Report on Credit Spreads and Business Cycle Fluctuations

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Abstract

The present report studies the GZ credit spread, a credit spread index developed by Gilchrist et al. (2009) and Gilchrist and Zakrajšek (2012). Empirical evidence suggests that this variable is highly informative about economic activity. In particular, the excess bond premium, derived from the GZ credit spread, provides a better measure of financial conditions than traditional indicators such as the Baa–Aaa corporate bond spread or the paper–bill spread. Using classical and Bayesian VARs with zero and sign restrictions for the euro area, our results confirm that a positive exogenous shock to the excess bond premium exerts contractionary effects on economic activity. **Note: Incomplete draft, work in progress.**

1 Introduction

2 Credit spread: a new high-information index

Credit spreads are defined as the difference between the yield on risky and risk-free bonds of comparable maturities. They serve as indicators of the state of the financial sector. However, their computation, especially the components used, are not standardised, resulting in diverse measures, predictive outcomes, and interpretations. Gilchrist et al. (2009) and Gilchrist and Zakrajšek (2012) introduce a new credit spread index, the GZ credit spread, whose relevance lies in the excess bond premium, a residual component that has strong predictive power for economic activity. The current section will present the construction of the GZ credit spread (section 2.1), the excess bond premium (section 2.2) and how the GZ credit spreads is applied to the European economic context (section 2.3).

2.1 GZ credit spread

Gilchrist et al. (2009) developed a highly informative credit spread risk index. Due to the duration mismatch usually found in many credit spread indexes, that is, the comparison of corporate bonds with risk-free instruments of different maturities, a synthetic risk-free security was constructed. The purpose was to reflect the cash-flows of its principal, in our case, the corporate debt instrument. This security is defined for a corporate bond k issued by firm i that at time t yields a sequence of coupon cash flows $\{C(s) : s = 1, 2, \dots, S\}$ until maturity S. The price of the corresponding bond is

$$P_{it}[k] = \sum_{s=1}^{S} C(s) D(t_s),$$

where $D(t) = e^{-r_t t}$ is the discount function in period t. The price of the corresponding risk-free security, $P_t^f[k]$, is calculated by discounting the same cash flow sequence $\{C(s) : s = 1, 2, \dots, S\}$ using the zero-coupon Treasury yield in period t. Gürkaynak et al. (2007) provide an estimation of the US Treasury yield curve, used here. With $P_t^f\,[k]$ we can compute the yield $y_t^f\,[k]$ of an hypothetical Treasury security characterised by the same cash-flows of the same underlying corporate bond. We thus obtain the credit spread

$$S_{it}\,[k] = y_{it}\,[k] - y_t^f\,[f]$$

with $y_{it}\,[k]$ being the yield of the corporate bond k. With this method, we are able to avoid just pegging our corporate yield with the yield of a Treasury security having the same maturity. In order to generalise the credit spread, we need to aggregate it. We will then obtain a simple credit spread index, the GZ credit spread, that will represent the entire maturity spectrum along with the range of credit quality of the corporate cash market:

$$S_t^{GZ} = \frac{1}{N_t} \sum_i \sum_k S_{it}[k].$$

The GZ credit spread represents the average of the credit spreads on outstanding bonds for any given period, in our case, for any month. There are other default-risk indicators that could have been used for our present analysis. The spread between the yield of one-month A1/P1-rated non-financial commercial paper and the one-month Treasury yield, referred as the paper-bill spread, and the spread between yield on indexes of Baa- and Aaa-rated seasoned industrial corporate bond (Baa-Aaa spread) can be considered as examples. However, the GZ credit spread seems to outperform these two mentioned and widely used credit spread. Although these variables seem to be characterised by the same dynamics, such as their counter-cyclicality with respect to economic swings, they do not exhibit the same statistical features. Amongst themselves, they do not have any significant correlations Gilchrist and Zakrajšek (2012, p. 1697) and, in terms of variance, they display different levels of volatility. Figure 1 in the Appendix illustrates these differences in a clearer manner.

The reason why GZ credit spread is introduced lies in that it goes along the line of other extensively used credit spreads but surpasses their predictive power in terms of various measures of economic activity. In contrast to the paper-bill spread and Baa-Aaa spread, we observe from the data collected by Gilchrist and Zakrajšek (2012) that the GZ credit spread is highly significant predictor of the growth of private (non-farm) payroll employment, the change in the civilian unemployment rate, the growth of manufacturing industrial production and the growth of real GDP. This result is relevant for the short as well as the long run. Overall, an increase in the GZ credit spread represents a negative response to the labour market as well as output in general. In order to offer more context, we may mention that an increase of 100 basis points in the GZ credit spread results in a subsequent reduction in the real GDP growth of about 1.25 percentage points within a year whereas the effect of the two other spreads evanesce gradually from the first quarter onwards.

In ideal terms, the GZ credit spread should be able to reflect the dynamics of economic fundamentals with respect to a looming economic downturn (Philippon (2009)). There are, however, a series of frictions that produce noise over the relationship between what the bond market is signalling about its current state, and, by extension, the financial shape of the agents within, and economic fundamentals. As shown by Elton et al. (2001), the financial health of the agent explain no more than half of variations in corporate bond credit spreads. The rest of the variation reflects other factors such as time-varying liquidity premium, tax treatment of corporate bonds and a premium to the exposure to default risks demanded by investors. It is for this very reason that the GZ credit spread needs to be decomposed so that one can separate the countercyclical dynamics of expected defaults, drawn from the unexplained variations in the credit spread, and the excess bond premium. The latter factor extracts the cyclical changes between the default risk which amounts to the financial health of agents and the credit spread.

In short, the GZ credit spread has a high predictive content in terms of economic fundamentals. The reason why it is so linked to economic fundaments dwells in its capacity to reflect the financial health of agents. As soon as the financial position of agents deteriorate, there is a repercussion to the capital position of financial intermediaries that, in turn, will reduce the supply of credit. It goes without saying that such reductions affect spending and production. However, the GZ credit spread is noisy in the sense that it also contains other factors unrelated to real economic activity and should be corrected accordingly by decomposing it and extracting the excess bond premium. The following section will introduce this component and provide a few remarks about its properties.

2.2 Excess Bond Premium

As pointed out by Philippon (2009) amongst others, there is a 'credit spread puzzle' that motivates for a decomposition of the GZ credit spread in order to obtain what we call the excess bond premium. The aim would be to break down the GZ credit spread so that we may determine the part of the credit spread that is separated from the systematic movements in default risk which encompass various types of compensations for expected defaults. In other words, we are aiming at determining a representation in price of the variations to the exposure of the US corporate credit risk.

In order to accomplish this objective, we use the idea that, for a given bond k for a firm i at time t, the growth rate of its the credit spread, that is, its log, is linearly related to firm-specific measure of expected default and a vector of bond specific characteristics. We then have:

$$\ln S_{it}[k] = \beta DFT_{it} + \gamma' \mathbf{Z}_{it}[k] + \epsilon_{it}[k]$$

where DFT_{it} represents the firm-specific default measurement, $\mathbf{Z}_{it}[k]$ is a vector of bond characteristics and the the disturbance $\epsilon_{it}[k] \sim \mathcal{N}(0, \sigma^2)$ is referred to as the 'pricing error'. This regression is estimated via OLS and can be reformulated in order to obtain the predictive level of the spread for bond k for a firm i at time t

$$\hat{S}_{it}[k] = \exp\left[\hat{\beta} DFT_{it} + \hat{\gamma}' Z_{it}[k] + \frac{\hat{\sigma}^2}{2}\right]$$

where the parameters $(\hat{\beta}, \hat{\gamma})$ are the OLS estimates of the regression and $\hat{\sigma}^2$ is the estimated variance of $\epsilon_{it}[k]$. In terms of aggregation, we follow a similar route as with the GZ credit spread (SHOW NUMBER) and we average across bonds and firms. We thus obtain the predicted component of the GZ credit spread

$$\hat{S}_t^{GZ} = \frac{1}{N_t} \sum \sum \hat{S}_{it}[k].$$

Immediately, we can derivate the excess bond premium which will be the difference between the GZ credit spread and the estimated credit spread drawn from the estimation of $\hat{S}_t^{GZ}$. We thus obtain

$$EBP_t = S_t^{GZ} - \hat{S}_t^{GZ}.$$

The excess bond premium encapsulates the residual of the bond spread that reflects the financial state of agents in the bond market without the cyclical component of that is driven in part by the expectations of agents with respect to defaults.

Our question now is to determine the firm-specific default measurement DFT_{it}. For that purpose, Gilchrist and Zakrajšek (2012) use the 'distance to default' (DD) framework developed by Merton (1974). This framework has the advantage that volatility and the underlying value of the firm can be inferred from the capital structure of the firm, its equity and the volatility of the equity. The estimation of these two elements enables you to compute, under various assumptions, the default risk of a firm. We are going to abstract ourselves from the details leading to the formulation of our default measurement and directly present the following firm-specific DD over a one-year horizon, previously derived from the resulting solutions of the Merton DD model:

$$DD = \frac{\ln(V/D) + \left(\mu_V - 0.5\sigma_V^2\right)}{\sigma_V}$$

where V is the total value of the firm, D is the face value of the firm's debt, μ_V denotes the expected continuously compounded return on V and σ_V is the volatility of firm value. This equation defines the default DD with respect to the ratio between the value of assets to debt. The changes in that very ratio will determine the default probability of the entity by computing the cumulative distribution function $\Phi(-DD)$. In terms of economic intuition, note that DD is pro-cyclical which would mean that it is expected by equity investors that defaults increase during economic downturn. Empirically, Gilchrist and Zakrajšek (2012, p. 1704) report that it is indeed the case, specifically during the 2008 crisis where economic activity and DD fell substantially.

With regards to the bond vector $\mathbf{Z}_{it}[k]$, the objective is to control for specific bond characteristics which would bias the bond yield via terms or liquidity premiums. The bond's duration, the amount outstanding and the age of the issue are just a few examples of the types of controls imposed to the regression. The results for the estimation of the parameter $\hat{\beta}$ with regards to the variable DD are highly significant, that is to say that $\hat{\beta}$ is a statistically adequate predictor for the log credit spread. To be more precise, a decrease in one standard deviation of the measure of default DD results in an increase of 15 basis points of the credit spread. We may now compute the excess bond premium which is the difference between the GZ credit spread and the fitted value for $\hat{S}_t^{GZ}$. The results can be seen in the following figure:

We observe that the figure has powerful predictive properties. The shaded blue zones represent economic downturns, or formally recessions dated by the NBER, such as the 2008 crisis. The excess bond premium follows a counter-cyclical trajectory, in that, it increases ex-ante and/or during those economic downturns. There are two further elements two notice. First, it does not well capture the crisis of the 1990 and, secondly, after the dot-com bubble, it plunges to historic lows. Let us remind ourselves that the period between 2001 and 2007 saw a rapid increase in the volume of credit and a surge

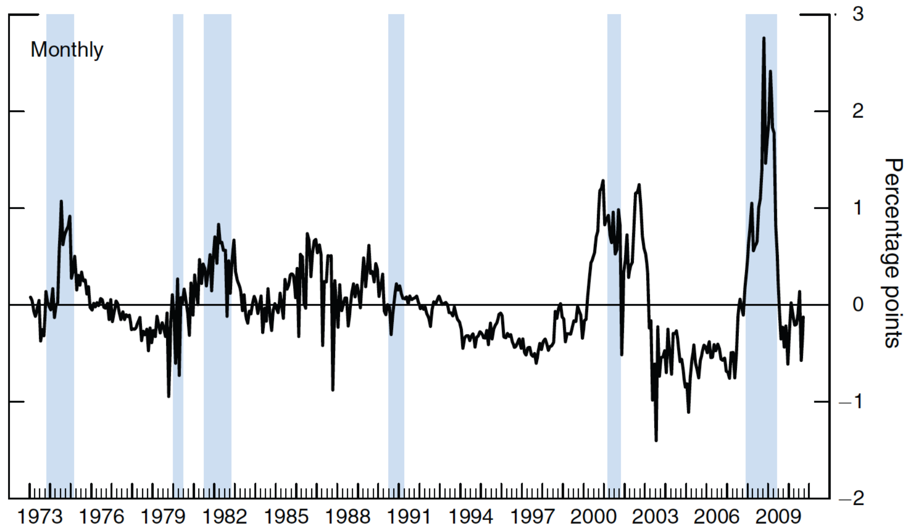

Figure 1: Excess bond premium
Note: Use updated data!

in financial prices, two important factors that contributed to the sub-prime mortgage crisis. The link between the excess bond premium and economic fundamentals is therefore palpable because it reflects the financial health of agents. The most telling example is, as expected, the 2008 crisis where debt increased substantially. By extension, agents struggled to repay the outstanding debt and the excess bond premium shot itself, further aggravated, in a second period, by concerns over the financial health of important European financial institutions.

We may further add that there is also empirical arguments that corroborate the reliability of the excess bond premium with respect to its counterpart: the GZ credit spread. In the appendix, figure , it can be found a regression that compares the predictive power of the GZ credit spread and the excess bond premium. In terms of regressors, we can find real GDP and its components, that is, nondurable goods personal expenditure (C-NDS), durable goods personal expenditure (C-D), residential investment (I-RES), business fixed investment in equipment and software (I-ES), business fixed investment in high-tech equipment (I-HT), business fixed investment in structures (I-NRS) and business inventories (INV). It is divided in two panels containing two different time frames. To be more precise, an increase in 100 basis points of the excess bond premium results in a reduction of real GDP of more than 1.5 percentage points whereas the same drop for the GZ credit spread results in only 0.5 percentage points in GDP over the year. For the rest of the variables, the excess bond premium surpasses its counterpart as well. Let us now turn to the case of the Euro area. The same methodology is used but it is cut short from the corresponding computation of the excess bond premium. In the present paper, let us recall, we are going to use the credit spread calculated by Gilchrist and Mojon (2014).

2.3 Credit risk for the Euro Area

Up to this point, we looked at the GZ credit spread and the excess bond premium. We demonstrated that they are variables that ought to be taken into account when observing economic activity due to their high predictive power. In our paper, we are going to focus on the GZ credit spread for the Euro area leaving aside the excess bond premium as in Gilchrist and Mojon (2014). We introduced the excess bond premium to highlight the driving factors of the credit spread. Without its introduction, we would have missed how the probability of defaults, an element grounded in the real economy because it directly affects output, is encapsulated in the credit spread. It also allowed us to see the composition of the credit spread and that it is somehow biased by its cyclical component which does not merely contain the true measurement of defaults but also expectations of investors, taxes and liquidity premiums, amongst others.

Gilchrist and Mojon (2014) follow the same methodology as in Gilchrist and Zakrajšek (2012) but do not go further in computing the excess bond premium for the Euro area. For further information about the excess bond premium in the Euro area, look at Boneva et al. (2019) where they decompose the non-financial corporate bonds into credit risk fundamentals and excess bond premium for the Euro area. It needs to be said that the Euro area has certain peculiarities when compared to the United States. We may mention that banking institutions dominate the European financial system and that the respective weight of countries within reflect a fragmentation of the Euro area financial market. This fragmentation of the financial system exacerbate spill-over effects between countries, thereby highlighting the relationship between sovereign debt conditions and country-specific financial markets. Instead of introducing a hypothetical risk free bond as in the US case, we use the German Bund as the risk free bond. We have a spread S_{it} of a corporate bond i at time t defined as the substation of the yield of the corporate bond R_{it} and the German Bund zero coupon interest of the similar duration $ZCR_t^{DE}\left(Dur\left(i,t\right)\right)$:

$$S_{it} = R_{it} - ZCR_t^{DE}\left(Dur\left(i,t\right)\right).$$

From there we can also compute country-specific credit risk indicators S_t^k:

$$S_t^k = \sum_i w_{it} S_{it}$$

where the weight is

$$w_{i,t} = \frac{MVAL_{it}}{\sum_i MVAL_{i,t}}.$$

We define the weight has the ratio between the market value at issue of the security and the total market value at issue of all bonds in the sample during a point in time. Figure 3 and 4 provide a glimpse at how the credit spreads for the Euro area resembles that of the United States in figure 1. We may therefore infer that, although the Euro area credit spreads are not as good as if we had extracted their own excess bond premium, they is still a relatively adequate indicator for economic activity. Gilchrist and Mojon (2014) corroborate this assertion by carrying out a series of empirical analysis that examine how the credit spreads perform in terms of prediction of various measures of real economic activity and inflation.

Gilchrist and Mojon (2014) do not have the ambition of determining only one credit spread as in Gilchrist and Zakrajšek (2012). They provide a few credit spreads that aim at extracting the characteristics of the Euro area such as the previously mentioned fragmentation of the financial market and the role of banks. That is why, they produce a credit spread for banks and, another one, for non-financial institutions, as well as country-specific credit spreads into which we are not going to precisely dive in the current paper. Their empirical research focuses, as with Gilchrist and Zakrajšek (2012), on the ability of these credit spreads to predict Euro area economic activity in a quarterly basis. Indicators for economic activity are, for example, industrial production, unemployment, consumption, etc. including inflation. Gilchrist and Mojon (2014) specify a forecasting regression equation from where we may capture the predictive power of a specific credit spread, say non-financial credit spreads.

The results of the regression maintain that bank credit spread and the non-financial credit spread are highly statistically significant predictors of the four-quarter ahead change in future economic activity, industrial production and the unemployment rate. To be more specific, an increase of one percent point in non-financial credit spread predicts a 0.81 percent rise in the unemployment rate and a decline of 1.64 in real GPD. There is, however, one disparity with the findings of Gilchrist and Zakrajšek (2012). For the analysis on Europe, credit spreads also have significant explanatory power for consumption growth. In terms of the period during which the credit spread is able to predict the variable in question, we can no longer assert that they entirely predict economic activity. In particular, the banking credit spread cannot properly forecast GDP growth before the 2008 crisis, whereas the non-financial credit spread is still able to predict in a statistically significant way GDP growth during the quarters prior to the crisis. This could be due to the lack of data. During the period preceding the 2008 crisis, the banking credit spread remained stable and its non-financial counterpart widened. All in all, the credit spreads have a negative impact on economic activity. The impact is translated into a decline in output growth, consumption and investment and a rise in unemployment.

There are two variables that should not be forgotten: inflation and bank lending. For the former, the regression indicates that the non-financial credit spread is a statistically significant predictor. To be more precise, an increase in a one percentage point of the non-financial credit spread predicts a 0.45 percent drop on inflation. Note that, for the bank credit spread, the result is similar but not statistically significant. Overall, credit spreads reduce inflation. For the latter, that is, bank lending, we need to point out that credit was divided into consumer loans, housing loans and loans to non-financial corporations. The performance of the two credit spreads differ. In the Appendix, we present the results of Gilchrist and Mojon (2014) in figure 5. We observe that an increase in the credit spread of one percentage point results in a statistically significant prediction for the bank credit spread in the three loan categories with a decline of 2.89 percent for consumer loans, 1.29 percent for housing loans and 4.55 percent for loans to non-financial corporations. For non-financial credit spreads, the statistical significance is mixed because an increase in the credit spread also reduces the type of loan growth but it is not statistically significant for housing loans.

The reason why we provide somewhat more details for this variable, bank lending, is because theoretically it is linked with the credit spread in its core. The message that Gilchrist and Mojon (2014) as well as Gilchrist and Zakrajšek (2012) want to highlight is that signals from underlying fundamentals of the real economy can be captured by credit spreads. The reason dwells in the fact that credit spreads are meant to measure credit supply conditions and, in turn, the supply of credit plays a considerable role in the economy in the present as well as in the future. This is the reason why it should provide information for future economic activity. Credit influences the spending behaviour of households and firms' decisions about inputs and investments. This is the origin, at least theoretically, of the importance of credit spreads. What now needs to be studied is the macroeconomic implications of the credit spread on various macroeconomic variables. This task will be presented in the next section.

3 Macroeconomic implications

We looked at different measures of credit spreads. From them we obtain valuable information about economic activity. By looking at the GZ credit spread and the excess bond premium, we were able to understand that credit spreads contain a mix of signals derived not only from the default risk of the agent but from expectations, taxes and premiums. The excess bond premium better captures the risk that directly affects economic activity, excluding the previously mentioned noisy factors. In the present paper, we are not going to use the excess bond premium. Its use was for conceptual matters. Instead, we will stay in the first stage of the analysis and focus on the macroeconomic implications of the credit spread, leaving aside, as a reminder, the excess bond premium. In particular, we are going to analyse the macroeconomic consequences of shocks to the credit spread non-financial institutions in the Euro area. The data is provided by Gilchrist and Mojon (2014)[1]. In total, eight variables will be used, including our credit spread. The data spans from the second month of 1990 to the ninth month of 2014. More information about the sources of the data can be found in the Appendix. In a first stage, we are going to see the effects of a shock on the credit spread according to a classical structural VAR. Impulse response functions of the endogenous variables to an orthogonalised shock to the the credit spread is going to be presented as well as their corresponding forecast error variance decompositions. Then, in a second stage, we are going to perform some modifications to the structural VAR and introduce sign and zero restrictions. As in the first case, impulse response functions and forecast error variance decompositions will be presented.

3.1 Classical VAR approach

In this section, we will examine the macroeconomic consequences of shocks to the credit spread for non-financial corporations in the Euro area during a period ranging from 1990 to 2014. We do so by adding the credit spread to a standard structural VAR. Structural VAR operate under two assumptions. The first assumption is that the relationship between the structural shocks and the forecast errors is linear, and it given by

$$u_t = A_0 \epsilon_t$$

where ϵ_t is the vector of structural shocks, and A_0 is the so-called 'structural impact matrix', i.e. the matrix mapping the structural shocks into the forecast errors (Benati [2021], from lecture). The second assumption is that the structural shocks are unit-variance, i.e.

$$\mathbb{E}\left[\epsilon_t \epsilon_t'\right] = I_N$$

$$\mathbb{E}[\epsilon_t \epsilon_t'] = I_N$$

where I_N is the $N \times N$ identity matrix. These two assumptions allow us to obtain the key equation of our structural VAR, that is,

$$A_0 A_0' = \Sigma.$$

[1]https://publications.banque-france.fr/en/economic-and-financial-publications-working-papers/credit-risk-euro-area

Keeping in mind that Σ^{OLS} is a consistent estimator of Σ , and, consequently, the factorisation Σ allows you to estimate A_0, we are going to identify the structural VAR based on the Cholesky factor of Σ^{OLS}. Hence, our variables will be classified according to two sets: variables that will be affected by our specific shock on the credit spread on impact and the variables that are not affected by the shock on impact.

At our disposal, we have the following endogenous variables: (i) unemployment rate; (ii) log Euro credit; (iii) log industrial production; (iv) log consumer price index [2]; (v) the credit spread for non-financial corporations; (vi) log economic uncertainty; (vii) log stock price; and (viii) the ECB policy rate. Note the order of the variables as they are separated by the credit spread in the position (v). The variables between (i) and (v) are characterised by being inertial variables, that is, variables that are expected stay put within the month. The rest of the variables can be considered to be variables that incorporate new information near-instantaneously, and therefore are 'jumping'. We note that the present paper tried to follow as closely as possible the ordering of Gilchrist and Zakrajšek (2012). We assumed, for example, by analogy that real business fixed investment is related the our variable of Euro credit, and real GDP is related to industrial production. We are not going to mention all the the analogies done but the presented order is meant to reproduce the macroeconomic analysis of Gilchrist and Zakrajšek (2012). All in all, the identifying assumption implied by this recursive ordering is that shocks to the credit spread affect economic activity and the consumer price index with a lag, whereas financial asset prices, economic uncertainty and the monetary policy rate of the ECB can react contemporaneously to such shock. We are going to use a VAR of order 6 and a horizon of 3 years.

$$
Y_0 = A_0 \varepsilon_0 = \underbrace{\begin{array}{cccccccc} \varepsilon_{1,0} & \varepsilon_{2,0} & \varepsilon_{3,0} & \varepsilon_{4,0} & \varepsilon_{5,0} & \varepsilon_{6,0} & \varepsilon_{7,0} & \varepsilon_{8,0} \\ \left[\begin{matrix} x & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ x & x & 0 & 0 & 0 & 0 & 0 & 0 \\ x & x & x & 0 & 0 & 0 & 0 & 0 \\ x & x & x & x & 0 & 0 & 0 & 0 \\ x & x & x & x & x & 0 & 0 & 0 \\ x & x & x & x & x & x & 0 & 0 \\ x & x & x & x & x & x & x & 0 \\ x & x & x & x & x & x & x & x \end{matrix}\right. & & & & & & & \left.\right] \end{array}}_{A_0} \quad \underbrace{\begin{bmatrix} \varepsilon_{1,0} \\ \varepsilon_{2,0} \\ \varepsilon_{3,0} \\ \varepsilon_{4,0} \\ \varepsilon_{5,0} \\ \varepsilon_{6,0} \\ \varepsilon_{7,0} \\ \varepsilon_{8,0} \end{bmatrix}}_{\varepsilon_0} \quad \begin{array}{l} \rightarrow \text{Unemployment Rate} \\ \rightarrow \ln(\text{EuroCredit}) \\ \rightarrow \ln(\text{IndustrialProd}) \\ \rightarrow \ln(\text{CPI}) \\ \rightarrow \text{CreditSpread} \\ \rightarrow \ln(\text{EcoUncertainty}) \\ \rightarrow \ln(\text{StockPrice}) \\ \rightarrow \text{RateECB} \end{array}
$$

where 'x' represents a 'non-zero' unit. Under this formulation, we can clearly see that a restriction on the fifth shock satisfies our assumption about the credit spread shock, in that, $\epsilon_{5,0}$ is the only shock that impacts upon the economic uncertainty, stock price and the ECB rate and does not impact upon the other four variables. Figure 2 depicts the impulse response functions of the endogenous variables to an orthogonalised shock to the credit spread for non-financial corporations. Note that we restricted ourselves to 36 months, as shown in the x-axis, and all the the impulse response functions as well as the forecast error variance decomposition are bootstrapped by a thousand iterations which include the confidence intervals (the 5th in dotted red and the 95th in solid rate percentile).

An unanticipated increase in the credit spread is followed by a significant reduction in real economic activity as it can be seen for industrial production which drops by almost about 4 points in the first ten months. In other words, the adverse financial shock on industrial production bottoms out at about 3.5 points below trend ten months after the shock whereas the drop in credit is much more severe and persistent. Credit decreases continuously and at the end of our time range it reaches 4 points below the unconditional mean zero. Unemployment is also negatively affected, or rather positively if we look strictly at the graph. It has a hump shape, increases sharply and tops to 0.7 points above zero around the 20th month. In terms of inflation, we see a reduction in the consumer price index, even though the results of this structural VAR for inflation are rather mixed as they contain sudden drops and spikes and in terms of confidence intervals, we cannot properly assert a clear reduction in inflation. We can, however, affirm that our shock increases uncertainty and reduces prices of stocks and the monetary policy rate.

Each of the impulse response functions is accompanied by its own graph depicting the fractional error variance deviation which shows the amount of variation in the endogenous variables explained by the orthogonalised shock to the credit spread. These innovations account for 10 percent of the variations in the unemployment rate and, at a similar level, around 5 to 10 percent of variations of credit and

[2]Seasonally adjusted via ARIMA X-13.

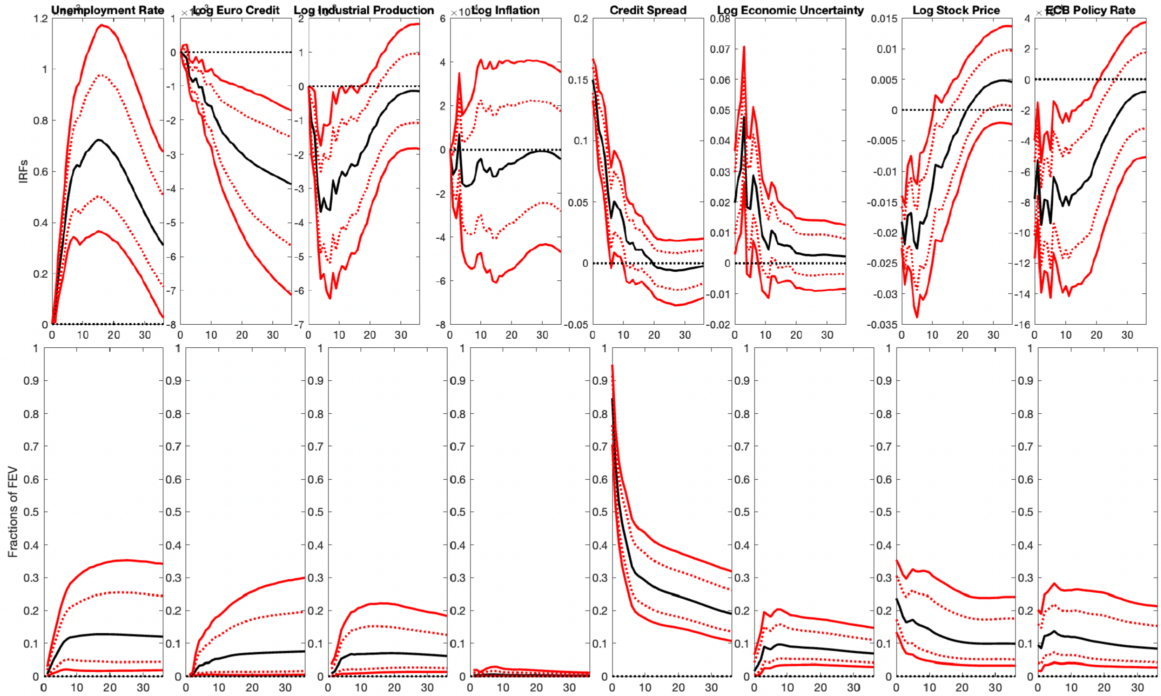

Figure 2: IRFs and FEVD

Note: Code again within overleaf

industrial production. To inflation, however, the credit spread seems to play no role which would explain the mixed dynamics in the corresponding impulse response function.

In terms of non-inertial variables, the innovations account for slightly more. Economic uncertainty, stock price and ECB policy rate are explained at around 10 to 15 percent by the shock. Note that on impact, variations to stock prices are explained by around 25 percent to the orthogonalised shock to the credit spread, the highest fraction. This could could be interpreted by the nature of the credit spread. Recall that our credit spread contains a component that does not reflect the default risk but other factors such as investor expectations and liquid premiums. It could be argued that changes in the credit spread are internalised by investors in the stock market almost immediately. That fraction fades up to 10 percent and remains stable afterwards.

The results here provided are somewhat consistent with the notion that credit spread provides a timely and useful indicator of the supply credit conditions which affect real variables. However, the results are mixed, specially with inflation where the credit spread plays almost not role. Let us then impose zero and sign restrictions to our VAR in order to better capture dynamics mentioned in the previous section.

3.2 Zero and sign restriction approach

In order to improve our analysis for the understanding of the macroeconomic implications of the shocks to credit spread, we are going to conduct Bayesian estimation of our VAR including sign and zero restrictions. In other words, we are going to impose upon the data prior information about the signs of the variables and constrain variables upon impact to remain inertial. For that, we have the following endogenous variables: (i) unemployment rate (U_t); (ii) log Euro credit (Cr_t); (iii) log industrial production (Prd_t); (iv) log consumer price index (CPR_t); (v) the credit spread for non-financial corporations (S_t); (vi) log economic uncertainty ($cert_t$); (vii) log stock price (Sp_t); and (viii) the ECB policy rate (R_t). Let us present our methodology and simplify our problem to a VAR of order 1 of the form: $Y_t = BY_{t-1} + A_0\epsilon_t$.

We start by defining the structural form of the VAR of lag one:

$$\underbrace{A_0^{-1}}_{\tilde{A}_0} Y_t = \underbrace{A_0^{-1}B}_{\tilde{B}} Y_{t-1} + \epsilon_t$$

which can be simplified by taking the transpose

$$Y_t^{'}\left(A_0^{-1}\right)^{'} = Y_t^{'}\underbrace{\tilde{A}_0^{'}}_{\hat{A}_0}.$$

We can therefore write

$$Y_t^{'}\hat{A}_0 = Y_{t-1}^{'}\left(A_0^{-1}B\right)^{'} + \epsilon_t^{'} = Y_{t-1}^{'}\hat{B}^{'} + \epsilon_t^{'}$$

and obtain

$$Y_t^{'}\hat{A}_0 = Y_{t-1}^{'}\tilde{B}^{'} + \epsilon_t^{'}.$$

We observe that in this VAR structural form, the disturbances in each equation are structural shocks. Let us assume for the time being that the credit spread shock $\epsilon_{S,t}$ is the first shock in ϵ_t, even though in our case it is in the fifth place. We then have:

$$\underbrace{\begin{bmatrix} U_t\ Cr_t\ Prd_t\ CPR_t\ S_t\ cert_t\ Sp_t\ R_t \end{bmatrix}}_{Y_t'} \underbrace{\begin{bmatrix} x & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ x & x & 0 & 0 & 0 & 0 & 0 & 0 \\ x & x & x & 0 & 0 & 0 & 0 & 0 \\ x & x & x & x & 0 & 0 & 0 & 0 \\ x & x & x & x & x & 0 & 0 & 0 \\ x & x & x & x & x & x & 0 & 0 \\ x & x & x & x & x & x & x & 0 \\ x & x & x & x & x & x & x & x \end{bmatrix}}_{A_0}$$

$$= \underbrace{\begin{bmatrix} U_{t-1}\ Cr_{t-1}\ Prd_{t-1}\ CPR_{t-1}\ S_{t-1}\ cert_{t-1}\ Sp_{t-1}\ R_{t-1} \end{bmatrix}}_{Y_{t-1}'} \underbrace{\left[\begin{array}{c|ccccccc} x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \\ x & x & x & x & x & x & x & x \end{array}\right]}_{\tilde{B}}$$

$$+ \begin{bmatrix} \varepsilon_{s,t}\ \text{Other shocks} \end{bmatrix}.$$

so that our first equation in the VAR0s structural form, that is,

$$\underbrace{\begin{bmatrix} U_t\ \ Cr_t\ \ Prd_t\ \ CPR_t\ \ S_t\ \ cert_t\ \ Sp_t\ \ R_t \end{bmatrix}}_{Y_t'} \begin{bmatrix} \hat{A}_0^{11} \\ \hat{A}_0^{21} \\ \hat{A}_0^{31} \\ \hat{A}_0^{41} \\ \hat{A}_0^{51} \\ \hat{A}_0^{61} \\ \hat{A}_0^{71} \\ \hat{A}_0^{81} \end{bmatrix} =$$

$$\underbrace{\begin{bmatrix} U_{t-1}\ \ Cr_{t-1}\ \ Prd_{t-1}\ \ CPR_{t-1}\ \ S_{t-1}\ \ cert_{t-1}\ \ Sp_{t-1}\ \ R_{t-1} \end{bmatrix}}_{Y_{t-1}'} \begin{bmatrix} x \\ x \\ x \\ x \\ x \\ x \\ x \\ x \end{bmatrix} + \varepsilon_{R,t}.$$

is the vector for the credit spread. By looking at the contemporaneous portion of the credit spread vector, we have the equation

$$\hat{A}_0^{11}U_t + \hat{A}_0^{21}Cr_t + \hat{A}_0^{31}Prd_t + \hat{A}_0^{41}CPR_t + \hat{A}_0^{51}S_t + \hat{A}_0^{61}cert_t + \hat{A}_0^{71}Sp_t + \hat{A}_0^{81}R_t = \epsilon_{R,t}$$

which reformulated results in:

$$S_t = -\frac{\hat{A}_0^{11}}{\hat{A}_0^{51}}U_t - \frac{\hat{A}_0^{21}}{\hat{A}_0^{51}}Cr_t - \frac{\hat{A}_0^{31}}{\hat{A}_0^{51}}Prd_t - \frac{\hat{A}_0^{41}}{\hat{A}_0^{51}}CPR_t - \frac{\hat{A}_0^{61}}{\hat{A}_0^{51}}cert_t - \frac{\hat{A}_0^{71}}{\hat{A}_0^{51}}Sp_t - \frac{\hat{A}_0^{81}}{\hat{A}_0^{51}}R_t + \epsilon_{S,t}.$$

Following the constraints of the classical approach, the unemployment rate, Euro credit, the industrial production and the consumer price index do not react contemporaneously to a shock in the credit spread. We then have

$$\hat{A}_0^{11} = \hat{A}_0^{21} = \hat{A}_0^{31} = \hat{A}_0^{41} = 0$$

so that

$$\hat{A}_0 = \left[\begin{array}{c|ccccccc} 0 & x & x & x & x & x & x & x \\ 0 & x & x & x & x & x & x & x \\ 0 & x & x & x & x & x & x & x \\ 0 & x & x & x & x & x & x & x \\ \hat{A}_0^{51} & x & x & x & x & x & x & x \\ \hat{A}_0^{61} & x & x & x & x & x & x & x \\ \hat{A}_0^{71} & x & x & x & x & x & x & x \\ \hat{A}_0^{81} & x & x & x & x & x & x & x \end{array}\right].$$

In terms of sign restrictions, in accordance to what we found in the empirical findings of the first section, we impose that a positive shock to the credit spread will positively affect economic uncertainty. Needless to say, as soon as the risk of default of corporations in the economy increases, the future becomes more uncertain. We also impose a negative restriction to the stock price because increasing credit spreads negatively affect the stock market. Indeed, because of the link between the credit spread and the financial health of agents, the value of the stocks of these agents are expected to decrease. And finally, we consider credit spread to also have a negative impact on interest rates. The reason dwells in the fact that as soon as the economy dwindles, the monetary authority reacts accordingly and decreases interest rates. These considerations result in the following restrictions:

$$a_{61} \equiv -\frac{\hat{A}_0^{61}}{\hat{A}_0^{51}} > 0 \qquad a_{71} \equiv -\frac{\hat{A}_0^{71}}{\hat{A}_0^{61}} < 0 \qquad a_{81} \equiv -\frac{\hat{A}_0^{81}}{\hat{A}_0^{61}} < 0$$

These restrictions together with the zero restrictions are jointly imposed via the algorithm of Arias et al. (2018) and we obtain in figure 3 the impulse response functions and fraction error variance decompositions.

As with our previous results, also bootstrapped, we obtain the same dynamics with a few differences specially in the fractional error variance decomposition. The upper set of graphs represent the impulse response functions of the endogenous variables to an orthogonalised shock to the credit spread. An unanticipated increase in the credit spread is followed by a reduction in real economic activity as it can be seen for industrial production which drops by a bit more than 4 points during the first five months. Afterwards, it seems to have oscillatory dynamics. Credit also decreases but has an inverse hump-shape as it seems to converge to its steady state within the period of 3 years. Unemployment is similar to our previous results and inflation now does seem to have a clearer negative dynamic. Disinflation seems to prevail for more than 30 months. In response to these adverse economic developments, monetary policy is eased significantly as seen by the drop to -1 points on impact. This sudden reduction could explain how credit, unemployment and industrial production were able to change their negative trends, specially credit and unemployment that were far from the unconditional zero mean within the 3 years in the classical approach.

With respect to the non-inertial variables, the effects are also similar. Economic uncertainty spikes on impact but, this time, returns to its steady state within ten months. That is to say, economic uncertainty dissipates in a shorter span. Stock prices and the policy rate also fall and both seem to get to their steady state around the 25th month. In terms of the fractional error variance decomposition, there are more differences. First note how inflation reacts to the orthogonalised shock. Now, about 8 percent of the variation of inflation is explained by the credit spread shock. Let us recall that with the classical approach we obtain an almost non-existent fraction. Overall, about 10 percent of the variations in unemployment rate, euro credit and industrial production are explained by the shock. The strongest difference comes from the stock price and monetary policy. On impact, the credit spread explains respectively 70 percent and 20 percent of their variations, more than double for the monetary policy and almost triple for stock

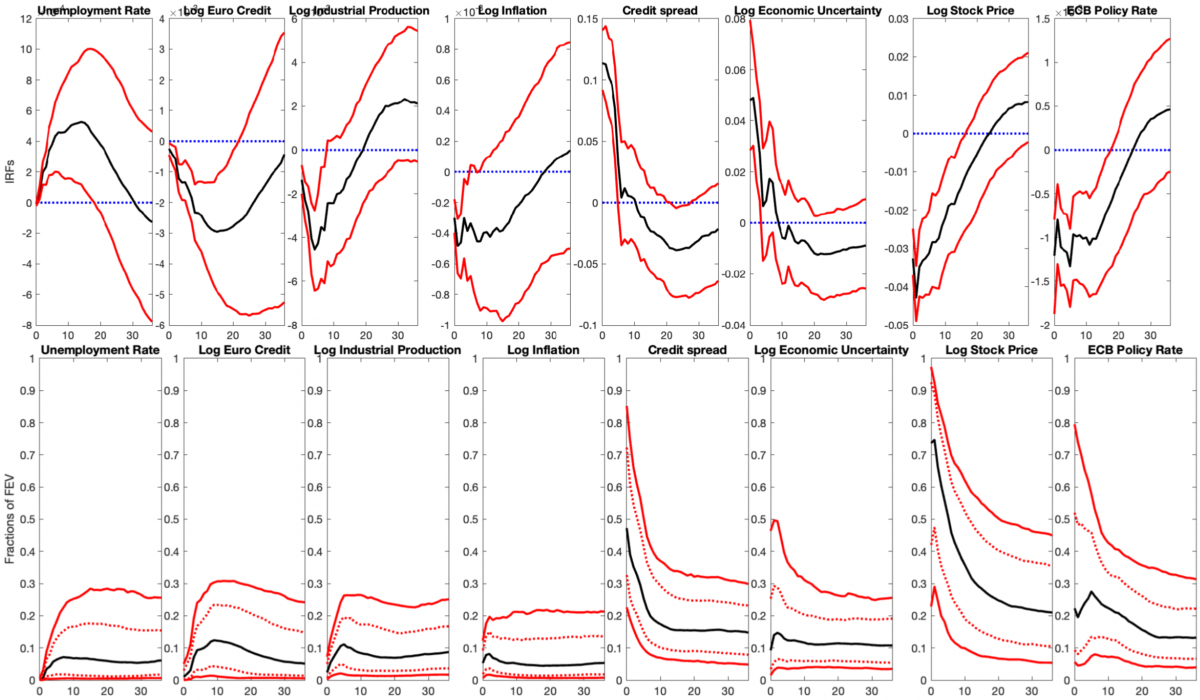

Figure 3: IRFs and FEVD with zero and sign restrictions
Note: Code again within overleaf

prices. In other words, the credit spread does indeed have an effect on the perception of investors about the financial health of agents, and monetary policy react accordingly in a strong manner.

All in all, the macroeconomic dynamic here presented are consistent with the financial acceleration mechanisms highlighted by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) in that a reduction in the supply of credit, from an increase in the risk of agents reflected by the credit spread, causes a drop in assets prices, as seen by the impulse response functions for the stock price, and a contraction in economic activity. We can also say that the results reflect the nature of our object of study, that is, corporate bonds. Compared to equity prices, bonds and the subjacent credit spread are better able to capture the downside risks of economic growth. This point was modelled by Gourio (2013).

4 Conclusion

In this short report, we examined credit spreads and the excess bond premium. Among the various measures of credit spreads, those developed by Gilchrist et al. (2009), Gilchrist and Zakrajšek (2012), and Gilchrist and Mojon (2014) provide a clearer picture of the financial health of economic agents. A simple credit spread often obscures information about default risk and may also capture factors unrelated to the true financial condition of borrowers. While our focus was on the Euro area credit spread of Gilchrist and Mojon (2014), incorporating the excess bond premium allowed us to better identify the components driving credit spreads. From a macroeconomic perspective, credit spreads clearly enhance the analysis of credit dynamics and their influence on economic activity. Overall, rising credit spreads signal deteriorating conditions rather than favorable prospects.

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Appendix

Note: Appendix must be added with the relevant illustrations and data sources!

Data

1. Economic Policy Uncertainty Citation: Davis, Steven J., 2016. "An Index of Global Economic Policy Uncertainty," Macroeconomic Review, October. Updated from 1997 onwards.

2. Industrial Production: Euro area 17 (fixed composition) - Industrial Production Index, Total Industry (excluding construction) - NACE Rev2; Eurostat; Working day and seasonally adjusted start 1991, taken from https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=132.STS.M.I8.Y.PROD.NS0020.4.000.

3. HICP: Euro area (changing composition) - HICP - Overall index, Monthly Index, European Central Bank, Seasonally adjusted, via ARIMA X-13.

4. Unemployment Rate: Euro area 17 (fixed composition) - Standardised unemployment, Rate, Total (all ages), Total (male & female); unspecified; Eurostat; Seasonally adjusted, not working day adjusted, percentage of civilian workforce. Before January 1995, from ECB dataset.

5. ECB Policy Rate : Before January 1999, it is the 'short-term intrest rate' from the ECB dataset.

6. Credit: Euro area (changing composition), Outstanding amounts at the end of the period (stocks), Monetary and Financial Institutions (MFIs) reporting sector - Loans [A20] and securities [AT1], Total maturity, All currencies combined - Euro area (changing composition) Before January 1998, it is the 'short-term intrest Euro area (changing composition), Index of Notional Stocks, Monetary and Financial Institutions (MFIs) reporting sector - Loans excluding reverse repos with central counterparties, Total maturity, All currencies combined - Euro area (changing composition).

7. Monthly, Euro area (changing composition), Euro, Dow Jones Euro Stoxx Price Index Average of observations through period.

8. spr_nfc_bund_ea: from Gilchrist and Mojon (2014).

Figures