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## The role of sentiment in the provision of credit

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**The Role of Sentiment in the Provision of Credit**

by

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# The Role of Sentiment in the Provision of Credit

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## Abstract

The provision of credit has been shown to be eminent for macroeconomic activity. Recent research highlighted that optimism may play a role in the provision of credit through leverage cycles. A decomposition of corporate bond spreads allows the modelling of a propensity-to-lend through an excess bond premium. In the US economy, optimism in various sentiment measures causes within a VAR model, including other financial market variables, a fall of this excess bond premium and therefore increase the propensity-to-lend. Use of the Michigan Consumer Sentiment Index and animal spirit indices show a variation of information content in sentiment and different types of animal spirits. The overall reaction to positive animal spirits seems to be dominated by a positive response of the credit provision and its subsequent reversal, while an increase in the MCSI causes a more persistent positive response. (JEL E03, E22, E32, E44)

## 1 Introduction

The supply of credit has played a dominant role both in the Great Recession and the build-up of the subprime mortgage bubble. Empirically it has been postulated the importance of increasing credit supply in the rise of house prices (Mian and Sufi, 2010a) and decreasing credit supply in the burst (Mian and Sufi, 2010b). The varying credit supply between and after 2002 (beginning of the subprime mortgage bubble) is illustrated in Table 1. The table shows how both the mean credit growth and the standard deviation increase after 2002. Financial friction models have underpinned this empirical analysis theoretically by moving away from perfect markets of credit through the inclusion of a borrowing constraint (e.g. Iacoviello, 2005). Indeed, Hall (2011a,b) proposes a financial frictions model in which the credit tightening generates an enduring slump which can be compared to the Great Recession.

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\*The idea for the paper stemmed from a course on Financial Markets and the Macroeconomy by Tommaso Monacelli at the Kiel Institute for the World Economy, where I delved into the issue of the determination of the credit supply in relation to financial friction models. I thank my supervisor at the UAM Beatriz de Blas and my supervisor at the Kiel Institute Steffen Ahrens, who was also the discussant at the Conference on ASP Term Papers at the Kiel Institute, for their helpful comments and suggestions. I would also like to thank the participants at the conference for their questions and remarks.

Table 1: Variation in the Credit Supply 1996-2002 vs. 2002-2006

Period	Mean	SD
Mortgage debt annualized growth (Equifax data)		
1996 - 2002	0.089	0.065
2002 - 2005	0.145	0.081
Mortgage origination for home purchases annual growth (HMDA data)		
1996 - 2002	0.144	0.089
2002 - 2005	0.194	0.189

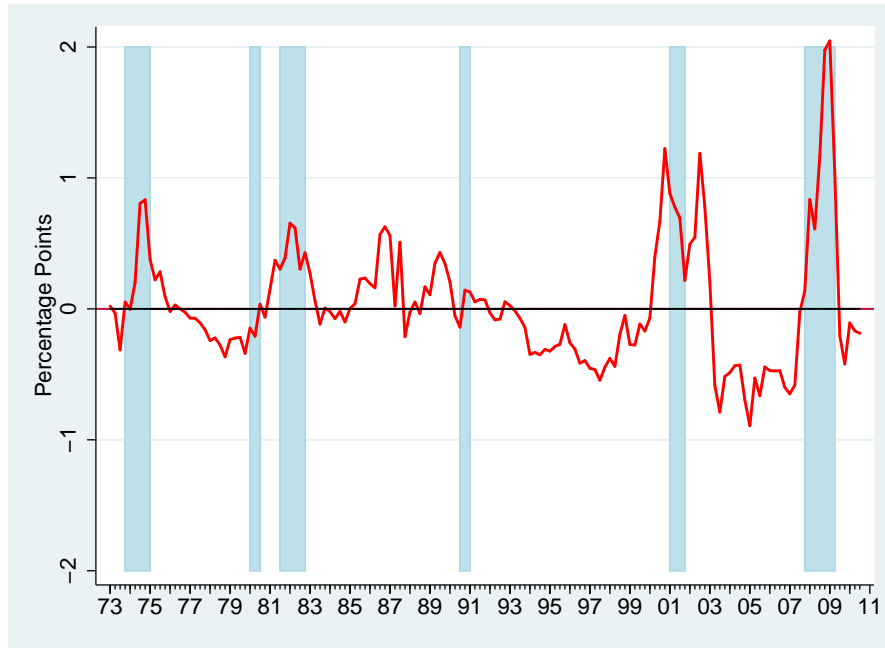
Source: Mian and Sufi (2009)

The procyclical nature of credit supply has, however, lacked extensive research. Exceptions include the research into leverage cycles and the credit spread puzzle. Fostel and Geanakoplos (2012) criticise the common treatment of leverage as exogenous or even constant. They therefore propose the theory of leverage cycles outlining a model in which leverage is endogenised and varies procyclically caused by optimism. Gilchrist and Zakrajsek (2012) (henceforth GZ2012) address the issue of the credit spread puzzle showing the procyclicality of credit provision. The puzzle is caused by the inability of firm-specific risk to explain the credit bond spread - the yield difference between private debt securities and treasury bonds with comparable characteristics. They decompose the credit spread into a firm-specific risk component and an excess bond premium which represents the non-idiosyncratic share of the price of credit. This allows them to show that the credit bond spread can predict macroeconomic activity, and moreover that this predictive nature derives from the countercyclical residual component of the credit bond spread. For the countercyclical variation of the excess bond premium and therefore the procyclical variation of credit supply see Figure 1. This figure shows the procyclicality of credit provision, outlining how the excess bond premium rises in the presence of recessions. In the latter part of their paper they then assess the health of financial intermediaries as a determinant of this residual.

This paper will draw on the time-variation and procyclicality of credit provision as proposed in financial friction models and observed by GZ2012. The excess bond premium is interpreted as a propensity-to-lend, as the residual in the bond spread puzzle has been linked previously to a varying demand of a liquidity premium (e.g. Houweling et al., 2005). GZ2012 postulated one determinant of this liquidity premium - the health of financial intermediaries - while this paper will center on sentiment as a determinant. The rationale for the inclusion of sentiment as a determinant is provided by the theoretical underpinning of leverage cycles. The analysis draws on much of the latter part of the paper by GZ2012. It uses the identified relationship between the price of credit and macroeconomic activity to argue for the transmission of sentiment through credit provision into the macroeconomy. Furthermore the paper employs a similar VAR approach and the excess bond premium constructed by them to determine the effect of sentiment on the provision of credit in the US.

In this vein the paper's contributions are threefold. Firstly, it assesses an additional determinant (sentiment) of the time variation in credit supply contributing to a solution of the credit spread puzzle. Secondly, it establishes a link between consumer sentiment and credit

Figure 1: Excess Bond Premium



Source: Gilchrist and Zakrajsek (2012)

*a* The shaded areas show the NBER recessions.

supply and addresses the way it is incorporated into the economy. Finally, within this analysis the paper introduces various sentiment indices to determine the effects.

The results highlight both the overall effect of sentiment on the willingness-to-lend and the variation that exists within sentiment. Increases in all sentiment measures affect the excess bond premium negatively and therefore corroborate the hypothesis that optimism increases the propensity-to-lend. Moreover, these results are robust over longer time-samples, a different identification strategy for the MCSI and varying specifications of the macroeconomic animal spirit measure. The three constructed animal spirit measures vary considerably due to their distinct information on which they are based, which underscores the complexity of sentiment. Nonetheless, all three decrease the excess bond premium highlighting the positive effect of optimism on credit supply regardless of the type of sentiment.

The rest of the paper is structured as follows. The next section develops the theoretical underpinning for the behaviourally induced time-variation in the credit supply as a transmission channel of sentiment to economic activity. Here I will introduce three dimensions of analysis, firstly the overall effect of sentiment on credit provision, secondly the distinction between animal spirits and sentiment, which may be driven by news, and finally the question between animal spirits derived from different underlying information. Section 3 will outline the empirical model, identify the data and the different model specifications and propose various sentiment measures. The subsequent section then compares the results of the VARs and discusses them in the light of the proposed theory. Finally, Section 5 will conclude the findings and address limitations and further avenues of research in the area.

## 2 Credit Supply, Sentiment and Macroeconomic Activity

This section postulates the theoretical relationship between credit supply, sentiment and macroeconomic variables, which provides the foundation for the subsequent empirical analysis. Firstly, credit supply will be analysed and linked to macroeconomic activity. Secondly it will be drawn from sentiment literature in relationship to financial markets and the macro economy, before finally linking these two to propose credit supply as a transmission channel of sentiment to economic activity.

Credit supply consists of two elements - price and quantity - which may vary depending on the context. Most of the literature on credit has focused on the price, while the quantity of credit has often been treated as constant or at least exogenous, although both elements are two sides of the same coin. The equilibrium of supply and demand, subject among other factors to market nervousness and volatility, determines both interest rates and equilibrium leverage (Geanakoplos, 2010). The price of credit, often measured by the credit spread, has attracted much attention in research. The credit spread puzzle highlights the incompatibility of the price of credit with the pure default risk of the issuer of debt, which only explains less than a third of the credit spread (Amato and Remolona, 2003; Huang and Huang, 2012). The residual element of the credit spread has been linked to corporate tax treatment (Elton et al., 2001), however, more importantly, highlighting the role of market nervousness and volatility, to a time-varying liquidity premium (Driessen, 2005; Houweling et al., 2005), which also contributes to excess volatility in the credit spread (Bao and Pan, 2013). Collin-Dufresne et al. (2001) do not find evidence for the influence of standard liquidity measures on the credit spread but postulate the importance of supply and demand shocks unrelated to the default risk component. Expanding on the role of market nervousness, the financial intermediaries' influence on this residual credit spread has also been established (Cúrdia and Woodford, 2010; Gilchrist and Zakrajsek, 2012). This time-varying residual component of the price of credit resembles the time-variation in the quantity of credit provision marked by pro-cyclical leverage cycles, which are caused by anxious perceptions of news (Fostel and Geanakoplos, 2008, 2012; Geanakoplos, 2010).

The time-variation in credit provision represents a possible financial disturbance to macroeconomic activity through market nervousness or volatility. Financial friction models outline the transmission from financial disturbances into the macro economy. The financial friction these models employ are mainly incomplete contracts, which give rise to the existence of a collateral constraint on borrowing, in which the ability to borrow depends on the potential use of assets as collateral, that is the expected future value of the assets and a loan-to-value (LTV) parameter which scales the usability of the value as collateral. The financial friction models mimic the transmission of financial disturbances in most cases through the departure from a representative agent model, embracing heterogeneity, through distinct preferences of savers and borrowers and a collateral constraint, as proposed in incomplete contract models, deriving the ability to borrow from expected asset prices and the LTV parameter. In this framework asset price developments (Iacoviello, 2005; Philippon and Midrigan, 2011) and more importantly deleveraging shocks, similar to the sudden stop problem (Eggertsson and

Krugman, 2012; Mendoza, 2010), can depress the ability to borrow and thus economic activity. The financial friction models outline the importance of the quantity of credit provided and its propagation in the economy. However, the quantity itself is regarded exogenously, through for instance deleveraging shocks to the LTV parameter, a gauge of the willingness-to-lend.

GZ2012 show, drawing on the macroeconomic predictability through financial indicators (e.g. Estrella and Hardouvelis, 1991; Fama, 1981), that the excess bond premium is highly predictive of macroeconomic activity. The construction of this excess bond premium, as the residual of the default risk, allows the interpretation of it as a proxy for the willingness-to-lend in the economy and its time-variation. In a nutshell the theoretical transmission channel is the following: a reduced willingness-to-lend - represented by the excess bond premium - constrains borrowing, as postulated by financial friction models, and subsequently depresses economic activity. The excess bond premium therefore represents an avenue to analyse the willingness-to-lend endogenously.

Various determinants of the residual credit spread (excess bond premium) have been proposed which could subsequently affect macroeconomic activity. Nevertheless, research lacks the identification of sentiment's role on this measure, despite the importance of sentiment in financial markets and for the economy as a whole. Behavioural finance literature outlines the deviation from efficient markets, due to the human nature, which causes another friction. Limited arbitrage and psychological processes cause asset prices to deviate from fundamental values. Agents aim to simplify the complexity of real life and thus cognitively follow heuristics, so-called-rules of thumb, which may cause an over- or underreaction of markets (for a survey see Barberis and Thaler, 2003), often called animal spirits. Emotional finance, explains the occurrence of asset price bubbles, including the subprime mortgage bubble and its burst, through emotions, drawing on psychoanalytical theory connecting it through the occurrence of bubbles with the macroeconomy (Taffler and Tuckett, 2010; Tuckett and Taffler, 2008; Tuckett, 2011).

The value of behavioural economic findings, namely the effect of optimism - cognitive or emotional -, has been previously recognised through better reconciling macroeconomic models with empiric evidence, such as the non-normality of output gaps (De Grauwe, 2011, 2012; Woodford, 2013). The major difference to standard models is the inclusion of heuristics and a deviation from rational expectations. Drawing on the cognitive limitations to rational decision-making due to the complexity of economic decisions, as proposed by behavioural finance, optimism is incorporated in these models through heterogeneous agents with varying expectations. Emotions are incorporated through an error-term in the expectation determination which represents varying states-of-mind. The fraction of optimistic agents gives a measure of animal spirits, that means optimism or pessimism, and the importance of it has been established through the correlation between changes in the fraction of optimistic agents and changes in the output gap (De Grauwe, 2012). These models also linked optimism to the previously proposed determinant of the excess bond premium, financial intermediaries. The effect of financial intermediaries on the credit spread in an environment marked by animal spirits is highlighted by extending the basic model with a banking sector, which amplifies the effect of animal spirits (De Grauwe and Macchiarelli, 2013). It is one of the exceptions of research that has linked sentiment theoretically to credit supply albeit indirectly through financial interme-

diaries, whose effect on the excess bond premium has been identified by GZ2012.

The role of behavioural factors in other contexts manifests the potential role that it can also play in the willingness-to-lend, which is supported by research into leverage cycles. This approach not only proposes the cyclical variation and pro-cyclicality of leverage, but also argues that bad news and pessimism decrease leverage (Fostel and Geanakoplos, 2012; Geanakoplos, 2010). Developing this behavioural line of reasoning, outlines that sentiment - caused by animal spirits - can be an important determinant of the excess bond premium, causing it through shifts in optimism and pessimism to vary. This represents the variation in the willingness-to-lend in financial friction models constraining borrowing and finally depressing macroeconomic activity. Therefore animal spirits in this framework has a strong element of self-reinforcement through the existence of financial frictions. In a recent study Barsky and Sims (2012) also outline the importance that sentiment has on macroeconomic variables, namely output and consumption. While this seems to support the previously developed reasoning, with negative animal spirits causing consumption and economic activity to fall, they show that this relationship is caused by a news shock to sentiment representing new information, rather than deviations from fundamental information as a result of animal spirits. They extend the debate around sentiment, whether it is formed through animal spirits or additional information which is unobservable through other channels. This means that sentiment cannot be self-reinforcing as in the framework above. This theory therefore provides a competing channel for sentiment to affect macroeconomic activity, against which the results can be evaluated.

Finally, while the previous discussion centered on macroeconomic sentiment, it may similarly originate from other sources of information, such as asset price variation. This information derives importance for two reasons. Firstly, the recent periods of boom and bust attach an important role to asset prices, particularly house prices in the Great Recession (cf. Mian and Sufi, 2010a,b). Secondly, this prevalence of asset prices is substantiated theoretically by the modelling of the borrowing constraint, the limited usability of assets as collateral to obtain credit, in financial friction models. This also suggests the importance of sentiment in respect to asset prices to determine the willingness-to-lend, instead of solely overall macroeconomic performance. Even though asset prices enter separately from the scale parameter which reflects the overall willingness-to-lend in those models, this willingness-to-lend may also be influenced by the evolution of asset prices. Finally, the utilization of the excess bond premium, which is derived from corporate bonds, may introduce a particular exposure to financial market sentiment, in contrast to other variables of credit provision. This closer link of asset prices to the lending decision suggests a stronger effect of this type of sentiment on lending, than macroeconomic sentiment.

In conclusion, credit provision varies in time and is linked to macroeconomic activity. The credit provision has been decomposed by GZ2012 into a systematic default risk part and a non-systematic residual usable as a proxy for the willingness-to-lend. Financial friction models argue for the propagation of a decreased willingness-to-lend to affect macroeconomic activity, thus offering a channel to explain the relationship between the excess bond premium and macroeconomic activity. The excess bond premium then allows the endogenous identification of the willingness-to-lend, in which sentiment can play an eminent role due to the importance of animal spirits in finance and macroeconomics. The following sections will outline and



analyse the importance of sentiment in the excess bond premium and evaluate whether the willingness-to-lend represents a transmission channel of animal spirits into macroeconomic activity, contrasting it to the news aspect in sentiment and determine if sentiment's effect varies between different sources of animal spirits.

### 3 Empirical Strategy

The analysis of the behavioural determinants in the provision of credit, through a variation in the willingness-to-lend, is done via a VAR estimation as used by GZ2012, extending it through sentiment measures. This section will firstly identify the employed data and the sources used in a variation of the VAR model used firstly by GZ2012 whose value for the analysis will be established in the second subsection. Finally, the third subsection will then outline an operationalization of the behavioural factors through various sentiment measures to extend the model respectively.

#### 3.1 Data

The data can be divided into two different blocks, firstly the data derived from the GZ2012 paper, which is the basis for the analysis as it provides the excess bond premium - the main variable of interest. This data is extended through other sources of data in order to obtain a longer sample period for some of their variables for robustness checks (see Table 2). The second block of data (see Table 3) refers to various measures of sentiment, both direct ones and variables which serve for the construction of sentiment indices.

The GZ2012 paper provides most of the data for the baseline model. However, the data is relatively limited in terms of the sample period. While the excess bond premium is provided in a relatively long-sample from January 1973 till September 2010, both in monthly and quarterly frequency, the other variables are only available in a smaller sample period. This is especially an issue for the financial health variables which are only provided from January 2003 till September 2010. Therefore the baseline model is estimated from the January 2003 to September 2010 data. The market variables of the volatility index and value-weighted excess market return are similarly limited in this data, but can be extended easily through other data bases. The value-weighted excess market return has been extended in a monthly fashion until 1975 through the Kenneth French data library excess market return (Mkt-RF), which is as in GZ2012 based on the value-weighted excess market return from CRSP listed companies in NYSE, NASDAQ and AMEX. Similarly, the volatility index can be extended through the Chicago Board Options Exchange (CBOE) S&P500 volatility index (VIX). The daily time-series has been collapsed to a monthly one, using only the last observation per month, in line with the GZ2012 data. This extends the volatility index until January 1990, as there are no observations for the VIX index previous to this date. This extension to 1990 provides the second specification of the basic model for the robustness checks. The first basic model is estimated for the same time sample as the baseline model (2003-2010). However, as a further robustness check, the CBOE S&P100 volatility index (VXO) will be used instead of the VIX, as it extends until 1986. The daily data is collapsed in the same fashion as for the VIX index. The use of the VXO and the time sample from 1986 till 2010 represents the final specification

Table 2: Block 1 Variables and Sources

Variables	Frequency	Time Sample	Used in Model	Source
Excess Bond Premium	monthly	Jan1986 - Sep2010	Baseline, Basic	GZ2012
Broker-Dealer Ex. Return	monthly	Jan2003 - Sep2010	Baseline	GZ2012
1-year CDS Average	monthly	Jan2003 - Sep2010	Baseline	GZ2012
5-year CDS Average	monthly	Jan2003 - Sep2010	Baseline	GZ2012
VW Ex. Market Return	monthly	Jan2003 - Sep2010	Baseline	GZ2012
S&P500 VIX	monthly	Jan2003 - Sep 2010	Baseline	GZ2012
VW Ex. Market Return	monthly	Jan1986 - Sep2010	Basic	KFDL
S&P500 VIX	monthly	Jan1990 - Sep2010	Basic (03/90)	CRSP
S&P100 VXO	monthly	Jan1986 - Sep2010	Basic (86)	CRSP
Excess Bond Premium	quarterly	1990:1 - 2010:3	OPG	GZ2012
VW Ex. Market Return	quarterly	1990:1 - 2010:3	OPG	GZ2012
S&P500 VIX	quarterly	1990:1 - 2010:3	OPG	CRSP

*a* The number of the basic model refers to the starting year. When no number is mentioned the variable is used in all three basic models.

*b* The OPG model refers to the quarterly model which is estimated as a robustness check based on the FRED Output Gap data.

*c* KFDL stands for Kenneth French Data Library.

*d* The volatility measures (VIX and VXO) are constructed from daily data based on the last day of the period.

*e* The time sample refers to the dates which have been finally used and not the original time sample. Many variables had longer time horizons but were not used in the vector autoregressions.

of the basic model.

Various variables have been used to derive the sentiment measures in the manner explained above. The first measure, the expected Michigan Consumer Sentiment Index (MCSI - Index of Consumer Expectations), has been directly obtained from the University of Michigan Consumers Survey data base using only the forward-looking element from the entire sentiment index.<sup>1</sup> The MCSI is a measure of consumer confidence in the USA derived monthly through a survey approach asking households various questions about their view on personal, business and overall economic issues. As such it represents a measure of sentiment about the future and is therefore used as a potential determinant of the credit supply. The other three sentiment measures are constructed animal spirit measures. The data sources for this construction is outlined below and the actual construction is explained in Section 3.3. The second measure - macroeconomic animal spirit - as proposed by De Grauwe, is based on the output gap. The output gap has been computed on the basis of the industrial production data to approximate the output gap in a monthly fashion through the OECD Main Economic Indicators Production and Sales database, using Production of total industry. The asset price sentiment measure is based on data from CRSP, including listings from the NYSE, NASDAQ and AMEX, in line

<sup>1</sup>The MCSI can be decomposed into a current and expected component. The expected component has been used instead of the entire index as the analysis is interested in the sentiment - optimism and pessimism - about the future. Moreover, both the entire index and the forward-looking component are highly correlated (0.98) so that this does not affect the analysis.

Table 3: Variables used for the Sentiment Measure Construction

Sentiment Measure	Frequency	Variables Used	Source
MCSI	monthly	Forward-Looking MCSI	UoM CSD
Macroeconomic Animal Spirit	monthly	Industrial Production	OECD MEI
Macroeconomic Animal Spirit	quarterly	GDPPOT	FRED
	quarterly	GDPC1	FRED
Stock Price Animal Spirit	monthly	VWRETD	CRSP
House Price Animal Spirit	monthly	FMHPI	Freddie Mac
	monthly	CPALTT01USM661S	FRED

*a* UoM CSD refers to the University of Michigan Consumers Survey Database.

*b* The macroeconomic animal spirit index has been constructed both in a monthly and quarterly frequency to overcome the uncertainty introduced by the use of industrial production as a monthly proxy for the output gap.

*c* VWRETD refers to the value-weighted return including distributions for the NYSE, NASDAQ and AMEX.

*d* The other abbreviations of the variables are the codes used in the respective databases (as mentioned in the sources) for the US data.

*e* The construction of the animal spirit measures is outlined in Section 3.3.

*f* One of the sentiment measures is used in each model and explicitly referred to. The time sample in each case overspans the entire sample period from January 1986 till September 2010.

with the sample for the excess market return. The variables used in order to construct the asset price sentiment index are monthly value-weighted return including distributions (vwretd) and the risk-free market rate, which is the normal 3-months real rate on treasuries also obtained from CRSP. Finally, the house price sentiment index is based on national house price data from the Freddie Mac House Price Index (FMHPI) which due to their nominal price measurement has been adjusted by the US total for all items CPI from the Federal Reserve Economic Data (FRED) (CPALTT01USM661S). All the measures are obtained in a monthly frequency with relatively large periods. In one of the robustness checks below quarterly data has been used which is obtained from GZ2012 and the output gap represents the actual US Output Gap, including services instead of only using the output gap from industrial production data as done in the baseline model. The output gap has been computed on the basis of FRED data, namely real potential GDP in chained 2009 US dollars (GDPPOT), provided by U.S. Congressional Budget Office, and seasonally adjusted annual rate real GDP in chained 2009 US dollars (GDPC1), from the Department of Commerce.

### 3.2 The Model

An empirical analysis of the determinants of credit provision can be approached either through the quantity or the price of credit. The quantity approach, in contrast to the price approach, is susceptible to the absence of a smooth change in the quantity lend due to two reasons. Firstly, leverage levels are usually fixed relatively long-term, which means that leverage cannot react immediately to market changes as a result of long-term commitment. Secondly, a problem which arises not only at the levels of debt, leverage, but also the flows, the lending itself, is that the actual variation in the willingness-to-lend is not observable due to the absence of continu-

ous changes. Price changes usually reflect changes in the determinants continuously, however, in the case of lending one only observes a discrete change of lending or not lending instead of the actual underlying changes in the willingness-to-lend. The loan-to-value parameter, of house prices for instance, may be able to overcome the limitations through the observation of a continuous change for new credits. Moreover, it would provide a measure for credit to households. However, in order to represent an overall willingness-to-lend, this parameter would need to be decomposed into a default risk component and a non-systematic residual. The excess bond premium computed by GZ2012, as noted above, can serve as a proxy to overcome this issue, despite being linked to corporate credit and not household credit as financial friction models propose. The close relationship between prices and quantity of debt due to the same underlying determinants (cf. Geanakoplos, 2010), allows the use of the observable changes in the price to identify the unobservable underlying changes in the provision of credit. The excess bond premium represents in this context an ideal measure, as it eliminates the financial health of bond issuers from the credit spread, so that it only contains a time-variation of the willingness-to-lend by the creditors. Based on the "credit spread puzzle", it abstracts the fundamental factors related to the credit spread, the market characteristics affecting the solvency of the bond issuers, and thus contains only the isolated lending propensity of creditors.

Additionally, the VAR framework outlined in this study represents an ideal basis to analyse the variation in the willingness-to-lend. GZ2012 draw on this time-variation in the excess bond premium and identify the effect of the health of the financial sector on it through this VAR estimation. The framework can be extended to incorporate time-varying behavioural factors. This allows the determination of the effect that deviations from rational decision-making have on the time-variation of the willingness-to-lend expressed by the excess bond premium. Extending the VAR estimation of GZ2012 with the behavioural factors establishes the baseline model below, which includes all the variables from GZ2012 and the sentiment measure, showing the excess effect of sentiment.

$$\begin{pmatrix} EBP_t \\ X_t \\ Y_t \\ \chi_t \end{pmatrix} = \beta_0 + \beta_1(L, m)EBP_{t-1} + \beta_2(L, m)X_{t-1} + \beta_3(L, m)Y_{t-1} + \beta_4(L, m)\chi_{t-1} + U_t. \quad (1)$$

In this specification the EBP represents the excess bond premium, the vector  $X_t$  represents the health of the financial intermediaries ( $X_t = [5yrCDS_t, 1yrCDS_t, XBDRET_t]'$ ) including CDS of Broker-Dealers at 5 and 1 year horizons as well as the excess broker-dealer return. The vector  $Y_t$  contains the financial market variables included by GZ2012, namely value-weighted excess market return and the market volatility index of the S&P500 ( $Y_t = [VWXRET_t, VIX_t]'$ ). The actual innovation in this model compared to the one outlined in GZ2012 is the sentiment measure given by  $\chi_t$ , which varies with the different specification of animal spirit or sentiment and will be determined in the following subsection. The terms  $\beta_1(L, m)$  to  $\beta_4(L, m)$  represent two-months lag polynomials of coefficients for the respective variables and the corresponding lag<sup>2</sup>. Finally,  $U_t$  is the vector of the error terms.

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<sup>2</sup>Testing the optimal lag length of the various models showed that the optimal lag length in most models and according to most statistics is two months.

The identification of the ordering of the variables is following a Choleski decomposition. The ordering of the financial market and financial intermediaries' health variables remains unchanged in comparison to GZ2012. In this ordering the variables affecting the financial market precede the variables of the financial intermediaries. As financial intermediaries interact within the market their risk and profitability seems to be contemporaneously affected by the financial market more than the other way round. Moreover in this setup volatility precedes profit and profit precedes risk, as the S&P500 VIX precedes the excess market return and the excess broker/dealer return precedes the CDS averages, the price of insuring against the financial intermediaries' risks. This part of the ordering also follows a understandable causal relationship. The issue of the incorporation of the sentiment in this framework is overcome in most specifications by the construction of the animal spirit measures. By construction, which will be outlined in Section 3.3, these are composed by past values and therefore precede the present values of the other variables. Thus they are incorporated at the beginning. The MCSI follows a similar line of reasoning, albeit not being strictly observable, it still imposes a state of mind on the decision-maker, the sentiment, which affects each decision-making and therefore is likely to precede the other variables. However, in this case this argument is not as clear as in the animal spirit measures, as the sentiment is likely to be affected by the other variables at the same time. In the presence of this interaction, a dual causality between sentiment and other variables, an identification through a Choleski decomposition may not be ideal, however, due to a lack of research into the interaction between sentiment and financial variables it is the best possible identification scheme available. Nevertheless, the potential dual causality between the MCSI is recognised and addressed in a robustness check where the sentiment is incorporated after financial market and financial intermediaries' health variables (see Section 4.3).

The baseline model has the benefit of being comparable with the previous study of the excess bond premium and allows sentiment to affect the financial health indicators. Nonetheless, limited availability of the data of these financial health indicators restricts the estimation to the time sample from January 2003 till September 2010. The availability of data has been addressed in the data section above, and will be overcome through the estimation of a basic model abstracting from the financial health indicators as a robustness check for the baseline model. This basic model therefore only includes the excess bond premium, the market variables and the sentiment measure as shown below.

$$\begin{pmatrix} EBP_t \\ Y_t \\ \chi_t \end{pmatrix} = \beta_0 + \beta_1(L, m)EBP_{t-1} + \beta_2(L, m)Y_{t-1} + \beta_3(L, m)\chi_{t-1} + U_t. \quad (2)$$

The second model allows to make the analysis subject to a considerably longer time-sample and to analyse whether the exclusion of the financial health indicators affect the results of the consequences of sentiment variation on the excess bond premium. This basic model will be estimated under three different time-samples (2003-2010; 1990-2010; 1986-2010).

### 3.3 Sentiment Measures

In the operationalization of cognitive and emotional factors, on top of the model base stated above, the model will encompass four different specifications. The complexity of the human

mind complicates the operationalization of market sentiment, the behavioural deviations from rationality, through a single measure, especially in the aggregate, which is why this paper will consider the effect of a number of different measures. There will be four different specifications considered, which themselves may be varied for robustness checks. First of all, two measures of macroeconomic sentiment will be considered, linking it to the question of general sentiment transmission into the economy. The other two measures focus on asset price sentiment in order to analyse the different effects of varying information types, represented by stock and house price sentiment.

### **Michigan Consumer Sentiment Index (MCSI)**

One approach to obtain a value of sentiment is the measurement of a sentiment index based on survey data, such as the Michigan Consumer Sentiment Index (MCSI) (see Katona, 1951). This index has been used among others in the study by Barsky and Sims (2012) to show its effect on macroeconomic activity. This consumer sentiment index represents a valuable measure due to the survey approach obtaining empiric data on the sentiment. However, a caveat of this measure is the absence of the underlying determination process of this sentiment. Highlighted in the debate about the news or animal spirit component, this index can represent both (see Barsky and Sims, 2012) as the formation is unclear. Thus, this consumer sentiment index is a valid starting point for the analysis. The actual measure used is a subindex within the overall consumer sentiment index, namely the forward-looking component - the index of consumer expectations.

### **Macroeconomic Animal Spirit Index**

An alternative approach used in behavioural macroeconomics, is the modelling of animal spirits through a simple framework employing behavioural finance theory and heterogenous agents. De Grauwe (2012) proposes this index, which is a relation between extrapolist agents and fundamentalist agents, similar to the behavioural finance distinction between chartists and fundamentalists. The extrapolists are rationally bounded and therefore form their expectations based on the use of heuristics, rules-of-thumb, extrapolating past results of the output gap (see Equation 3). In contrast, fundamentalists predict the steady-state output-gap, which in this context will be assumed to be zero, following De Grauwe (2012) (see Equation 4).

$$E_t^e y_{t+1} = y_{t-1}, \tag{3}$$

$$E_t^f y_{t+1} = 0. \tag{4}$$

The agents however, continuously evaluate the performance of the different forecasts based on derived utility of both subject to a deterministic component formed through a quadratic loss function and a stochastic error term representing the state-of-mind during the evaluation. This evaluation then provides the fractions of agents that forecast in a fundamentalist or extrapolist fashion. The animal spirit index is then designed based on the fraction of extrapolists and the nature of their extrapolation, positive or negative.

$$\chi_t = \begin{cases} \alpha_{e,t} & \text{if } y_{t-1} \geq 0, \\ 1 - \alpha_{e,t} & \text{if } y_{t-1} < 0. \end{cases} \quad (5)$$

Equation (5) shows the animal spirit index  $\chi_t$ , where  $\alpha_{e,t}$  is the fraction of extrapolists in the population.<sup>3</sup> In this context, due to the quarterly frequency of the output gap data on GDP, the analysis will draw on a derivation of the output gap from monthly industrial production data to obtain data with a monthly frequency on the output gap. In this case the output gap will be obtained applying a Hodrick-Prescott filter to this data and removing the trend element<sup>4</sup>. As a robustness check, the macroeconomic animal spirit is also constructed on a quarterly frequency based on the actual output gap data. The use of the quadratic loss function implies that the animal spirit measure is subject to the way the variable of interest is included and may deviate only due to a different representation of the same value, for example using a representation of the percentage value 1.5 or actual percentages 1.5%. This issue on how the animal spirit measures are affected and how this alters the analysis will also be assessed in the robustness checks (see Section 4.3). The substantial benefit of this and the following animal spirit indices is the foundation on theory, so that they can be interpreted as behavioural deviations, driven by cognition and emotion rather than news shocks. However, the theoretical aspect introduces another caveat, the modelling may not be appropriate to capture animal spirits. Therefore it introduces a joint hypothesis testing of the effect of cognition and emotion on the excess bond premium and, simultaneously, it tests the modelling of cognition and emotion through the animal spirit index.

## Stock Price Animal Spirit Index

The sentiment towards asset prices can be operationalised in a similar way to the simple heuristics model. Indeed, De Grauwe (2012) links the stock market to the general behavioural macroeconomic model through a discounted dividend model and the relationship between dividends and economic output. Alternatively stock prices could be modelled in a financial framework, abstracting the relationship to the real-economy and stressing the market sentiment within the stock market. This latter approach will be employed in this paper. Drawing on the same distinction as previously in the macroeconomic setting, behavioural finance has also proposed the distinction between chartists and fundamentalists (e.g. De Grauwe and Grimaldi, 2005), where chartists extrapolate the price trend of the return and fundamentalists follow a trading rule based on fundamentals. Based on the assumption of market efficiency, so that all information is known at the time and price changes represent new information (Fama, 1970), the fundamentalists expect the market return, representing the risk-free market rate and the necessary equity-premium<sup>5</sup>.

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<sup>3</sup>For a formal derivation of this index see Appendix A.

<sup>4</sup>The smoothing parameter for this filter and the HP filter for the House Price Animal Spirit is determined by the Ravn-Uhlig rule, so that due to the monthly frequency of the data the parameter is set to 129600.

<sup>5</sup>A more sophisticated modelling of the fundamentalist expectation, which has been intended, through an AR(1) trend-stationary dividend process and a dividend growth model (cf. Timmermann, 1996) encountered some issues with the dividend figures of the aggregate market and subsequently created a constant overexpectation of the stock return.

The risk-free market rate is observed, however the equity premium has to be determined. The observed equity premium, the excess market return, cannot be used in this aggregate context. Using the contemporary excess market return, the actual return, which is subtracted subsequently in order to obtain the forecasting error for the determination of the fraction of extrapolating agents, would enter into the determination of the expectation, causing a bias. Also using the previous period excess market return imposes a problem to the analysis, as it would introduce a similar heuristics element into the fundamentalist rule, as the discounting depended on the previous return. This challenge can be overcome in two ways. The first approach uses just the arithmetic average market return in order to derive the entire applied discount rate. The second approach, which will be employed in the analysis, draws on a theoretical derivation of the equity premium, which however will be much lower than the first approach due to the existence of the equity premium puzzle. Outlining the equity premium puzzle, Mehra and Prescott (1985) argue that the equity premium obtained from valid risk-aversion given the risk-free rates, can only be 0.35% annually. Thus the second approach, in contrast to the first one, uses a varying discount rate 0.029% above the monthly varying risk-free rate<sup>6</sup>.

The animal spirit index in this case can be similarly constructed as above, using the utility based on the quadratic loss function of the two rules' deviation from the actual realized return. The only difference is the variable over which it is constructed (Equation 6). The threshold should also be adapted to the new fundamentalist rule, however due to simplicity it remains at zero.<sup>7</sup>

$$\chi_t = \begin{cases} \alpha_{e,t} & \text{if } R_{t-1} \geq 0, \\ 1 - \alpha_{e,t} & \text{if } R_{t-1} < 0 \end{cases} \quad (6)$$

### House Price Animal Spirit Index

Finally, the house price animal spirit index will also be constructed in a similar way to the ones above. However, in contrast to the macroeconomic index and the stock return index, there is no clear fundamental value, such as steady-state output or efficient market prices. House prices lack the dividend element and investment is solely based on capital-gains through price developments. Therefore the fundamentalists rule has to implement a price trend in order to capture this characteristic. This price trend will be obtained similarly to the monthly output gap from industrial production data in the macroeconomic animal spirit index. The nominal house price data obtained from the FMHPI has been adjusted for CPI inflation and subsequently been filtered through a Hodrick-Prescott filter to determine the real trend element, which represents the fundamentalist rule. Equation (7) highlights the fundamentalist rule, where  $HP_t$  is the capital gain from house prices in period  $t$  and  $\tau_t^{HP}$  is the trend component from the Hodrick-Prescott filter of the house price index.

$$E_t^f HP_{t+1} = \tau_{t+1}^{HP}, \quad (7)$$

The extrapolist rule is again a simple extrapolation of the previous return

$$E_t^e HP_{t+1} = HP_{t-1}. \quad (8)$$

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<sup>6</sup>The difference between both approaches is only minimal however, as the resulting animal spirit indices from both figures have a correlation of 0.97.

<sup>7</sup>Estimations have shown that the different thresholds do not have an effect on the animal spirit indices.



Here the animal spirit index is again constructed in a similar fashion, however the threshold is changed due to the importance of capital gains, so that the threshold for optimism or pessimism is the actual trend component from the Hodrick-Prescott filter (see Equation 9).

$$\chi_t = \begin{cases} \alpha_{e,t} & \text{if } HP_{t-1} \geq \tau_{t-1}^{HP}, \\ 1 - \alpha_{e,t} & \text{if } HP_{t-1} < \tau_{t-1}^{HP}. \end{cases} \quad (9)$$

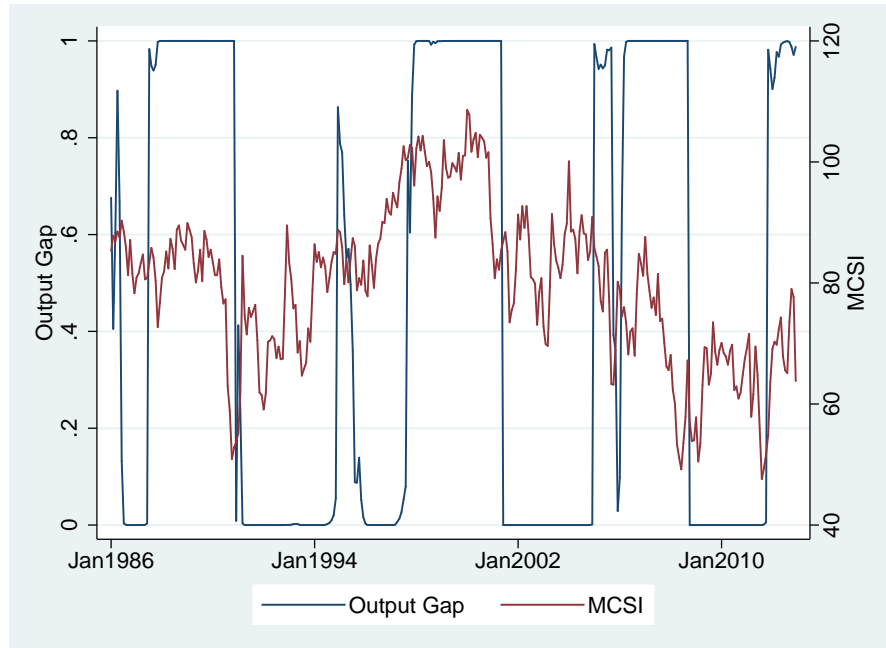
## 4 Results

This section will present the empirical results and analyse these within the light of the theory. It will present the role that the different sentiment measures play in the prediction of the excess bond premium and through this proxy, on the provision of credit. The first part of this section will present the sentiment measures, which have been constructed to quantify sentiment through the concept proposed by De Grauwe (2012). The sentiment measures will be divided in the whole analysis into two blocks, macroeconomic sentiment, which includes the survey data from the MCSI and the animal spirit constructed on the expectations of the output gap. The second block is asset price sentiment, that means animal spirit indices derived from stock and house price data. The second subsection will establish the effect of sentiment on the provision of credit by analysing the three previously established hypotheses, outlining the effect of sentiment on credit provision and disentangling the varying effects of the sentiment measures. The third subsection will then show the robustness checks which have been undertaken to substantiate the results. These robustness checks relate to three potential threats of validity. The first part of this subsection discusses the issue of the identification scheme and how the issue of the limited time sample of the baseline model is overcome through the estimation of basic models without the inclusion of financial intermediaries' health variables. The second part of this subsection then scrutinises the construction of the animal spirit index.

### 4.1 Animal Spirit Indices

The animal spirit measures are derived from the success of the respective fundamentalist or chartist expectations. These expectations deviate substantially in terms of the return that is expected. The figures in Appendix B show the output gap expectations, the stock price expectations and the house return above trend expectations. The fundamentalist expectations in the first and latter are by definition zero, and in the stock price is the fundamental expectation fluctuating along the risk-free rate plus the required equity premium as defined above. The extrapolist expectations differ considerably in the three cases, which is due to the different nature of the variations in the three cases, as the extrapolist expectation only mirrors the lagged return data. The output gap expectations represent the cyclical pattern of the output gap, with long periods above or below the zero output gap. In contrast the stock prices chartist expectations are extremely volatile with frequent reversals of positive and negative sentiment, which resembles the volatility of the stock market, which due to the annualised figures may even be exaggerated. Finally, the house price expectations are very stable in the first period till the early 2000s, with only a brief period in the late 80s to early 90s deviating from trend, and then experiences a spike and a strong fall, showing the strong effects of the subprime mortgage bubble and its burst on the return from house prices above the trend.

Figure 2: Macroeconomic Sentiment Measures



Sources: OECD Main Economic Indicators Production and Sales Database, University of Michigan Consumers Survey Data Base

*a* MCSI refers to the forward-looking component of the Michigan Consumer Sentiment Index.

*b* Macroeconomic Sentiment is calculated following De Grauwe (2012) from an Output Gap constructed through a Hodrick-Prescott Filter of monthly Industrial Production Data.

The patterns of the expectations and returns are subsequently translated in the animal spirit indices. Longer and stronger deviations of the extrapolist rule from the fundamentalist rule derive from the actual variation in the variables and thus increase the success of the extrapolist rule. As a result the animal spirit index is driven to the extremes, where everybody predicts positive or negative deviations from the fundamentalist rule in the future (index of 1 and 0 respectively). The index of 0.5 in the figures represents the state when everybody follows fundamentalist expectations. Figure 2 shows the macroeconomic sentiment measures over time. The animal spirit index reflects the variation of the output gap with relatively long periods above or below potential GDP and is therefore at the extreme levels for long periods, arguing for high levels of positive and negative sentiment. The measure reflects a relatively high degree of extrapolation in the population, which however is not the driver of the following results, as will be shown in the robustness checks in Section 4.3. In comparison the empiric macroeconomic sentiment measure, the MCSI does not move as abruptly but rather evolves smoothly from a positive to a negative state. Nevertheless, both measures move mostly in the same direction.

The asset price animal spirit indices (Figure 3) also resemble the degree of variation of the respective expectations. The stock price animal spirit is extremely volatile and almost appears like a random walk. The high fluctuations in the stock return also imply these strong fluctuations in the animal spirit index due to the construction, on one hand the loss function

Table 4: Correlations Sentiment Measures

	MCSI	Output Gap	House Price	Stock Price
MCSI	1			
Output Gap Animal Spirit	0.224	1		
House Price Animal Spirit	0.173	0.451	1	
Stock Price Animal Spirit	-0.048	0.032	0.079	1

Sources: OECD Main Economic Indicators Production and Sales Database, University of Michigan Consumers Survey Data Base, CRSP, FMHPI, FRED

*a* The Sentiment Measures are constructed as outlined in Section 3.3.

*b* Correlations are calculated over the time from January 1986 till December 2012.

Figure 3: Asset Price Sentiment Measures



Sources: CRSP, FMHPI, FRED

*a* The Sentiment Measures are constructed as outlined in Section 3.3.

of the two expectations changes quickly, and on the other hand, more importantly, the index depends on the previous return, if positive the index will be equal or above 0.5 and if negative it will be equal or below 0.5. This means that if the return fluctuates between positive and negative constantly, the animal spirit index fluctuates constantly between the upper and lower half of the index.

The other asset price sentiment, the house price animal spirit represents the low deviation in the first part of the sample, so that there is hardly any extrapolation in the market, with the exception of the late 80s and early 90s, until the subprime mortgage bubble begins to inflate, when the market extrapolates strongly positively, before this reverses after the burst. The figure in this context illustrates nicely the different focus during the subprime mortgage bubble, with high degrees of extrapolation - deviations from the fundamentals - in the housing

market, leading to speculation and at the same time very stable levels of stock price animal spirits around the entirety of fundamental expectations.

The covariation between the four measures is illustrated over the time by Figure 4, which manifests the link between house price and output gap animal spirit during the subprime mortgage bubble and the Great Recession. It also shows the low covariation between stock price and output gap animal spirit, albeit high levels of extrapolation positive or negative in the stock price animal spirit tend to coincide with high levels of extrapolation in the output gap animal spirit, which is the case in the late 90s and early 2000s, during the dot.com bubble and the early 2010s during the recent stock market hike. The latter one represents then to some extent a deviation from the animal spirit from the MCSI. Viewing the correlations of the four sentiment measures (see Table 4) the high correlation between the output gap and house price animal spirit is striking with 0.451. Nevertheless as previously noticed, much of this correlation will be driven by the subprime mortgage bubble and its burst. The stock price animal spirit due to its high volatility in comparison to the other measures hardly expresses any correlation with the other measures. The macroeconomic animal spirit measure only shares 22.4% of the variation with the MCSI, which according to De Grauwe (2012) is the empiric counterpart of the macroeconomic animal spirit index. However, this low correlation can be explained with the fact that the MCSI with the survey nature is a broader macroeconomic sentiment measure than the animal spirit which just depends on the output gap expectations. Therefore they are both macroeconomic sentiment measures but cannot be viewed as complete counterparts. This additional information in the MCSI could be some kind of news element but also animal spirit that is not captured by the designed animal spirit index, either due to the broader base of the MCSI or due to a more complex nature of this animal spirit.

## 4.2 Sentiment and Credit Provision - The Baseline Model

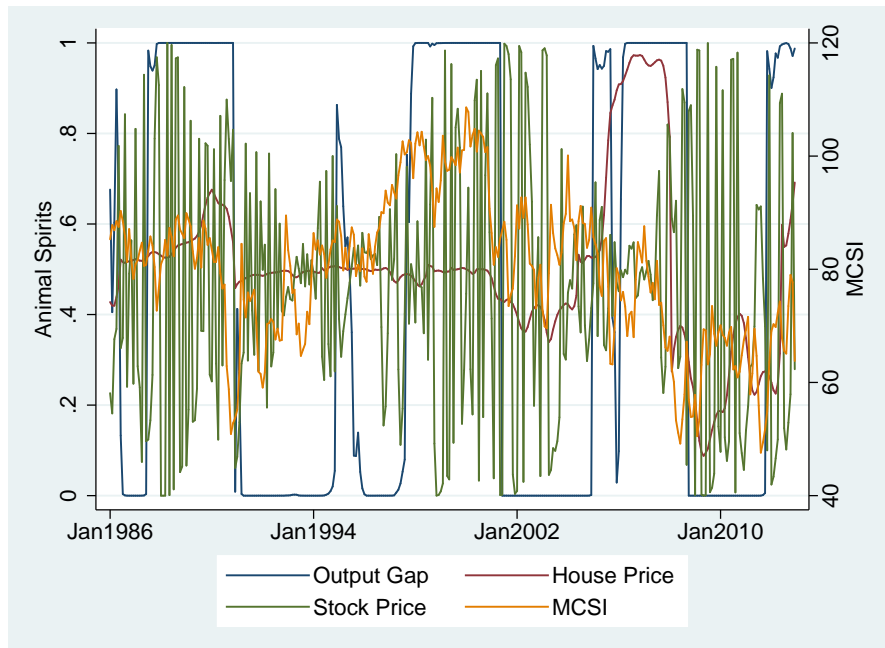
The baseline model serves to analyse the effect of the various sentiment measures on the excess bond premium and through this proxy of the propensity-to-lend on the actual provision of credit. Figures 5 and 6 show the impulse response functions from the four different specifications of the baseline model, differing in the sentiment measure. The subsection will outline the results of the baseline briefly, before discussing the results in the context of the three theoretical hypotheses developed in section two. It will show the positive relationship between sentiment and the propensity-to-lend firstly, then discuss the differences between animal spirit and potential rational information content in the MCSI sentiment measure and finally draw on the distinct effects between macroeconomic and asset price sentiment.

The Figures 5 and 6 show the actual impulse response and a 90% confidence band<sup>8</sup> based on bootstrap estimation with 2000 repetitions for a standard deviation sentiment shock. The first two models comprise the macroeconomic sentiment while the latter two the asset price sentiment. In all four models a standard deviation sentiment shock has a significant effect on the excess bond premium at the 90% significance level. The immediate effects of the sentiment shocks on the excess bond premium are negative in all models and the decrease varies

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<sup>8</sup>90% confidence bands have been applied by similar studies such as Iacoviello (e.g. 2005).

Figure 4: Sentiment Measures



Sources: OECD Main Economic Indicators Production and Sales Database, University of Michigan Consumers Survey Data Base, CRSP, FMHPI, FRED  
*a* The Sentiment Measures are constructed as outlined in Section 3.3.

in magnitude between 0.035 percentage points and 0.07 percentage points for a stock price animal spirit shock and a Michigan Consumer Sentiment shock respectively. The effect of the stock price animal spirit shock is the only case where the immediate effect is not significant at the 90% level, however it gains significance after one month. The peak effects are reached in three of the four models after one to three months, with the exception of the macroeconomic sentiment, where the immediate effect of a 0.05 percentage point decrease represents the peak effect. The effect of the Michigan Consumer Sentiment shock on the excess bond premium is somewhat reversed after one month and then increases again to reach the peak effect of a 0.11 percentage point decrease after two months. The response to the stock price animal spirit shock resembles the reversal and the subsequent increase of the MCSI response, however the reversal occurs after two months instead of one. The peak effect of the stock price animal spirit shock is also a decrease of the excess bond premium of 0.11 percentage points which is experienced both after one and three months. Finally the house price animal spirit shock causes a response of the excess bond premium which differs in the extent that it does not exhibit the reversal. The peak effect of a 0.9 percentage point decrease of the excess bond premium is reached after one month and remains stable for another month. In terms of persistence all models differ widely. The macroeconomic sentiment shock has no persistence and is already insignificant after one month. Moreover, it gains significance again after seven months, however with a positive effect on the excess bond premium. On the other extreme is the other macroeconomic sentiment measure, the MCSI, which exhibits high persistence and remains significantly different from zero for more than a year, thus the sentiment shock has a negative effect on the excess bond premium even after a year. The asset price sentiment measure shocks are less persistent with significantly decreases in the excess bond premium

observed between one and four months after the house price animal spirit shock and one and seven months after the stock price animal spirit shock.

The results presented above confirm the negative effect of optimism on the liquidity premium measured by the excess bond premium and therefore substantiate the postulated argument of the positive effect of optimism on credit provision. A shock of an optimistic nature therefore increases the provision of credit. A pessimism shock on the other hand reduces the provision of credit and can generate a liquidity trap as observed in financial friction models. The credit provision seems to be affected immediately but also with a delay of one to three months where a strong effect can be observed, so that the major effects occur in a time horizon of a quarter at which the probability of the occurrence of a liquidity trap is highest. Nevertheless, the stronger persistence especially at the MCSI and the stock price animal spirit also highlights the potential of a longer existence of a liquidity trap after a sentiment shock. The significance of all animal spirit measures underline the role of sentiment in the provision of credit. Despite the variety of three animal spirit indices, the first one cyclical, the second volatile and the third stable with few deviations (see Figure 4), all of these show significant effects on the varying price of credit. Therefore regardless of the nature of the sentiment, it has an impact on the provision of credit.

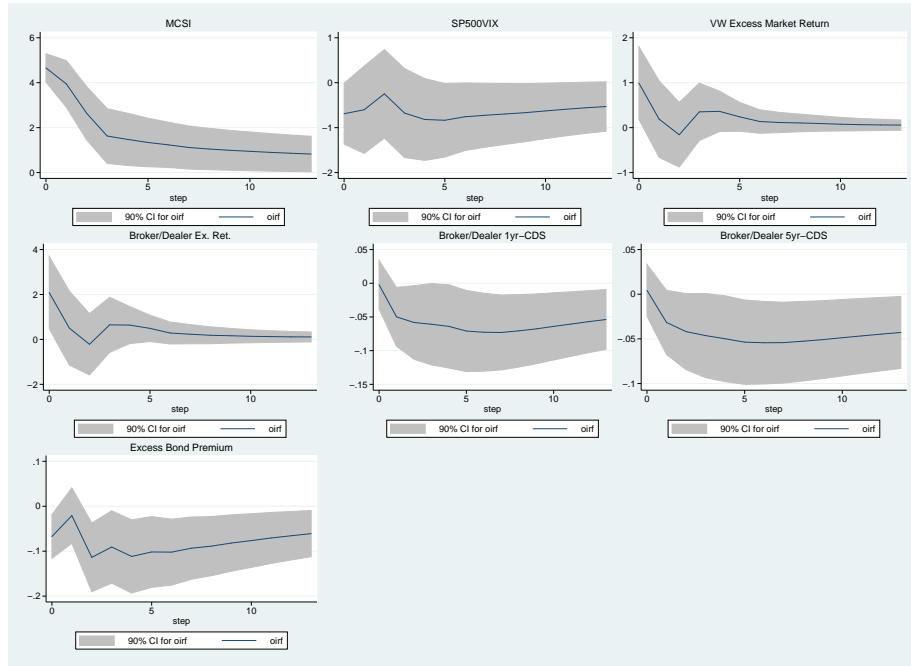
The important role that sentiment plays in the determination of the credit provision raises the issue of how sentiment originates and how it is incorporated, which are related to the second and third hypotheses postulated above. The difference between the macroeconomic sentiment measures in terms of their nature, empirical through surveys in case of the MCSI in contrast to the construction of the animal spirit index on the basis of behavioural macroeconomic theory, allows a deeper analysis of the effect of sentiment. The difference in terms of macroeconomic and asset price sentiment will be discussed below. The effect of the macroeconomic sentiment measures differ widely. The macroeconomic animal spirit shock decreases instantly the excess bond premium but has a positive effect in the long-term, while the MCSI has a persistent negative effect which increases in the second month after the shock. Analysing the incorporation of the sentiment measures in more detail shows further differences and offers a further insight in the incorporation of sentiment through the different channels. The direct effect of the sentiment measure on the excess bond premium as outlined by the VAR coefficients <sup>9</sup> (see Appendix C) shows that the direct effect of the MCSI is mildly positive after one month opposing the prior expectation but exhibits the strong negative direct effect after two months which is double the size of the first month's coefficient. Nevertheless, the positive direct effect results also from a high contemporaneous correlation between the MCSI and the CDS averages (see Table 5) as the incorporation of this sentiment measure offsets the positive effect of the CDS averages on the excess bond premium, which was existent without the sentiment measure. This positive effect however seems to push the excess bond premium after one month up briefly and results in the insignificant effect in this period. More interestingly

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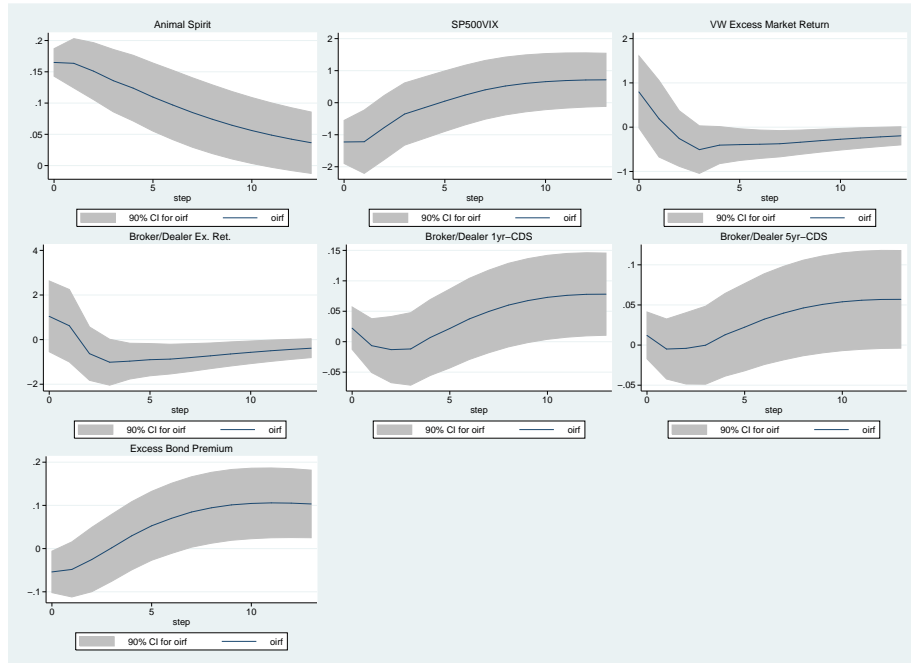
<sup>9</sup>This analysis of the VAR coefficients is pursued due to the information that it offers to the sentiment incorporation, giving an insight into the decision process that is followed by the market. It is recognised that the coefficients only show a partial picture and do not add explicit information to the impulse response functions in terms of the effect on the credit provision. Space constraints limit the ability to analyse the different channels of the effect, so that it is mainly concentrated on the direct effect despite the problem of abstracting from the overall effect.

Figure 5: Macroeconomic Sentiment - Baseline Model

(a) Baseline Model - MCSI



(b) Baseline Model - Macroeconomic Animal Spirit



Sources: Gilchrist and Zakrajsek (2012), OECD Main Economic Indicators Production and Sales Database, University of Michigan Consumers Survey Data Base

*a* Impulse Responses based on the time sample Jan 2003 - Sep 2010

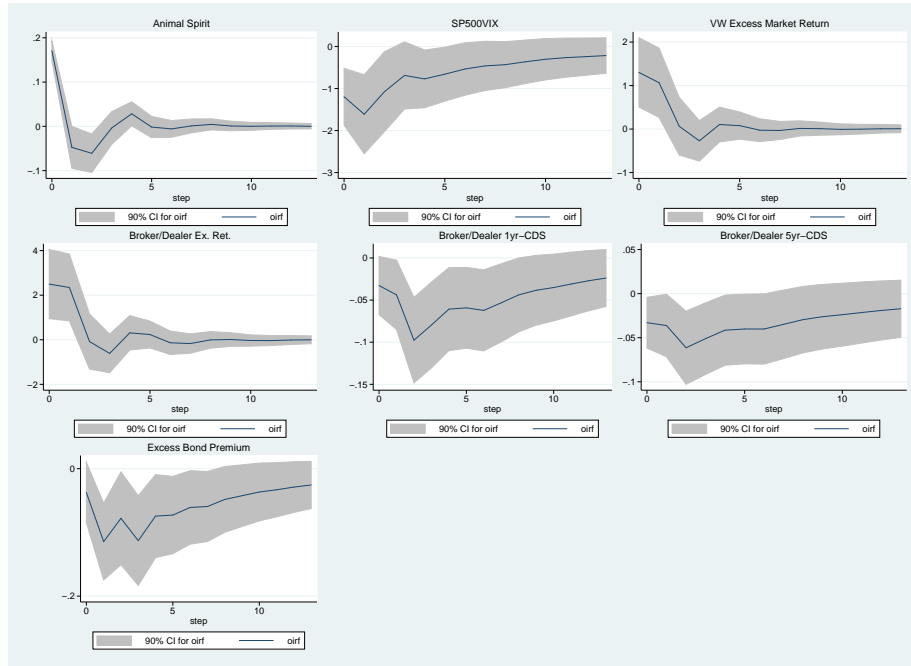
*b* MCSI refers to the forward-looking component of the Michigan Consumer Sentiment Index.

*c* Macroeconomic Sentiment is calculated following De Grauwe (2012) from an Output Gap constructed through a Hodrick-Prescott Filter of monthly Industrial Production Data

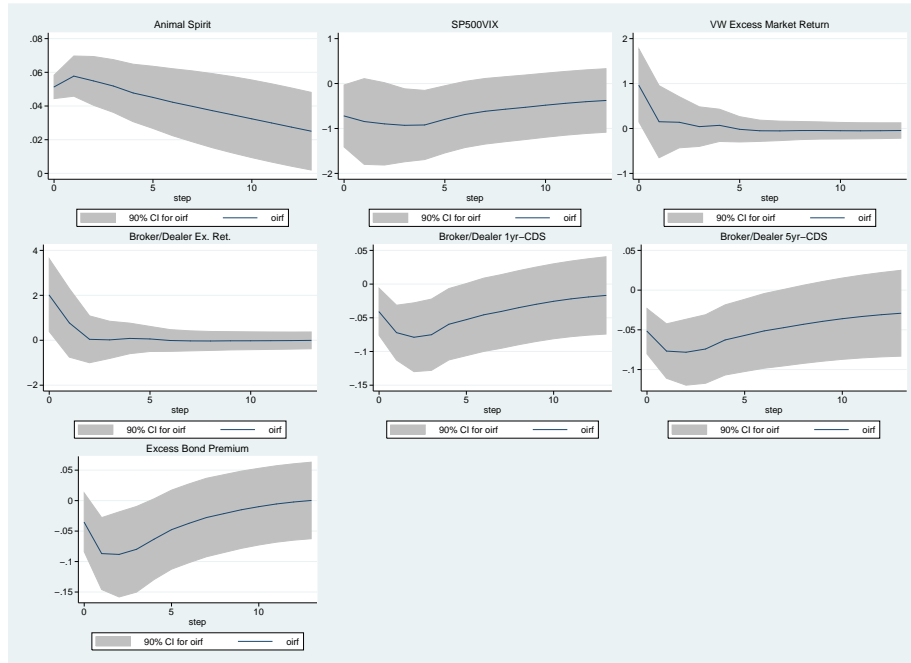
*d* 90% confidence bands are calculated based on 2000 bootstrap repetitions.

Figure 6: Asset Price Sentiment - Baseline Model

(a) Baseline Model - Stock Price Animal Spirit



(b) Baseline Model - House Price Animal Spirit



Sources: Gilchrist and Zakrajsek (2012), CRSP, FMHPI, St. Louis Fed

*a* Impulse Responses based on the time sample Jan 2003 - Sep 2010

*b* Stock Price and House Price Animal Spirits are calculated following De Grauwe (2012) from CRSP return data and a simple fundamentalist rule and from HP filter deviations from inflation adjusted FMHPI data respectively.

*c* FMHPI nominal prices have been adjusted by the US CPI for all items (seasonally adjusted).

*d* 90% confidence bands are calculated based on 2000 bootstrap repetitions.



Table 5: Correlations Macroeconomic Sentiment Measures with CDS averages

	MCSI	Animal Spirit Index
1-year CDS average	-0.722	-0.164
5-year CDS average	-0.743	-0.256

Sources: Gilchrist and Zakrajsek (2012), OECD Main Economic Indicators Production and Sales Database, University of Michigan Consumers Survey Data Base

*a* MCSI refers to the forward-looking component of the MCSI Index.

*b* Animal Spirit is calculated following De Grauwe (2012) from an Output Gap constructed through a Hodrick-Prescott Filter of monthly Industrial Production Data.

*c* Correlations are calculated over the time from January 2003 till September 2010.

however, is the direct effect of the animal spirit index which comprises the expected negative direct effect after one month, but a stronger positive effect after two months. This suggests that the additional information content of the animal spirit index, abstracting from the indirect effects through other variables, is incorporated strongly after one month as expected. Optimism seems to reduce the excess bond premium after one month and thus increases credit provision but then after two months the irrationality of the optimism seems to be recognised and more than reversed. This highlights the role that irrationality plays in the market, however at the same time the rationality of the market which recognises the irrationality quickly and reverses it. Nevertheless, this imposes volatility in the market which is also observed in the overall effect of the macroeconomic sentiment with the long-term positive effect on the excess bond premium. The quick reversal of the overall effect on the excess bond premium after one month despite a negative coefficient is particularly driven by the interaction of the macroeconomic animal spirit measure with the CDS averages, which are affected positively immediate after the shock and then push the excess bond premium up in the first month after the shock. The interaction is further addressed in the robustness checks when the basic model is outlined. This pattern of incorporation and reversal of irrationality exhibited by the direct effects of macroeconomic animal spirits is shared by the asset price animal spirit measures' direct effects. It substantiates the results in terms of the incorporation of animal spirits in the market.

The other striking finding apart from the direct effects on animal spirits on the provision of credit is the different information content between the MCSI measure based on survey data and the macroeconomic animal spirit index. The MCSI as outlined above shares much contemporaneous information with the CDS averages, however also augments the information content for the excess bond premium after two months. The additional information which is not related to the interaction with other variables seems to be incorporated in delayed fashion after two months and not reversed as is the case with the animal spirit sentiment. The additional information content may thus represent the news element outlined by Barsky and Sims (2012) unobservable in other variables which drives the excess bond premium. However, it may also be more complex animal spirit sentiment which is not captured by the simple

construction of the animal spirit index and neither recognised by the agents as being irrational due to the complexity and therefore is not reversed as the animal spirit index is. Due to the induced joint hypothesis by the animal spirit construction, this study cannot answer this question whether the additional information is based on rational information content or complex irrationality. Nevertheless, the analysis shows that while simple animal spirits seem to have an immediate effect as expected and introduce volatility with a long-term opposing effect, more complex sentiment information has a long-term effect as expected despite not being able to determine the nature of the sentiment, rational or irrational.

The third hypothesis proposed is the existence of a stronger effect of asset price sentiment compared to macroeconomic sentiment. This argument is based on the closer relationship between asset market information and the excess bond premium due to the capital market nature of the latter. The previous analysis has shown already, that, on one hand, the direct effects are similar of the three animal spirit measures, and on the other hand, the overall effect of the asset price animal spirit measures are more significant and persistent. It validates the postulated hypothesis not only in terms of the stronger and longer lasting effect, but also in terms of the underlying reasoning. The effect on the excess bond premium shows the importance of asset price animal spirits. Irrational optimism derived from asset prices has a stronger and longer-lasting positive effect on credit provision than macroeconomic irrational optimism. This in the narrative of the liquidity trap highlights that the liquidity constraint will be binding more probably and longer in the presence of an irrationally pessimistic shock in asset price than an irrationally pessimistic shock in macroeconomic sentiment. The underlying reasoning for asset price sentiment, the link to the financial market is substantiated by the similarity of the direct effects while the overall effect varies. The magnitude of the coefficients vary, particularly in the case of the stock price whose first month effect is not more than offset in the second month. However they are relatively similar meaning that the important difference is the interaction with the other variables. The asset price animal spirits are more embedded in the financial market and therefore have a stronger effect on the credit provision than macroeconomic animal spirit.

### **4.3 Robustness Checks**

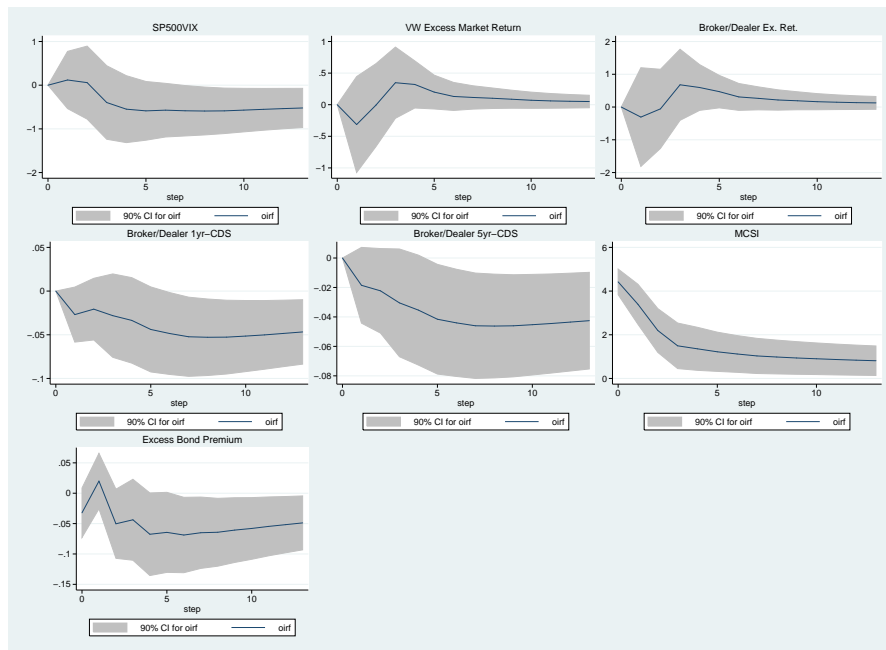
The model is susceptible to three types of critique as mentioned in the empirical strategy, one resembles the general problem of the ordering in VARs, the second relates to the limited time sample used in the baseline model, and the final one is linked to the construction of the animal spirit measure. The former two caveats are addressed through different model specifications which are presented in the first part of this subsection. The animal spirit construction issue is overcome afterwards through the estimation of the macroeconomic baseline model firstly at a quarterly frequency with the actual output gap instead of the industrial production output gap and secondly with animal spirits differing in the degree of choice intensity.

#### **Other model specifications**

The identification does not exhibit the same relevance in this model as in other VARs simply due to the construction of the animal spirit measures, which are based on past information and thus by construction precede the other variables substantiating the ordering with the animal

spirit measure first. The only model specification, which is susceptible to the identification critique is the MCSI specification. Even though the MCSI as a measure of consumer confidence - a sentiment measure - is treated similarly as a state of mind in which context other decisions are made, this argument could be challenged due to simultaneous causality between other variables and the state of mind (see Section 3.2). The state of mind may similarly be affected by the other variables, which argues for an inclusion after the financial market and financial intermediaries' health variables. The inclusion after the other variables just preceding the excess bond premium is outlined in Figure 7. The ordering of the other variables remains unchanged in this model.

Figure 7: Baseline Model - MCSI (Late Sentiment Incorporation)



Sources: Gilchrist and Zakrajsek (2012), University of Michigan Consumers Survey Data Base

*a* Impulse Responses based on the time sample Jan 2003 - Sep 2010

*b* MCSI refers to the forward-looking component of the Michigan Consumer Sentiment Index.

*c* 90% confidence bands are calculated based on 2000 bootstrap repetitions.

Figure 7 shows that the immediate effect is smaller with this change and insignificant, as less variation is attributed to the sentiment shock. In the previous specification all common variation between the variables in the VAR was attributed to the sentiment shock indicating that the variation in the MCSI affects the other variables contemporaneously without being affected by them itself. In contrast this specification attaches only the idiosyncratic share of variation to the sentiment shock. This suggests that the state of mind is not affecting the other variables' variation contemporaneously. As the sentiment is likely to interact with the other variables and containing feedback loops which lead to a dual causality, both specifications should be understood as a band in which the effect of a sentiment shock is to be seen. However, within the narrative of the importance of irrationality, the real effect is more likely to be closer to the former than the latter specification. Nonetheless, this unique variation may still represent rational information which is unobservable in the other variables as Barsky and

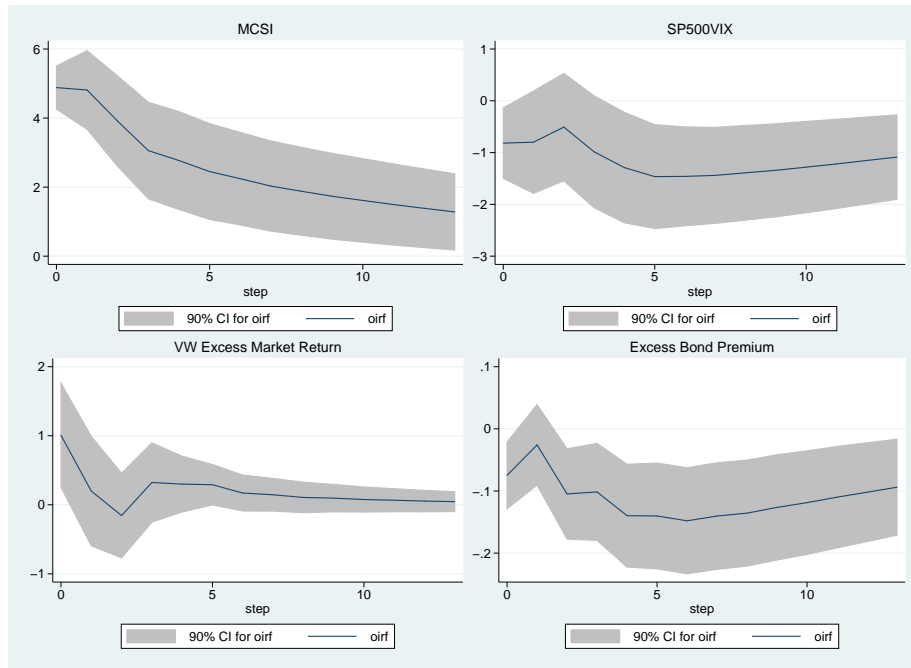
Sims (2012) postulate. The origin of the idiosyncratic variation and the uncertainty about the contemporaneous interaction of sentiment and other variables demands more thorough research in order to identify the actual effect better. As outlined previously much variation of sentiment seems to be contemporaneously shared with the CDS averages. Despite the variation and the uncertainty about the actual immediate interaction of sentiment and the other variables the crucial finding of this robustness check is that long-term persistence holds in either specification. After six months even in this specification, a sentiment shock reduces significantly the excess bond premium. This means it underscores the argument that optimism increases the propensity to lend.

The limited time sample has been extended through the estimation of a basic model without the inclusion of the financial intermediaries' health variables for which the data availability was an issue. The impulse responses of the basic models over the different time-samples which have been estimated do not differ considerably, so that only the main basic model with the time sample from January 1990 to September 2010 is presented (Figures 8 and 9). In the macroeconomic sentiment, due to the equal responses of the baseline and basic model in the baseline time-sample, the similarity of the extended time-sample in the basic model confirms the determined effects of the baseline model. The only difference in the basic MCSI model in all time-samples, however, is a propagation of the decrease of the excess bond premium after the second month so that it reaches the peak effect after six months with 0.16 percentage points. The peak effect of the baseline model seems to be more reliable due to the additional inclusion of the financial intermediaries' health variables. Nevertheless, immediate effect and persistence are equal in this model to the baseline model. The macroeconomic animal spirits overall effects in the impulse responses are all equal to the baseline model and therefore substantiate all the findings of the baseline model. Nonetheless, the direct effects of the coefficients have changed in all the basic models and even the signs have reversed (see Appendix C). Particularly important seems to be in this context the exclusion of the CDS averages which were affected immediately in a positive fashion in the baseline model and then had a positive effect on the excess bond premium one month after. The exclusion of these variables then attributed this positive effect to the animal spirit measure. This highlights the importance of the interaction with the other variables and explains the quick reverse of the overall effect of the shock after one month.

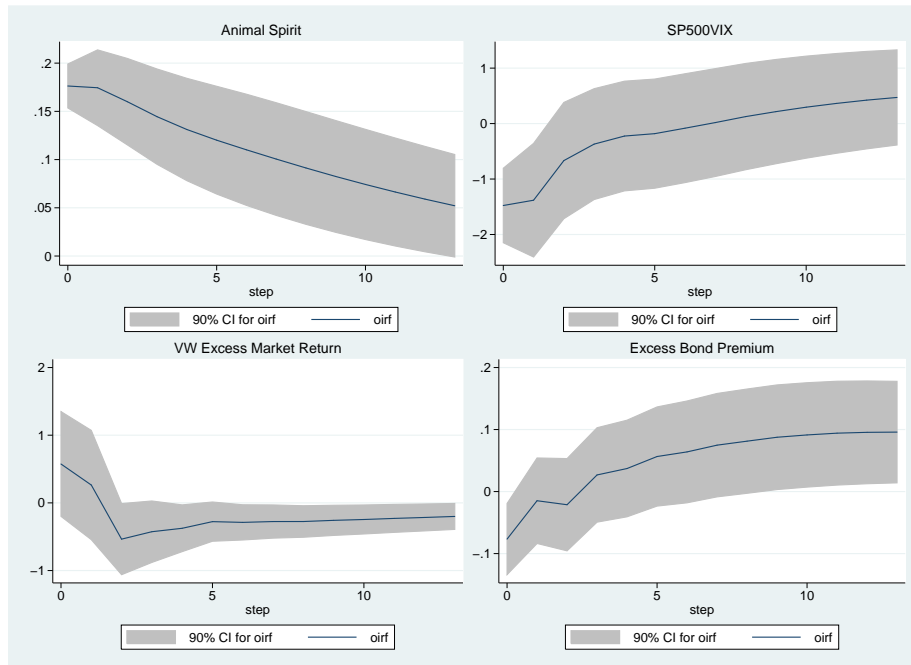
The importance of the other financial market variables is even more crucial in the case of the asset price animal spirit measures. Even though the time-sample extension does not affect the basic models in either case, the basic models deviate from the baseline model. The general positive effect of optimism on credit provision remains unchanged, however the significance is lower in the basic models than in the baseline models. The stock price animal spirit shock only shows significance for one month. While the excess bond premium response resembles roughly the baseline response, the major difference is the lack of the second peak after three months. Similarly in the house price animal spirit model, the sentiment shock does not generate the same peak effect and the effects are not as pronounced as in the basic model, so that in this model the sentiment shock does not create any significant effect on the excess bond premium. These models therefore highlight the importance particularly for asset price sentiment of the indirect effects through the other financial market variables, which generate the peak effects and the persistence. The argument of the stronger effect of asset price sentiment on the excess

Figure 8: Macroeconomic Sentiment - Basic Model (Sample 1990-2010)

(a) Basic Model - MCSI (Sample 1990-2010)



(b) Basic Model - Macroeconomic Animal Spirit (Sample 1990-2010)



Sources: Gilchrist and Zakrajsek (2012), OECD Main Economic Indicators Production and Sales Database, University of Michigan Consumers Survey Data Base, CRSP, K. French Data Library

*a* Impulse Responses based on the time sample Jan 1990 - Sep 2010

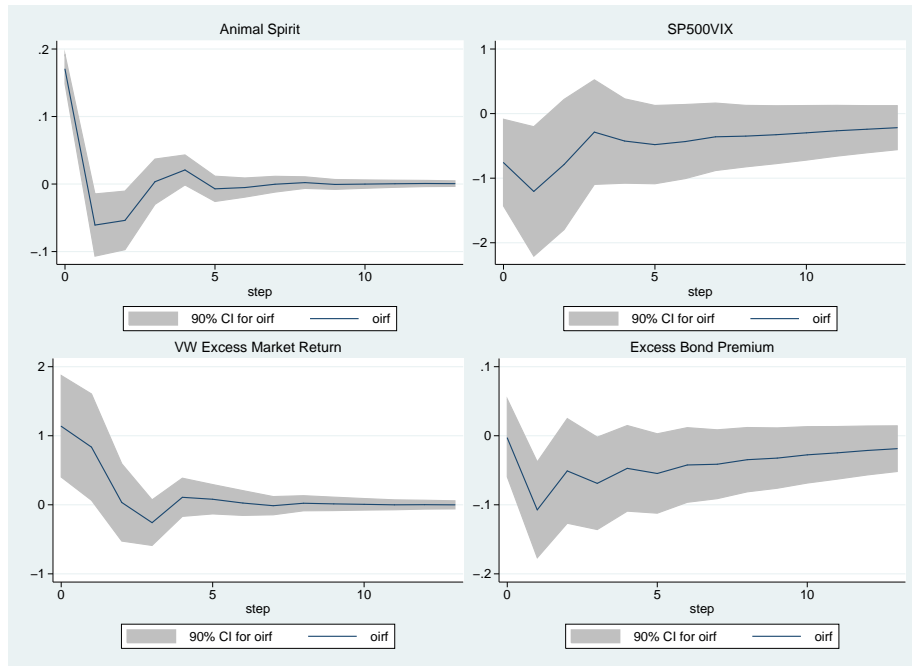
*b* MCSI refers to the forward-looking component of the Michigan Consumer Sentiment Index.

*c* Macroeconomic Sentiment is calculated following De Grauwe (2012) from an Output Gap constructed through a Hodrick-Prescott Filter of monthly Industrial Production Data.

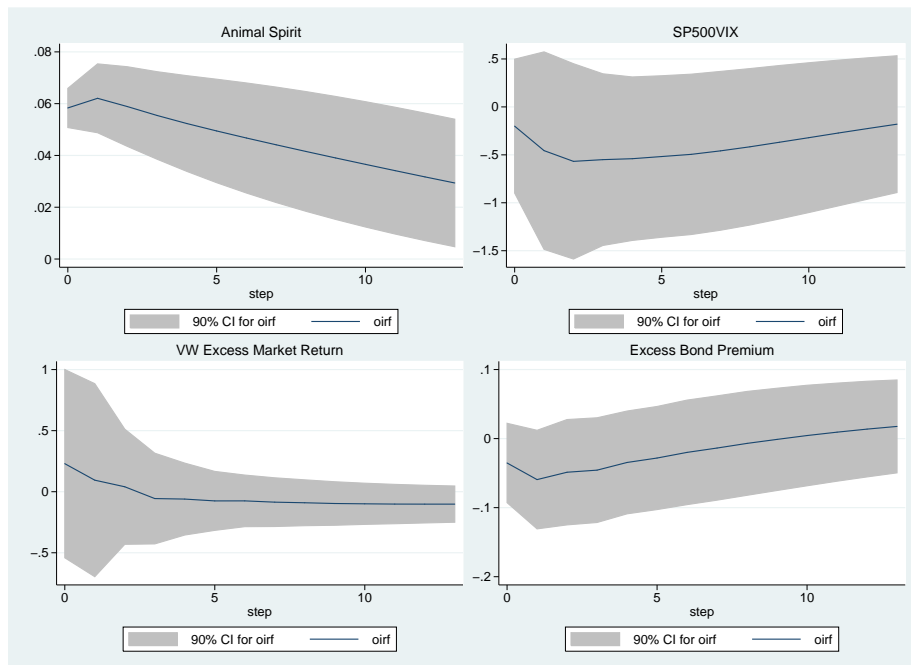
*d* 90% confidence bands are calculated based on 2000 bootstrap repetitions.

Figure 9: Asset Price Sentiment - Basic Model (Sample 1990-2010)

(a) Basic Model - Stock Price Animal Spirit (Sample 1990-2010)



(b) Basic Model - House Price Animal Spirit



Sources: Gilchrist and Zakrajsek (2012), CRSP, FMHPI, St. Louis Fed, K. French Data Library

*a* Impulse Responses based on the time sample Jan 1990 - Sep 2010

*b* Stock Price and House Price Animal Spirits are calculated following De Grauwe (2012) from CRSP return data and a simple fundamentalist rule and from HP filter deviations from inflation adjusted FMHPI data respectively.

*c* FMHPI nominal prices have been adjusted by the US CPI for all times (seasonally adjusted).

*d* 90% confidence bands are calculated based on 2000 bootstrap repetitions.

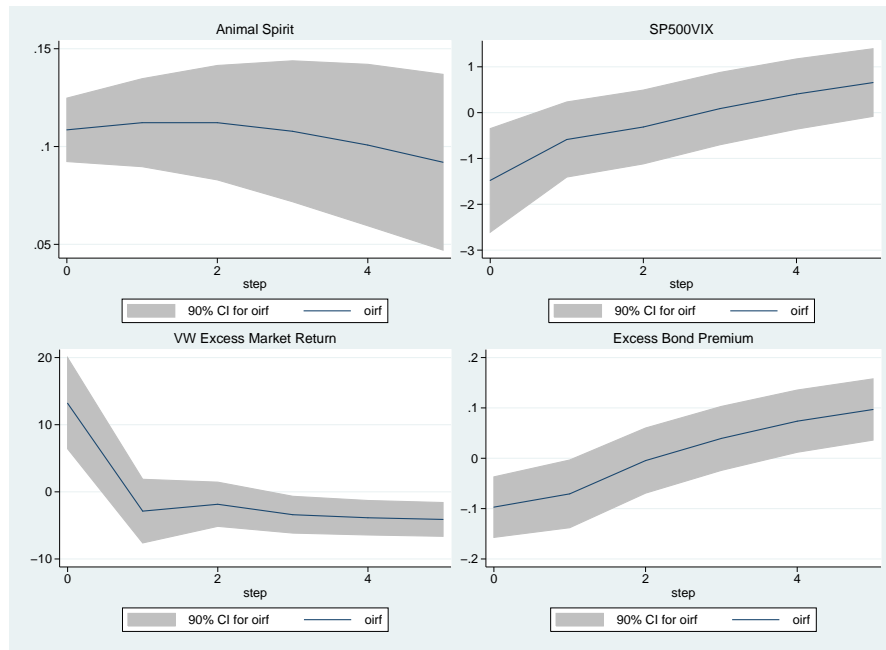
bond premium through a closer proximity to the financial market seems to be supported by the finding of the lower persistence and peak effects in this specification. Even though the macroeconomic sentiment interacts also strongly with the financial market variables, its importance is not comparable to the asset price sentiment's interaction, as the exclusion does not change the actual persistence or effects on the excess bond premium. These findings of the importance of the interaction resemble the amplification effect of financial markets proposed by De Grauwe and Macchiarelli (2013).

### **Different Animal Spirit Construction**

The validity of the results could be affected by the construction of the animal spirit measures, which is particularly the case for macroeconomic animal spirits due to the use of industrial production as a proxy. For this reason a quarterly model has been estimated where the actual output gap could be employed. This model however could only be estimated in the basic setup without the financial intermediaries' health variables. The model is based on the time sample from 1990:1 to 2010:3 and shown in Figure 10. The model is furthermore adapted to the quarterly setup by reducing the lags to only one quarter to be closer to the two months lags of the other basic model. The results show that the effect remains similar, indeed it is more persistent and is still significant after one quarter. This however may also be driven by the slight specification change. Nevertheless it highlights the positive effect of optimism on credit supply and shows that this is not generated by biases through the use of industrial production data as a proxy of the output gap.

The more general issue of animal spirit measures, which applies to all of them, is that they may deviate subject to the value of the variable of interest as explained in Section 3.3 due to the quadratic loss function in the utility. As the final fraction of extrapolists depends both on the utility and a choice intensity parameter (see Appendix A), the uncertainty of the variable formulation can be assessed through varying choice intensity parameters, which yields different degrees of extrapolation. Higher choice intensities lead to a higher fraction of extrapolists at each time. The potential deviation will be assessed as an illustration through the macroeconomic animal spirit measure which was constructed based on the percentage value of the industrial production output gap without applying percentages, i.e. for a 1.5% output gap the value for the animal spirit used was 1.5. The choice intensity was one, as proposed by De Grauwe (2012). As this specification already yielded a relatively high degree of extrapolation in the agents, this robustness check will draw on an output gap measure inclusion of for example 0.015, thus including the percentages. This changing specification allows determining the robustness of the animal spirit measure both to higher and lower degrees of extrapolation. Moreover, it shows directly the comparison of the baseline model and the other potential sensible inclusion of the variable of interest at the same choice intensity. Figure 11 illustrates the animal spirits under different choice intensities, highlighting the positive relationship between degree of extrapolation and choice intensity. Choice intensity one yields a mild variation around 0.5 a completely rational forecast, choice intensity of 1000 reaches an intermediate result between extrapolators and fundamentalists and choice intensity 20000 shows almost completely extrapolating forecasts moving straight from zero to one and vice versa. The baseline model above in this setup is similar to a choice intensity of 10000. The animal spirit measures show similar variations, however especially in the high degree of extrapolation,

Figure 10: Quarterly Output Gap Model -Macroeconomic Animal Spirit



Source: FRED

*a* This model is based on quarters, so that it only includes one lag in order to be more comparable to the previous models with two lags in the monthly setup. The steps in the impulse response functions therefore represent quarters instead of months too.

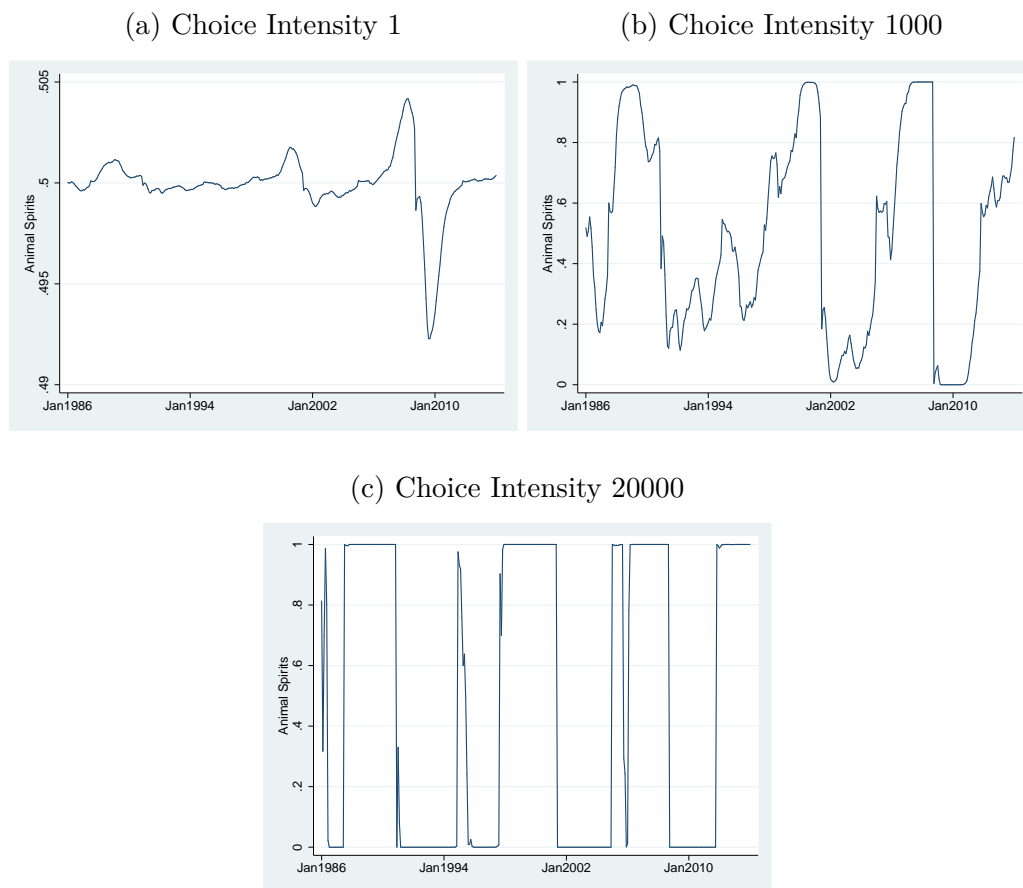
*b* The macroeconomic animal spirit measure is constructed as outlined in Section 3.3.

the variation is limited as it varies almost uniquely from positive to negative between zero and one similarly to a dummy variable and loses some part of the explanatory power.

Figures 12, 13 and 14 show the baseline models with these varying choice intensities. The actual response of the excess bond premium and thus of credit supply is not affected by the construction. The form remains the same and the positive sentiment shock has a negative reaction on the excess bond premium which increases the supply of credit. This effect is significant in the low intensity and intermediate intensity, while the high choice intensity induces insignificance of the effect (see Figure 14). This suggests that the results are particularly robust to a lower degree of extrapolation, however are susceptible to higher degrees of extrapolation. Nevertheless, the degrees of extrapolation needed to reach insignificance do not seem realistic as the whole population then existed only of extrapolators (see Figure 11c). In this case the lack of significance is likely to be caused by the reduced variation in the sentiment measure. Overall the uncertainty introduced through the squared errors in the utility function are therefore no issue, they only result in different degrees of extrapolation to which the results are not susceptible as long as they remain realistic. The degree of extrapolation reached with the baseline setup (see Figure 2) is an intermediately high degree of extrapolation and seems realistic.



Figure 11: Macroeconomic Animal Spirits under different Choice Intensities

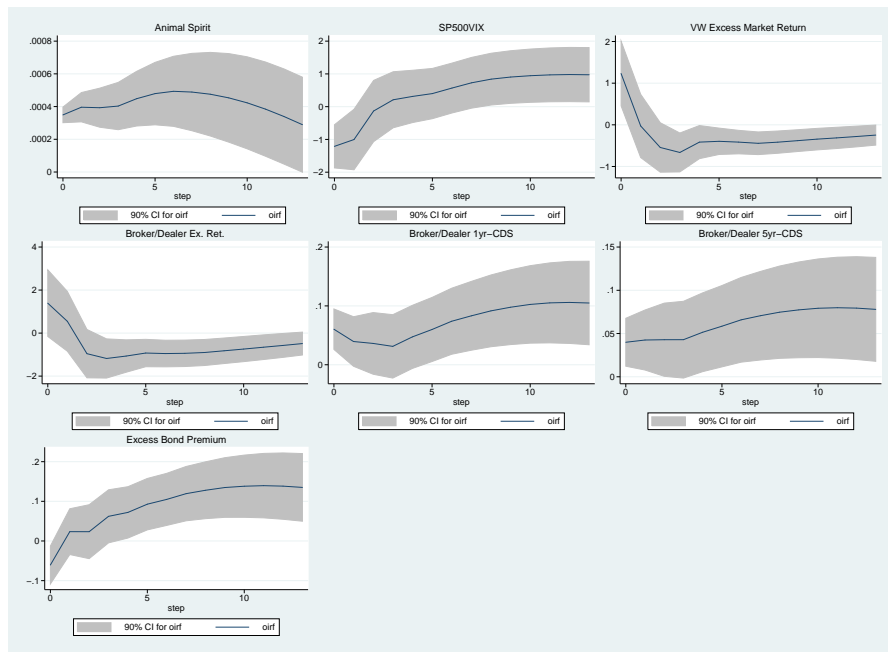


Source: OECD MEI

*a* These animal spirit measures differ from the previous ones as the output gap is measured in actual percentages rather than the value of the percentage. This means a 1.5% output gap enters as 0.015 in these whereas it entered as 1.5 previously. This specification has been adopted to obtain a wide range potential variation through the different choice intensities.

*b* The previous macroeconomic animal spirit as used at choice intensity one, the one used by De Grauwe (2012), resembles a choice intensity of roughly 1000 in this specification.

Figure 12: Baseline Model - Macroeconomic Animal Spirits Choice Intensity 1

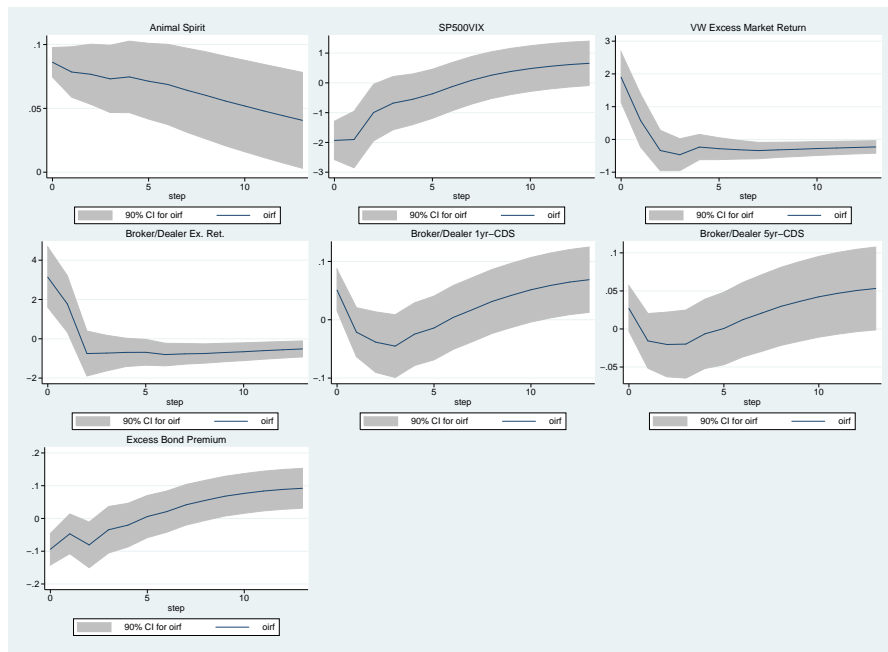


Source: OECD MEI

*a* These animal spirit measures differ from the previous ones as the output gap is measured in actual percentages rather than the value of the percentage. This means a 1.5% output gap enters as 0.015 in these whereas it entered as 1.5 previously. This specification has been adopted to obtain a wide range potential variation through the different choice intensities.

*b* The previous macroeconomic animal spirit as used at choice intensity one, the one used by De Grauwe (2012), resembles a choice intensity of roughly 1000 in this specification.

Figure 13: Baseline Model - Macroeconomic Animal Spirits Choice Intensity 1000

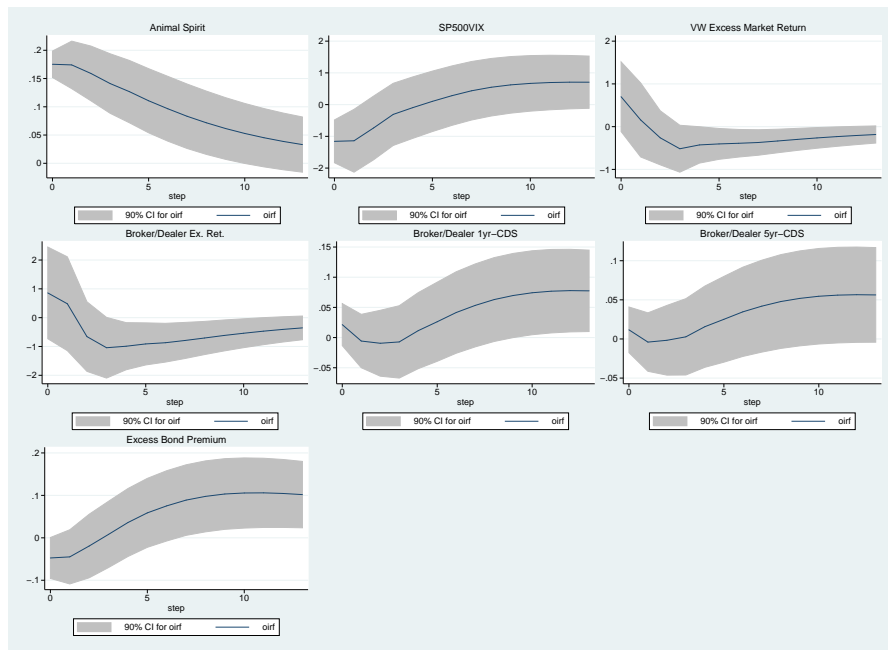


Source: OECD MEI

*a* These animal spirit measures differ from the previous ones as the output gap is measured in actual percentages rather than the value of the percentage. This means a 1.5% output gap enters as 0.015 in these whereas it entered as 1.5 previously. This specification has been adopted to obtain a wide range potential variation through the different choice intensities.

*b* The previous macroeconomic animal spirit as used at choice intensity one, the one used by De Grauwe (2012), resembles a choice intensity of roughly 1000 in this specification.

Figure 14: Baseline Model - Macroeconomic Animal Spirits Choice Intensity 20000



Source: OECD MEI

*a* These animal spirit measures differ from the previous ones as the output gap is measured in actual percentages rather than the value of the percentage. This means a 1.5% output gap enters as 0.015 in these whereas it entered as 1.5 previously. This specification has been adopted to obtain a wide range potential variation through the different choice intensities.

*b* The previous macroeconomic animal spirit as used at choice intensity one, the one used by De Grauwe (2012), resembles a choice intensity of roughly 1000 in this specification.

## 5 Conclusion

Section 2 provided three dimensions for the analysis of the interaction of sentiment with the macroeconomy through the credit channel represented by the propensity-to-lend. The first dimension represents the general importance of sentiment for the willingness-to-lend, while the second dimension draws on the potential distinction of sentiment into animal spirit and news content. Finally, the third dimension acknowledges the potentially varying types of animal spirit between macroeconomic, stock and house price animal spirit.

The results highlight both the overall effect of sentiment on the willingness-to-lend and the variation that exists within sentiment. Increases in all sentiment measures affect the excess bond premium negatively and therefore corroborate the hypothesis that optimism increases the propensity-to-lend. Moreover, these results are robust over longer time-samples, a different identification strategy for the MCSI and varying specifications of the macroeconomic animal spirit measure. The three constructed animal spirit measures vary considerably due to their distinct information on which they are based, which underscores the complexity of sentiment. Nonetheless, all three decrease the excess bond premium highlighting the positive effect of optimism on credit supply regardless of the type of sentiment.

The overall effect can be distinguished both in terms of type of sentiment and type of animal spirit, the second and third dimension respectively of the previous identified dimensions of analysis. The empirical measure (the MCSI) exhibits a strong persistence with a lasting effect of over a year. In contrast, the animal spirit measures have an impact which is quickly reversed. The effect of the animal spirit indices highlight the role irrationality plays in the market, but the reversal shows that this irrationality is quickly acknowledged and reversed. Therefore it introduces volatility, which in the case of optimism caused by macroeconomic animal spirits even leads to a long-term contraction of credit supply. The response of credit to the MCSI lacks this reversal, which suggests the existence of more complex information in this sentiment than in the simple animal spirit measures. The explanation of the contrasting reaction of the MCSI with respect to the reaction to the animal spirit is aggravated by a caveat of the animal spirit index construction. This caveat links to the joint hypothesis that is tested through the theoretical construction of the animal spirit index, which means simultaneously testing for the importance and the validity of the simple construction of this index. The difference between the MCSI and the animal spirit index can therefore be linked to the simple construction of animal spirit which does not capture the entirety of the complexity of behavioural sentiment. It may on the other hand however indicate the importance of non-behavioural sentiment substantiating the inclusion of rational information through the sentiment index. Therefore the paper cannot positively test the value of the news element in the MCSI but rather only corroborate the importance of animal spirits.

The distinction between the types of animal spirits show, that asset price information seems to be propagated more through other financial market variables than the macroeconomic sentiment, despite the latter possessing a close interaction with CDS averages. The interaction with other financial market variables increases the persistence of animal spirits and therefore the asset price animal spirits are more persistent than macroeconomic animal spirits.

This paper introduces a number of new avenues for further research. The most prominent can be seen to be the question of the complexity of sentiment, among others the issue of the news element or behavioural element in the information of the MCSI that is not contained in the simple animal spirit index, calling for a better measurement of animal spirit in this context. Moreover, the paper concentrated mainly on the direct effect of the sentiment measures due to space constraints and only briefly outlined the variation in other variables. Future research can also develop this interaction further. Finally linked to the sentiment side, microdata could be used to corroborate the results or to improve the ability to capture the complexity of sentiment. On the credit supply side, the paper has shown that sentiment is one of the determinants of the excess bond premium. A natural avenue for further research would be, based on the credit spread puzzle, how much of the credit spread is explained by sentiment compared to other variables.

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## A Macroeconomic Animal Spirit

### Expectations

The animal spirit measure as proposed by De Grauwe (2012) based on the use of heuristics, rules-of-thumb, allows for both cognitively bounded agents who extrapolate past results of GDP and fundamentalists who predict the steady-state output gap, which can be normalised at zero so that the two rules are specified as follows.

*Extrapolist Expectation*

$$\tilde{E}_t^e y_{t+1} = y_{t-1} \tag{10}$$

*Fundamentalist Expectation*

$$\tilde{E}_t^f y_{t+1} = 0 \tag{11}$$

### Evaluation of the Expectations

The agents evaluate the performance of their expectations continuously and may change their expectation behaviour. The agents compute the utility of their forecasts, based on the mean squared forecasting errors of their respective rule through a quadratic loss function, with a weight ( $\omega_k$ ) representing the tendency to forget errors further in the future.



## Loss Functions

### Utilities

#### *Fundamentalist Utility*

$$U_{f,t} = - \sum_{k=0}^{\infty} \omega_k [y_{t-k-1} - \tilde{E}_{t-k-2}^f y_{t-k-1}]^2$$

#### *Extrapolist Utility*

$$U_{e,t} = - \sum_{k=0}^{\infty} \omega_k [y_{t-k-1} - \tilde{E}_{t-k-2}^e y_{t-k-1}]^2$$

## Decision Making

The actual decision which expectation rule to follow is determined by the deterministic component of the utility and a random component  $(\epsilon_{f,t}, \epsilon_{e,t})$ , representing the state of mind which may induce the use of one expectation rule or the other, despite better performance of the other rule.

#### *Use of Fundamentalist Rule's Probability*

$$\alpha_{f,t} = P[U_{f,t} + \epsilon_{f,t} > U_{e,t} + \epsilon_{e,t}]$$

#### *Use of Extrapolist Rule's Probability*

$$\alpha_{e,t} = P[U_{e,t} + \epsilon_{e,t} > U_{f,t} + \epsilon_{f,t}] = 1 - \alpha_{f,t}$$

## Fraction of agents using each Expectation

Drawing on discrete choice theory and assuming the random components to be logistically distributed, the probabilities and subsequently fractions of agents, who use each rule, are then given as follows, where  $\gamma$  is an intensity of choice parameter.

#### *Fundamentalist Fraction*

$$\alpha_{f,t} = \frac{\exp(\gamma U_{f,t})}{\exp(\gamma U_{f,t}) + \exp(\gamma U_{e,t})}$$

#### *Extrapolist Fraction*

$$\alpha_{e,t} = \frac{\exp(\gamma U_{e,t})}{\exp(\gamma U_{f,t}) + \exp(\gamma U_{e,t})} = 1 - \alpha_{f,t}$$

## Animal Spirit Index

The animal spirit index, which corresponds to the sentiment index, is constructed so that depending on the fraction of optimistic or pessimistic extrapolators, the index fluctuates between zero and one, representing both the absence of fundamentalists in the case of pessimistic or optimistic extrapolation respectively. This is formalised as follows.

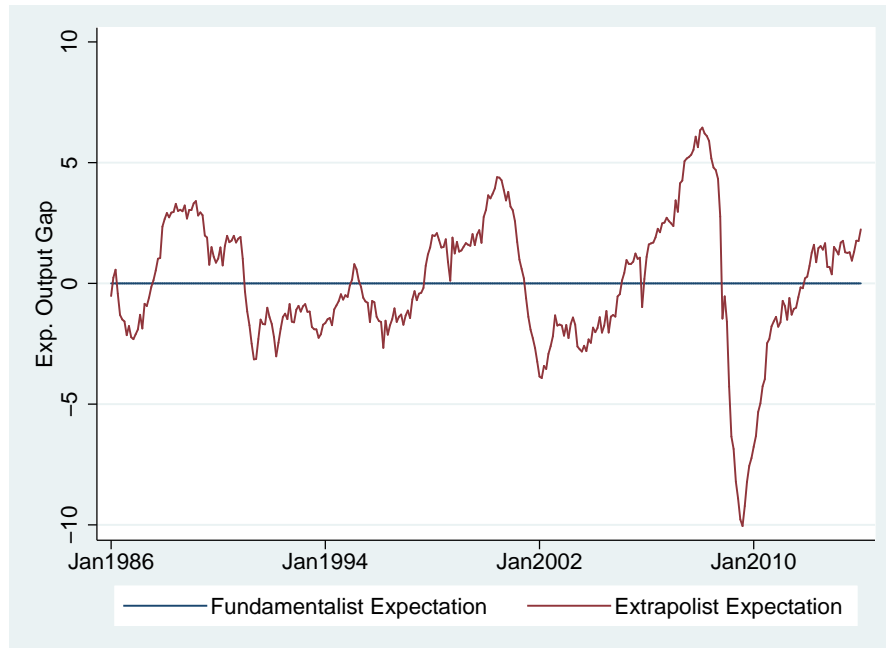
$$\chi_t = \begin{cases} \alpha_{e,t} & \text{if } y_{t-1} \geq 0 \\ 1 - \alpha_{e,t} & \text{if } y_{t-1} < 0 \end{cases}$$

## Asset Price Animal Spirit Indices

The other animal spirit indices follow the same pattern. The only difference are the expectations which underly the different variables (stock return and excess trend house price increase) and are formed as explained in the text. The variable in the loss function changes in line to with this variables to the return instead of output gap.

## B Fundamentalist and Extrapolist Expectations

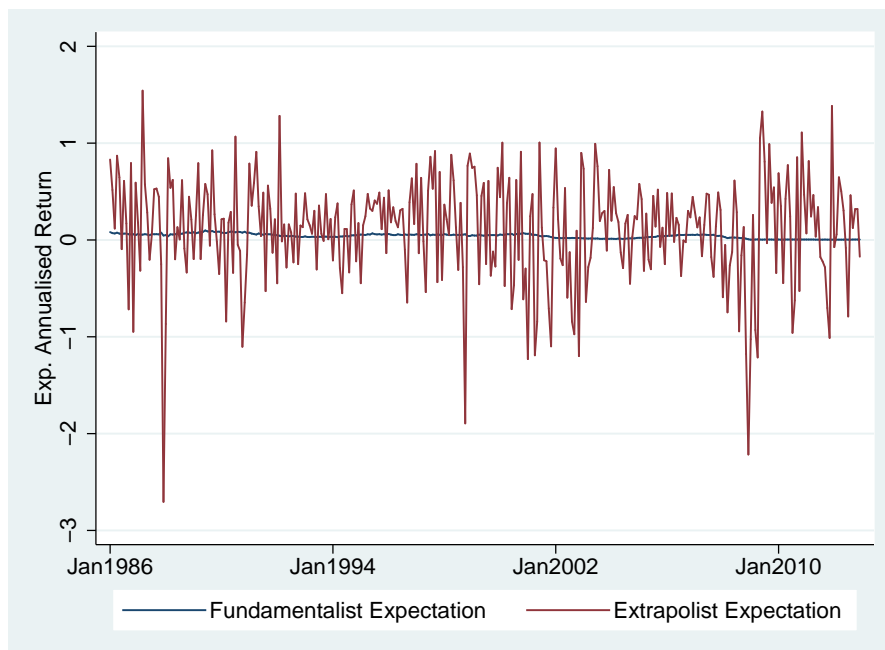
Figure 15: Output Gap Expectations



Source: OECD MEI

- a* The date refers to the predicted date not the date when the prediction was made.
- b* The fundamentalist expectation is a zero output gap.
- c* The extrapolist expectation is the past output gap extrapolated into the future. Therefore the expectation at each date is formed one month before and reflects the output gap two months before each date.

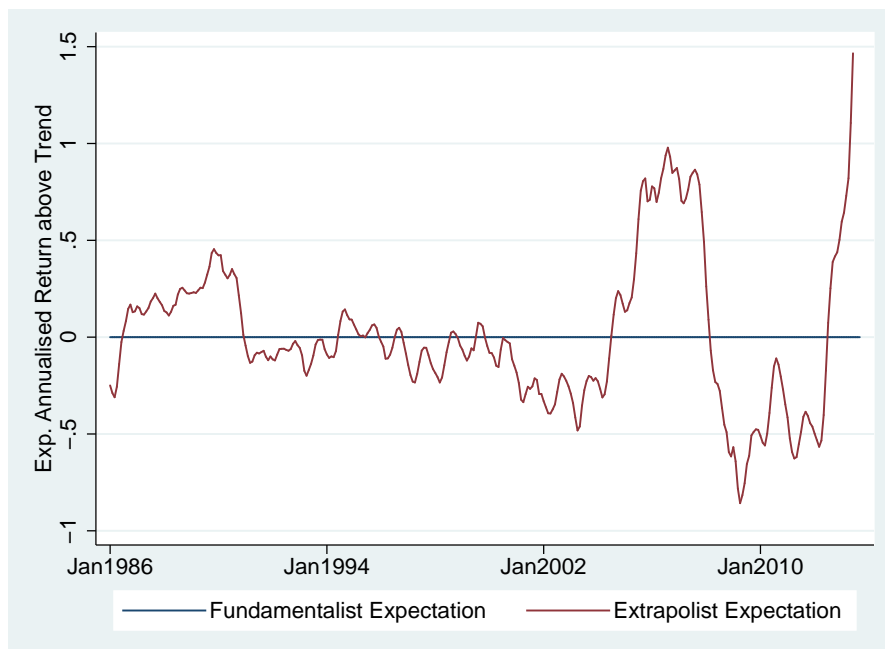
Figure 16: Stock Price Expectations



Source: CRSP

- a* The date refers to the predicted date not the date when the prediction was made.
- b* The fundamentalist expectation is the risk-free rate at the previous month plus an equity-premium of 0.35% annually.
- c* The extrapolist expectation is the past value-weighted return extrapolated into the future. Therefore the expectation at each date is formed one month before each date and represents the value-weighted return two months before.

Figure 17: House Price Expectations



Sources: FMHPI, FRED

- a* The date refers to the predicted date not the date when the prediction was made.
- b* The fundamentalist expectation is the trend element of the HP-Filter, thus a zero deviation from the trend.
- c* The extrapolist expectation is the past trend deviation from real house price return extrapolated into the future. Therefore the expectation at each date is formed one month before each date and represents the value-weighted return two months before.

## C VAR Coefficients

Table 6: VAR Coefficients - Excess Bond Premium Equation - Basic Model (1990-2010)

	MCSI	Macroeconomic Animal Spirit	Stock Price Animal Spirit	House Price Animal Spirit
Sentiment Lag 1	0.00849 (1.22)	0.341 (1.60)	-0.426* (-2.12)	-0.619 (-1.03)
Sentiment Lag 2	-0.0193** (-2.71)	-0.168 (-0.79)	0.152 (1.22)	0.648 (1.10)
S&P500VIX Lag 1	0.0126 (1.07)	0.0222 (1.70)	0.0120 (0.98)	0.0135 (1.05)
S&P500VIX Lag 2	-0.0187 (-1.68)	-0.0166 (-1.34)	-0.0205 (-1.80)	-0.0184 (-1.55)
VW Ex. Market Ret. Lag 1	-0.0266* (-2.14)	-0.0177 (-1.36)	-0.0213 (-1.69)	-0.0227 (-1.72)
VW Ex. Market Ret. Lag 2	-0.0124 (-1.37)	-0.00390 (-0.41)	-0.0307* (-2.12)	-0.00574 (-0.58)
Ex. Bond Premium Lag 1	0.403*** (3.81)	0.416*** (3.76)	0.464*** (4.43)	0.434*** (4.00)
Ex. Bond Premium Lag 2	0.380*** (3.46)	0.415*** (3.72)	0.447*** (4.07)	0.464*** (4.16)
<i>N</i>	91	91	91	91
<i>R</i> <sup>2</sup>	0.868	0.860	0.863	0.854

*t* statistics in parentheses, constant and September 2008 dummy omitted in this table

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Table 7: VAR Coefficients - Excess Bond Premium Equation - Baseline Model

	MCSI	Macroeconomic Animal Spirit	Stock Price Animal Spirit	House Price Animal Spirit
Sentiment Lag 1	0.00644 (1.04)	-0.194 (-1.00)	-0.259 (-1.49)	-0.320 (-0.58)
Sentiment Lag 2	-0.0129* (-2.08)	0.303 (1.59)	0.172 (1.55)	0.451 (0.82)
S&P500VIX Lag 1	0.0103 (0.85)	0.00452 (0.35)	0.00903 (0.75)	0.00962 (0.78)
S&P500VIX Lag 2	-0.0186 (-1.70)	-0.0101 (-0.85)	-0.0224* (-2.01)	-0.0185 (-1.64)
VW Ex. Market Ret. Lag 1	-0.00437 (-0.27)	-0.00635 (-0.39)	-0.00280 (-0.17)	-0.00297 (-0.18)
VW Ex. Market Ret. Lag 2	0.00384 (0.34)	0.0121 (1.02)	-0.00459 (-0.33)	0.0112 (0.89)
BD Ex. Return Lag 1	-0.00998 (-1.62)	-0.00733 (-1.17)	-0.00954 (-1.51)	-0.00825 (-1.30)
BD Ex. Return Lag 2	-0.0125 (-1.94)	-0.0131* (-2.00)	-0.0158* (-2.39)	-0.0145* (-2.08)
BD CDS 1-year Lag 1	0.578 (1.71)	0.489 (1.45)	0.510 (1.52)	0.447 (1.30)
BD CDS 1-year Lag 2	0.0597 (0.17)	0.00234 (0.01)	0.132 (0.38)	0.00375 (0.01)
BD CDS 5-year Lag 1	0.0936 (0.21)	0.362 (0.82)	0.167 (0.37)	0.310 (0.67)
BD CDS 5-year Lag 2	-0.423 (-0.91)	-0.493 (-1.08)	-0.389 (-0.86)	-0.361 (-0.74)
Ex. Bond Premium Lag 1	0.263* (2.36)	0.246* (2.17)	0.262* (2.34)	0.273* (2.40)
Ex. Bond Premium Lag 2	0.271** (2.62)	0.333*** (3.33)	0.291** (2.84)	0.332** (3.28)
<i>N</i>	91	91	91	91
<i>R</i> <sup>2</sup>	0.914	0.913	0.914	0.910

*t* statistics in parentheses, constant and September 2008 dummy omitted in this table

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$