

	PL10Y		PL2Y		Spread(10Y-2Y)	
	Coef.	(S.e.)	Coef.	(S.e.)	Coef.	(S.e.)
Mean equation *Surprises*						
CPI.YoY	1.767***	(0.342)	2.958***	(0.368)	-1.645***	(0.200)
CPI.YoY *Lag*			0.860*	(0.382)		
Ret.Sales	0.707*	(0.304)				
Ind.Pro	0.619*	(0.276)				
GDP.YoY					-2.099***	(0.548)
Mean equation *Controls*						
Constant	0.035	(0.071)	-0.040	(0.067)	0.060	(0.051)
EMBI	-305.924***	(24.74)	-173.715***	(22.53)	-73.768***	(15.48)
PLNEUR	-114.280***	(13.92)	-64.634***	(13.7)		
Wibor12M			10.706**	(4.036)		
SP500			13.161*	(6.693)		
VDAX			0.174**	(0.053)		
AR terms					AR(1,2,4,5,10.17)	
Variance equation *Surprises*						
Abs(DE_Cons.Conf)	-4.017***	(0.695)	-4.175**	(1.298)		
Abs(Wages.YoY)	-4.280***	(0.836)				
Abs(M3.MoM)	-1.476	(0.820)				
Abs(CPI.YoY)			11.954**	(4.269)		
Abs(Trd.Bal)			-10.468***	(2.000)		
Variance equation *GARCH terms*						
ω	1.001***	(0.221)	2.567***	(0.583)	0.516*	(0.207)
α_1	0.102		0.163		0.250**	(0.072)
α_2					-0.145*	(0.068)
β_1	0.898***	(0.014)	0.837***	(0.021)	0.734***	(0.198)
β_2					0.161	(0.173)
Student-t degrees of freedom	2.928***	(0.122)	2.511***	(0.067)	2.639***	(0.197)
No. of obs.; mean(Cond.Var)	2010	34.126	2009	40.824	1993	30.694
Test: Q(20); ARCH 1-5	0.288	0.768	0.925	0.836	0.022*	0.801

Notes: *, **, *** indicate significance at 5, 1 and 0.1% levels, respectively. The dependent variables are daily **yield changes** (as opposed to price changes) of 10-year, 2-year benchmark bond indices from Reuters and of the difference between them. Surprises are deviations from median expected value by Bloomberg expressed in standard deviations. *Lag* denotes a variable lagged *once*. The last row reports the p-values of Box Pierce Q-test testing the null of no autocorrelation of standardized residuals using twenty lags and Engle's LM ARCH test for 5 lags. Effects on conditional variance were assumed to stem only from absolute value of respective surprises. Time series for these regressions are Polish business days between January 2nd, 2007 and December 12th, 2014. See section 4.3 for a description of the modeling procedure.

Table 9 GARCH Modeling – Czech government bonds

	CZ10Y		CZ2Y		Spread(10Y-2Y)	
	Coef.	S.e.	Coef.	S.e.	Coef.	S.e.
Mean equation *Surprises*						
Ret.Sales	0.634*	(0.302)				
CPI.YoY			0.542*	(0.256)		
PPI.YoY			0.630*	(0.289)		
DE_Ind.Pro_Rec_OECD	1.375**	(0.512)				
DE_CPI.YoY_Exp_OECD	1.156***	(0.284)				
DE_CPI.YoY_Exp_ZEW					1.410**	(0.413)
DE_CPI.YoY_Exp_ZEW *Lag*					1.127*	(0.451)
DE_GDP.YoY_Rec_OECD *Lag*			-4.651***	(1.215)		
DE_Import.PI_Exp_OECD			1.180**	(0.401)		
DE_Ind.Pro			0.975**	(0.313)		
DE_PPI.YoY *Lag*					-0.624*	(0.263)
Mean equation *Controls*						
Constant	-0.114	(0.061)	-0.169**	(0.061)	0.062	(0.058)
EMBI	-122.305***	(18.93)	-69.747**	(20.15)	-51.527***	(13.17)
Pribor3M			17.064**	(6.516)		
Pribor12M	9.871*	(4.22)	21.953***	(6.275)	-17.274***	(4.159)
Euribor3M	-63.244***	(7.149)				
Euribor12M	70.041***	(5.478)				
PX	15.683**	(5.461)				
VDAX	-0.209***	(0.048)	-0.313***	(0.045)		
AR terms	AR(1,2,3,5)		AR(3), coef 0.049		AR(1), coef -0.174	
Variance equation *Surprises*						
Abs(PPI.YoY)	-2.902***	(0.77)				
Abs(DE_Cons.Conf)	-1.580	(0.88)				
Abs(DE_CPI.YoY)			5.227**	(1.929)		
Variance equation *GARCH terms*						
ω	1.187***	(0.337)	0.263*	(0.13)	4.237***	(0.816)
α_1	0.165***	(0.041)	0.092***	(0.021)	0.517***	(0.1)
β_1	0.834***	(0.026)	0.906***	(0.016)	0.427***	(0.054)
Student-t degrees of freedom	2.839***	(0.246)	3.004***	(0.256)	3.010***	(0.237)
No. of obs.; mean(Cond.Var)	2004	22.257	2006	22.746	1923	22.895
Test: Q(20); ARCH 1-5	0.118	0.533	0.301	0.297	0.935	0.311

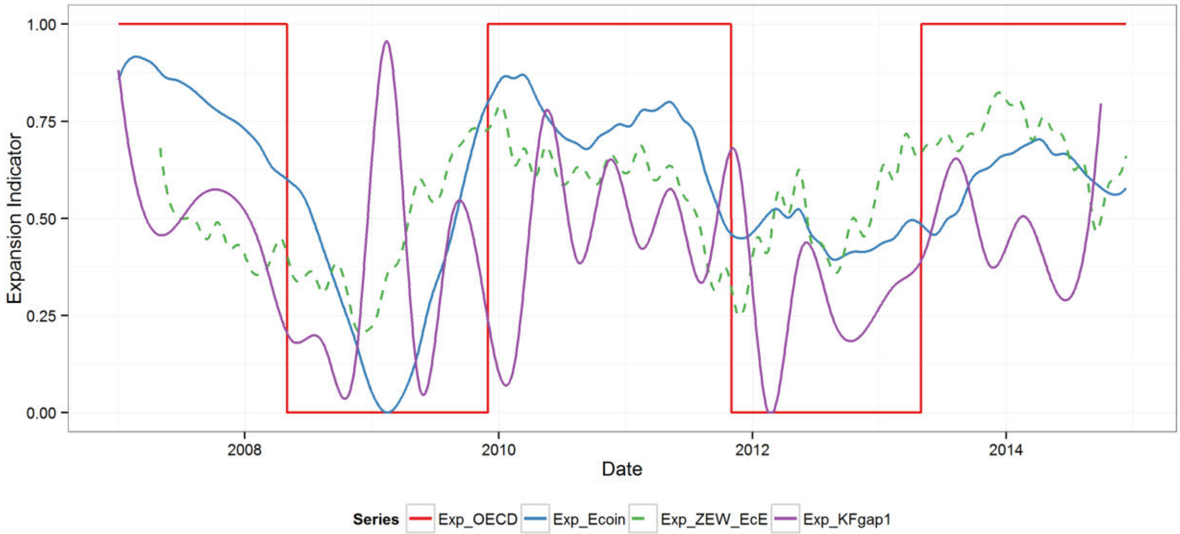
Notes: See Table 8. Time series for these regressions are Czech business days between January 2nd, 2007 and December 16th, 2014. See section 4.3 for a description of the modeling procedure.

Table 10 Data overview – Dependent variables and macroeconomic indicators

Code	Description	Freq.	Src.	Ticker
Data sources for the dependent variables				
PL10Y	Polish BM 10y Treasuries, BID&ASK prices, 2007 – mid Dec 2014	5m	RTH	PL10YT=RR
PL2Y	Polish BM 2y Treasuries, BID&ASK prices, 2008 – mid Dec 2014	5m	RTH	PL2YT=RR
CZ10Y	Czech BM 10y Treasuries, BID&ASK prices, 2007 – mid Dec 2014	5m	RTH	CZ10YT=RR
CZ2Y	Czech BM 2y Treasuries, BID&ASK prices, 2007 – mid Dec 2014	5m	RTH	CZ2YT=RR
PL10Y	Polish BM 10y Treasuries, Daily YTM, 2007 – mid Dec 2014	D	RD	BMPO10Y(RY)
PL2Y	Polish BM 2y Treasuries, Daily YTM, 2007 – mid Dec 2014	D	RD	BMPO02Y(RY)
CZ10Y	Czech BM 10y Treasuries, Daily YTM, 2007 – mid Dec 2014	D	RD	BMCZ10Y(RY)
CZ2Y	Czech BM 2y Treasuries, Daily YTM, 2007 – mid Dec 2014	D	RD	BMCZ02Y(RY)
Czech Macroeconomic Indicators				
CPI.YoY	Consumer Price Index, YoY	M	B	CZCPYOY
Cur.Acc	BoP Current Account Monthly; in CZK billions	M	B	CZCMCZK
GDP.YoY	GDP Constant Prices SA, YoY, Preliminary releases only	M	B	CZGDPSAY
Ind.Pro	Industrial Output, YoY	M	B	CZIPITYY
PPI.YoY	Producer Price Index Industrial, YoY	M	B	CZPPYOY
Ret.Sales	Retail Sales Constant Prices, YoY	M	B	CZRSYOY
Trd.Bal	Foreign Trade Balance, in CZK billions	M	B	CZTBAL
Unem	Unemployment Rate, Sep 2013 to Share of Unemployed 15-65	M	B	CZJLR, CZJLUNR
Polish Macroeconomic Indicators				
CPI.YoY	Consumer Price Index, YoY	M	B	POCPIYOY
Cur.Acc	BoP Current Account Transaction Basis Monthly, in Zloty billions	M	B	POMECBCA
GDP.YoY	GDP Constant Prices, YoY, Advance, Preliminary only	Q	B	POGDYOY
Employ	Poland Average Paid Employment Yearly	M	B	POEYYOY
Ind.Pro	Sold Industrial Output of Goods & Services, YoY	M	B	POISCYOY
M3.MoM	Money Supply M3, MoM	M	B	POM3LMOM
PPI.YoY	Producer Price Index, YoY	M	B	POPPIYOY
Ret.Sales	Retail Sales, YoY	M	B	PORSYOY
Trd.Bal	BoP CA Transaction Basis Goods Balance Monthly	M	B	POMECBGB
Unem	Unemployment Rate, share of labor force	M	B	POUER
Wages.YoY	Average Gross Wages, YoY	M	B	POWGYOY
German Macroeconomic Indicators				
Cons.Conf	GfK Consumer Confidence Survey, SA X-12-Arima	M	B	ECO1GFKC
CPI.YoY	Consumer Price Index, YoY	M	B	GRCP20YY
Cur.Acc	Current Account Balance NSA, in EURO billions	M	B	GRCAEU
Export.MoM	Exports SA, MoM	M	B	GRBTEXMM
Fct.Ord	"Factory Orders" Manufacturing Orders SA, MoM	M	B	GRIORTMM
GDP.YoY	GDP Chain Linked Pan Germany NSA, YoY, Preliminary only	Q	B	GDPB95YY
IFO.CAs	IFO Current Assessment (rescaled)	M	B	GRIFPCA
IFO.Exp	IFO Expectations (rescaled)	M	B	GRIFPEX
Import.PI	Germany Import Price Index YoY	M	B	GRIMP95Y
Ind.Pro	Industrial Production SA MoM	M	B	GRIPIMOM
PMI.Ind	Manufacturing Purchasing Managerss Index (rescaled)	M	B	PMITMGE
PPI.YoY	Producer Price Index, YoY	M	B	GRPFIYOY
Ret.Sales	Retail Sales Constant Prices NSA, YoY	M	B	GRFRINYY
Trd.Bal	Trade Balance NSA, in EUR billions	M	B	GRTBALE
Unem	Unemployment change, in hundred thousand persons	M	B	GRUECHNG
ZEW.Cur	ZEW Survey Current Situation (rescaled)	M	B	GRZECURR
ZEW.Exp	ZEW Survey Expectations (rescaled)	M	B	GRZEWI

Notes: Data sources of our control variables used in GARCH regressions are available on request. B=Bloomberg. R=Reuters, RTH=Reuters Tick History. Frequencies are 5-minute, daily, monthly and quarterly.

Figure 1 Business Cycle Indicators for Poland



Notes: The graph shows four different expansion indicators (1 = maximum expansion or the most favorable expectations, 0 = maximum recession or the most pessimistic expectations). The indicators were conducted on monthly or quarterly data and then interpolated through cubic splines (see Section 4.1). Values of the expansion and recession indicator on a particular day are used for interaction with the effects of macroeconomic announcements.

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