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Abstract

We analyze the effects of financial shocks on economic development in the Euro area and the Netherlands in particular. We develop VAR models that take account of feedback loops between financial market conditions and the real economy. These feedback loops operate via the aggregated Euro area level and affect the Dutch economy. Our empirical analysis is twofold as we analyze industry as well as GDP level data. Financial shocks are measured as shocks to corporate bond spreads and implied volatility. Bond spread shocks are found to have direct consequences for real economic development, with a 25 basis points shock giving an effect on industrial production of -0.6% after one year, and -1.35% after four years. A pure volatility shock seems to imply only higher uncertainty about future developments. Applying these figures to the financial crisis of 2008 shows that the model underpredicts the negative effects of the crisis.
JEL: G15, G01, F36
Keywords: Financial crisis, financial shocks, finance and real economic activity

Abstract (Nederlands)

We analyseren de effecten van financiële schokken op de economische ontwikkeling in de eurozone en Nederland in het bijzonder. De in deze bijdrage ontwikkelde VAR-modellen houden rekening met feedback loops tussen de financiële markten en de reële economie. De feedback loops opereren zowel via de geaggregeerde Eurozone als ook via de Nederlandse economie. Onze empirische analyse is tweeledig. We analyseren data voor de industrie en het BBP. Financiële schokken worden gemeten als schokken op de spreiding van de rentevoet op bedrijfsobligaties en op de impliciete volatiliteit op de aandelen beurs. Schokken op de spreiding van de rentevoet hebben ernstige gevolgen voor de reële economische ontwikkeling, waarbij een schok van 25 basispunten in de spreiding een effect heeft op de industriële productie van -0.6% na één jaar, en van -1.35% na vier jaar. Schokken in de volatiliteit lijken alleen een hogere onzekerheid over toekomstige ontwikkelingen te impliceren. Toegepast op de financiële crisis leidt dit model tot een effect op de industriële productie van -4.2% na één jaar en -9.7% na 4 jaar. Een vergelijking met het feitelijk effect van -17% na 7 maanden toont de gebreken van het model voor het voorspellen van de effecten van financiële crises.
JEL: G15, G01, F36
Trefwoorden: Financiële crisis, financiële schokken, financiewezen en reële economische activiteit

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1 Introduction

The financial crisis that started with the collapse of the U.S. sub-prime real estate markets in 2007, had a rather substantial impact on the real economy from 2008 on. This includes the development in production, trade, consumption and other important real economic variables as well as the activity of researchers in economics. By now, the crisis has inspired a tremendous number of publications dealing with the influence of financial shocks on real economic activity. An important question is to what extent the effects of a financial crisis on real economic variables can be predicted, once the crisis has occurred.

Our analysis differentiates between a supranational and a national level of real economic activity. The former corresponds to the Euro area level while the latter considers the Dutch economy. Regarding financial markets, our empirical approach makes use of supranational variables for the Euro area. We *believe* important financial developments take place at that level of aggregation as the Euro area defines a capital market shaped by a common monetary policy for all member countries. Our model allows for interactions between real economic development and financial markets at the supranational level. At the same time the model allows for reactions of national economic variables to changes in supranational aggregates and vice versa if there are any. This makes our model suitable for analyzing a small open economy as the Netherlands as part of a larger aggregate as the Euro area.

With regard to real economic activity we have two main lines of investigation. First, we look at industry data as an important contribution to an economy's value added. Second, we look at the aggregated economy analyzing GDP data. Our data sample suffers from the rather short time series since the introduction of the Euro. However, looking at industrial production provides us with data at monthly frequency. This data environment is helping our analysis not to suffer too much from the low degrees of freedom problem. Furthermore, looking at industry data is interesting by itself as it seems that the financial turmoil after 2008 affected industry particularly strong. But industrial production might not be representative for the economy as a whole. That is why we additionally analyze GDP data in this contribution. Given the short time horizon, we deal with the low degrees of freedom problem by applying suitable Bayesian estimation techniques.

At the industry level, we focus on Euro area and Dutch industrial production, Dutch turnover and new orders of capital goods as well as Dutch industry employment. As said before, industrial production might not be representative for the Euro area. It is nevertheless an important part of these economies and might be especially exposed to financial market conditions. According to the World Bank, value added from manufacturing in the Netherlands accounted for some 13% of GDP in 2010.[1] Industry accounted for some 860 thousand employees by 2009, total employment in the Dutch economy at the same time stood at about 8.7 mln. people.[2] Industrial production is to a large extent characterized by the production of investment goods. 37% (28%) of Dutch intra (extra) EU exports are due to machinery and transport equipment.[3] This makes industrial production dependent on global economic and financial conditions. The effects of financial turmoil could be witnessed during the months following the bankruptcy of Lehman Brothers Inc.; industrial production collapsed by almost 20%.

While industry is an important part of the Dutch economy, it is not its largest. GDP is in general of interest too, as it reflects the development of the total economy. Typically, GDP data deserve the

[1] Indicator NV.IND.MANF.ZS at http://databank.worldbank.org/.

[2] Centraal Bureau voor de Statistiek, CBS: `http://statline.cbs.nl`. Industry excluding energy and construction.

[3] Data from Eurostat International Trade database, http://epp.eurostat.ec.europa.eu/portal/page/portal/international_trade/data/database.

most attention in the public debate. GDP is more diversified across economic activities and hence, is less volatile than industrial production. We extend our analysis beyond industry and look also at the total Dutch economy. Regarding the modeling strategy, we do this in a similar fashion as for industry. Real economic activity is measured in our empirical model at the supranational level by Euro area and at the national level by Dutch GDP as well as Dutch total employment and investments.

We estimate our empirical models for industry and GDP related data combined with standard measures of financial conditions. Shocks to financial conditions are associated with financial market shocks. In agreement with our review of the literature, we measure financial conditions by a Euro area BBB corporate bond spread over comparable AAA rated securities and implied stock market volatility. Shocks to these variables capture collateral risk, bank risk, and private sector precautionary behavior. We contribute to the literature by providing estimates for the relationship between financial conditions and real economic activity for the Netherlands and the Euro area. Existing contributions, which we review below, focus almost exclusively on the U.S. economy.

Our main findings are as follows. Estimating the model with data up to 2008, shocks to the corporate bond spread have significant impact on real economic variables at the supranational and the national level. This holds both for industrial production and GDP. Furthermore, national investments and employment are affected. We estimate effects of a bond spread shock affecting industrial production more than aggregated GDP. In our industry model effects are significantly different from zero at the 95% confidence level, but confidence bands for impulse response functions are wide, especially at the longer time horizon. Qualitative results from the GDP analysis are similar, but error bands from our Bayesian estimation are considerably wide. Volatility shocks almost exclusively increase uncertainty about the expected development of the economy, but do not affect the expectation itself by much. Predicting the crisis from the model yields only limited success. We simulate the effects of a 180 basis points shock to the corporate bond spread which compares to the development after Lehman's bankruptcy in 2008. The predicted value for the loss in industrial production for the Netherlands would have been around 4.2 and 9.7% after 12 and 48 months. Actually, we witnessed a decline in Dutch industrial production of 17% within 7 months beginning with September 2008.

The literature distinguishes several channels to be represented by appropriate variables in an empirical model, viz. the financial accelerator, the bank lending channel, and macroeconomic volatility. The theoretical reasoning behind the financial accelerator mechanism has its roots in the contributions of Fazzari et al. (1988), Bernanke et al. (1996) and Kiyotaki and Moore (1997). Its success in macro-financial modeling is at least due to its appealing intuition.[4] The theoretical framework for this mechanism is based on the assumption of imperfect capital markets. The imperfection implies the lender's demand for some form of collateral provided by the borrower. Assuming further that the value of the provided collateral is procyclical introduces an "accelerator" effect. In periods of a booming economy its value increases while it falls during downturns with corresponding consequences for the borrower's investment and economic activity possibilities. It is this procyclicality, combined with macro shocks, that has received much attention during the recent years in macroprudential work (see e.g. Caruana (2010)).

The bank lending channel looks at the supply side of credit. For the bank lending channel

[4]By now there are several theoretical applications of this theory. Aghion et al. (2001, 2004a,b) and Schneider and Tornell (2004) relate the mechanism to currency crises. Cooley and Quadrini (2006), Matsuyama (2007) and Manova (2008) analyze the mechanism in models of heterogeneous firms and investment projects. Models that deal with contagion through financial accelerator mechanism can be found in Kyle and Xiong (2001), Paasche (2001), Boissay (2006) and Fostel and Geanakoplos (2008). Lorenzoni (2008) and Caballero and Krishnamurthy (2001, 2003) deal with the nature of capital market imperfections in this mechanism. Although these contributions are not directly linked to our empirical approach, they do highlight the importance of the mechanism.

to be operative, two conditions have to be satisfied: bank loans and market finance are imperfect substitutes, and banks react to a shortage of loanable funds by cutting back loans. In a financial crisis banks may become undercapitalized. This affects the degree to which banks can take risks in their interaction with firms and households. This drives up the cost of capital for the bank and forces it to cut back its risky loans (Thakor, 1996). There is substantial micro econometric evidence that shocks to bank capital do affect bank loan supply, both for large and small banks (Bernanke and Lown, 1991; Peek and Rosengren, 1995; Altunbaş et al., 2002). In addition, under-capitalized banks appear to charge higher interest rates, raising capital costs for firms and households alike. The effects for real economic activity compare to the financial accelerator if loanable funds are subject to procyclicality. The mechanism is of importance for macroprudential considerations if the banking industry is subject to macro shocks.

The reason for choosing the risk spread in our model as a measure of financial shocks is twofold. First, the spread measure is closely related to the theoretical concept of financial frictions, see e.g. Bernanke et al. (1996) or Bernanke et al. (1999). Second, there are empirical reasons. E.g. Faust et al. (2011), using Bayesian techniques, find that low graded bond spreads with a maturity of more than 5 years perform best in reflecting the dependence of the real economy on financial conditions. They are found to be superior compared with more than 100 other financial indicators.

There is a growing literature on the application of bond spreads in time-series models, either using VAR studies or distributed lag models. Most of these studies exclusively use data for the U.S. and employ the risk spread for some form of credit determined by the market. Usually, low grade corporate bond spreads over a save return with a maturity of 5 years or more are used. Studies include Mody and Taylor (2004), Gilchrist and Zakrajsek (2008), Gilchrist et al. (2009), Gilchrist et al. (2010), Gilchrist and Zakrajsek (2012), Antony et al. (2012) and recently Fornari and Stracca (2013).[5] Most of these studies exclusively use data for the U.S. and employ the risk spread for some form of credit determined by the market. Usually, low grade corporate bond spreads over a save return with a maturity of 5 years or more are used. Antony et al. (2012) study the impact of bond spread shocks on Euro area and German industrial production. Fornari and Stracca (2013) consider a cross section of countries, but do not use bond spreads. Instead they focus on financial corporations' stock prices. Some of the studies as e.g. Gilchrist and Zakrajsek (2012) also include measures of stock market volatility alongside spreads to account for financial conditions.

The non-financial part of the economy is covered differently in the cited studies. Mody and Taylor (2004) and Gilchrist and Zakrajsek (2008) estimate a rather simple distributed lag model for quarterly GDP growth. Gilchrist et al. (2009) estimate VARs in industrial production and employment. A low grade bond spread is added as an exogenous variable to this VAR. In a more general model, the authors estimate a factor augmented VAR (FAVAR) with various macroeconomic variables reflecting economic activity. Among them are the unemployment rate, non-farm employment, production, inflation and monetary variables. Financial conditions are included by a credit market factor constructed from various bond spreads over several maturities and investment grades. Antony et al. (2012) estimate a VAR in Euro area and German industrial production, employment and monetary variables. Gilchrist et al. (2010) and Gilchrist and Zakrajsek (2012) specify a detailed VAR in GDP, investments, prices and low grade corporate bond spreads. The estimates in all of these stud-

[5] One might also consider the GVAR literature on geographic transmission of financial shocks as relevant. For contributions in this direction see e.g. Galesi and Sgherri (2009), Chen et al. (2010), Beaton and Desroches (2011), Xu (2010), Chudik and Fratzscher (2011), Bussiére et al. (2011) and Eickmeier and Ng (2011). This literature, however, does not model the possibility of a self enforcing dynamic evolvement of financial shocks as in the accelerator theory considered in the present contribution. This is because financial conditions are included as a global exogenous variable to a VAR.

ies strongly support the theory of the financial accelerator as the risk spread measure significantly affects the real economy. We will come back to their quantitative results further below in Section 5.

The other financial conditions variable in our study is implied volatility. Households react to volatility via buffer stock saving. Gourinchas and Parker (2002) and Cagetti (2003) estimate life cycle models with relatively high time preference rates and moderate rates of risk aversion. An increase in income risk leads to a higher buffer stock of young households and a reduction in consumption until the new stock level is achieved. Bloom et al. (2007) apply the lumpy investment model with demand shocks to a panel of UK firms over the period 1972–91. They find that the precautionary effects of uncertainty are large – going from the lower quartile to the upper quartile of the uncertainty distribution typically halves the first year investment response to demand shocks. This implies the responsiveness of firms to any given policy stimulus may be much weaker in periods of high uncertainty, such as after the 1973 oil crisis and September 11, 2001. Bloom (2009) confirms these findings in an application using VIX volatility measures. We follow the same line, and use the VSTOXX measure of Euro area stock volatility.

The remainder of our paper is organised as follow. Section 2 takes a detailed look at our data. Section 3 presents our main models, methods and estimation results, while Section 4 looks at alternative estimates for robustness checks. Section 5 discusses the results and Section 6 concludes.

2 Data

Our analysis focuses on two data sets. First, we look at industry data, and second, we try to assess the role of financial shocks for GDP. The following subsections introduce our data.

2.1 Industry

Our sample runs from 1999 to 2011 with 156 monthly observations. In our first assessment, industrial production in the Netherlands and the Euro area as well as employment in Dutch industry are characterizing the real economy. Financial markets are covered through the corporate bond spread and implied market volatility.

The data for industrial production at monthly frequency are taken from the OECD.[6] The OECD defines industrial production as consisting of the output of industrial establishments covering mining and quarrying, manufacturing, and electricity, gas and water supply referring to UN (1983). Dutch employment in industry comes from the Dutch Statistical Office (Centraal Bureau voor de Statistiek, CBS) and corresponds to this definition. [7] Unfortunately, this data is only available quarterly. We will return to this issue and how we deal with it further below.

The financial markets block consist of the corporate bond spread and implied volatility. The corporate bond spread is the difference between the yield to maturity between Euro area corporate bonds with a BBB rating and Euro area AAA government bonds with 5 to 7 years to maturity. Bonds are weighted with their corresponding market capitalization. Volatility is measured by the 12 month implied volatility for the EURO STOXX 50 index. All series are taken from Datasteam/Thomson Reuters. We use the beginning of period value for each month. Figures 1 and 2 display the development of the series.

[6] OECD.StatExtracts database http://stata.oecd.org.

[7] CBS statistics online http://statline.cbs.nl.

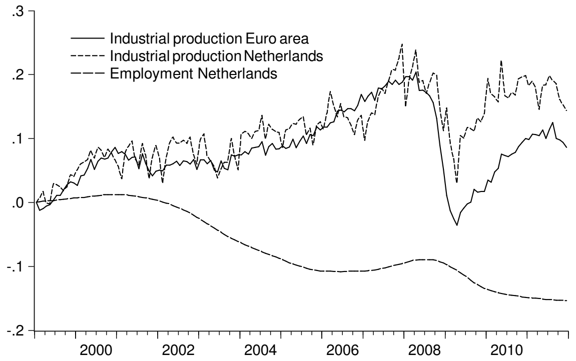


Figure 1: Industrial Production and Employment
Note: Log industrial production and employment (linear interpolated) (1999M1 normalized to zero)

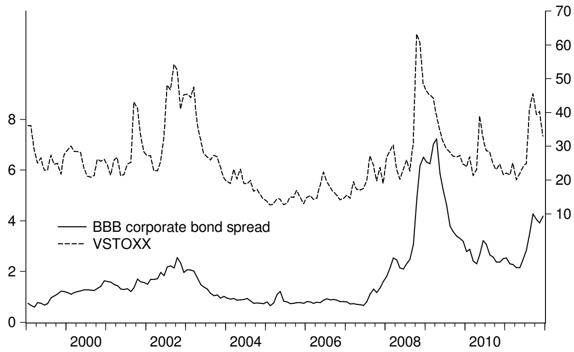


Figure 2: Corporate Bond Spread and Volatility
Note: BBB corporate bond spread over AAA government bonds (left) and implied 12 month volatility VSTOXX (right)

In our second assessment, we turn our attention to purely industrial production statistics. We therefore consider for the real economic block of our model industrial production, turnover and new orders for the Netherlands. Financial markets are covered again by the corporate bond spread and volatility. Figure 3 displays the development of production, turnover and new orders. Turnover covers manufacturing, quarrying and mining while new orders are restricted to manufacturing due to data availability. Both series were deflated using the corresponding producer price indices. Monthly data for sales, orders and prices are taken from the Eurostat's short-term business statistics.[8]

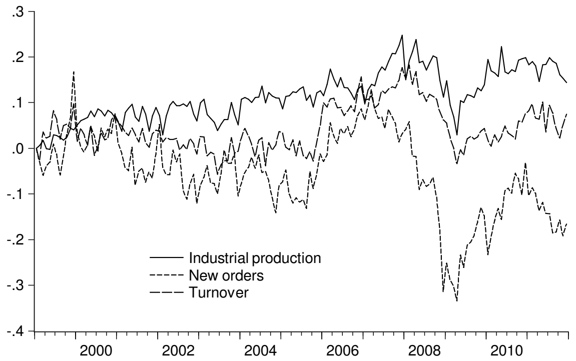


Figure 3: Industrial Production, Turnover and Orders
Note: Log industrial production, turnover in manufacturing, querying and mining and new orders in manufacturing for the Netherlands (1999M1 normalized to zero)

Next, we turn to the stationarity characteristics of the data. While production, employment, turnover and orders might be clear candidates for integrated time series, this is less clear for the spread measure and volatility. From a theoretical perspective, the former series might contain a unit root depending on the nature of technical progress and population growth. For the latter, there are some a priori reasons for stationarity. The corporate bond spread is a measure of credit constraints prevailing in the market. Firms that are subject to steadily increasing constraints might be forced to exit the market which decreases the aggregate spread. New firms might only enter the bond market if fulfilling some minimum credit worthiness requirements. This might form a selection mechanism

[8]Eurostat database http://http://epp.eurostat.ec.europa.eu. Turn over series sts_ind_tovt, new order series sts_ind_nord, producer price indices sts_ind_pric.

that implies stationarity for observed spreads. Some of the aforementioned studies, e.g. Mody and Taylor (2004) or Gilchrist and Zakrajsek (2008), treat the bond spread explicitly as stationary, while others as e.g. Gilchrist et al. (2010) remain silent on this issue. However, next to a unit root, another reason for integration might be a structural break in the time series, that would permanently change the level of the spread or of volatility.

Table 1 contains the results from unit root test applied to the log-levels (only levels in case of the spread and volatility) and first differences of our time series. We investigate the period 1999 to 2007 and an extended period running through 2011. We do not analyze the employment series as it is interpolated from quarterly data, which might affect unit root tests in an unknown way.[9] We employ the MZ_α and MZ_t statistics of Ng and Perron (2001) and the KPSS test. The resulting test statistics are given in Table 1.

	ind. prod. Euro area	ind. prod. Netherlands	turnover Netherlands	turnover capital goods Netherlands	new orders Netherlands	new orders capital goods Netherlands	BBB spread Euro area	VSTOXX Euro area
				1999-2007 levels				
MZ_α	-8.943	-25.613^{***}	-13.664	-18.911^{**}	-15.116^{*}	-18.911^{**}	-4.082	-5.220
MZ_t	-2.057	-3.414^{**}	-2.457	-2.979^{**}	-2.732^{*}	-2.979^{**}	-1.291	-1.533
KPSS	0.169^{**}	0.101	0.241^{***}	0.217^{***}	0.201^{**}	0.217^{***}	0.295	0.451^{*}
				first differences				
MZ_α	-18.762^{***}	-24.677^{***}	-9.587^{**}	-8.406^{**}	-8.786^{**}	-8.406^{**}	-60.530^{***}	-23.681^{***}
MZ_t	-3.036^{***}	-3.489^{***}	-2.088^{**}	-1.966^{*}	-2.072^{**}	-1.966^{*}	-5.432^{***}	-3.397^{***}
KPSS	0.146	0.174	0.244	0.215	0.165	0.215	0.130	0.092
				1999-2011 levels				
MZ_α	-7.881	-34.938^{***}	-19.592^{**}	-34.701^{***}	-15.781^{*}	-42.514^{***}	-5.004	-12.640^{**}
MZ_t	-1.950	-4.119^{***}	-3.130^{**}	-4.159^{***}	-2.801^{*}	-4.610^{***}	-1.346	-2.514^{**}
KPSS	0.145^{*}	0.072	0.113	0.130^{*}	0.093	0.082	0.576^{**}	0.130
				first differences				
MZ_α	-85.638^{***}	-38.783^{***}	-21.473^{***}	-8.945^{**}	-53.606^{***}	-29.020^{***}	-55.549^{***}	-28.919^{***}
MZ_t	-6.543^{***}	-4.394^{***}	-3.213^{***}	-2.026^{**}	-5.160^{***}	-3.784^{***}	-5.253^{***}	-3.742^{***}
KPSS	0.088	0.099	0.079	0.082	0.072	0.047	0.053	0.093

Note: For the trended series as production, turnover and orders, the test equations contain a constant and a linear trend. For the spread and VSTOXX the test equation only contains a constant. Null hypotheses for the MZ_α and MZ_t statistics is a unit root in the series and stationarity in case of the KPSS test. Long-run variances computed using a Parzen kernel with automatic bandwidth plug in. *(**,***) indicate whether the p-value of the test statistic is lower than 10%(5%, 1%).

Table 1: Unit root tests industry data

The results in Table 1 deliver no clear-cut picture. Apart from being unable to say anything on the stationarity properties of the employment series, results for the other trended series are mixed. For the short sample, the level of Euro area production seems to contain a unit root, while its Dutch counterpart does not. In case of capital goods turnover and new orders, the Ng and Perron and the KPSS tests come to opposite results. The same holds for the corporate bond spread while volatility seems to be non stationary. First differences of the data seem to be stationary.

Looking at the result for the extended sample, these results are confirmed. The only exception to this is volatility which now seems to be stationary. In first differences the tests point throughout at stationarity. As the figures above indicate, the sample from 2008 onwards is heavily influenced by the developments after the Lehman bankruptcy. We believe the results for the extended sample must be read with care due to this.

If we focus more on the results for the shorter sample, we summarize our findings as follows. For the industry series it seems not straightforward to assume unit root behavior that could lead to possible cointegration among the series. Additionally, we cannot test the employment series.

[9] See Section 3 for details on the interpolation method.

Graphical inspection of its level series does not really convince us to believe in its stationarity. The corporate bond spread might be non-stationary and the VSTOXX appears to be non-stationary.

Given this, we have no strong evidence for a modeling strategy that uses the data for the real economy, i.e. production and employment or production, turnover and sales, in levels. Given the mixed evidence on unit roots and trend stationarity, we do not see any viable econometric model that comprises these data in levels.

Looking at the financial variables, we have evidence for unit root behavior in the bond spread and volatility. As already mentioned, these data are used in the literature in levels also in combination with stationary data. As we do not want to deviate too much from the literature, we have to see how our findings and the literature could coexist. Taken together with the previous paragraph this is theoretically possible in case of cointegration between the spread and volatility. Table 2 gives our results from cointegration tests using the Johansen testing procedure.

H_0 no. of cointegrating relations	trace statistic	p-value
0	23.0977	0.0198
At most 1	4.37187	0.3596
H_0 no. of cointegrating relations	max-eigenvalue statistic	p-value
0	18.7259	0.0175
At most 1	4.37187	0.3596

Note: Johansen cointegration tests for bond spread and VSTOXX. Test VAR specified with 4 lags, constant in cointegration equation but not in VAR, sample period 1999 to 2007. Adding more lags to the test VAR does not change the conclusion from the tests.

Table 2: Cointegration tests

Both test statistics give the same result that the null hypothesis of no cointegration could be easily rejected, while we cannot reject the hypotheses of one cointegration relation. We have to stress here that unit root and cointegration test are of somewhat limited use given our rather short sample. However, we chose not to simply follow the literature by including the variables in levels without further inspection. Our inspection of the data at least reveals that there is no obvious reason precluding to do so as e.g. in (Hamilton, 1994, section 20.4).

To complete our preliminary data analysis for the industry, Table 3 presents descriptive statistics on the first (log)differences of production, employment, turnover and new orders for the period 1999 to 2007.

	Ind. prod. Euro area	Ind. prod. Netherlands	Employment Netherlands	Turnover Netherlands	New orders Netherlands
mean	2.106	2.773	-1.078	1.981	0.356
median	2.141	2.402	-1.202	1.493	3.024
max	28.298	67.168	1.597	72.380	118.792
minimum	-25.310	-49.927	-4.020	-98.122	-159.700
std. dev.	10.826	23.695	1.738	32.917	47.292

Note: Continuously compounded annualized monthly growth rates 1999 to 2007.

Table 3: Descriptive statistics

2.2 GDP

Our analysis for GDP follows essentially the assessment of the industrial production data set. For the real economic block of our model, we consider both Euro area and Dutch GDP as well as employment in the Netherlands. Seasonally adjusted GDP series and GDP deflators come from the OECD. As financial market variables we again consider the corporate bond spread and implied volatility. For them, we consider beginning of period realizations. Our quarterly data cover the period from 1999 to 2011.

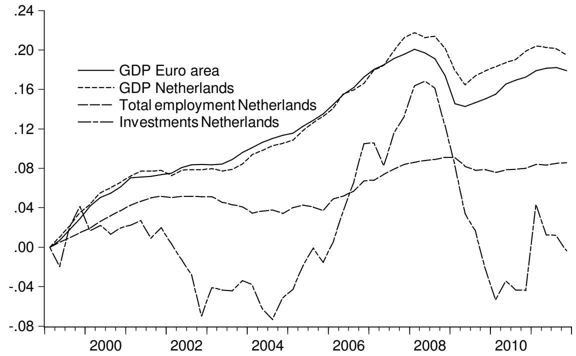


Figure 4: GDP and Employment

Note: Log GDP, total employment and investments (1999 I normalized to zero)

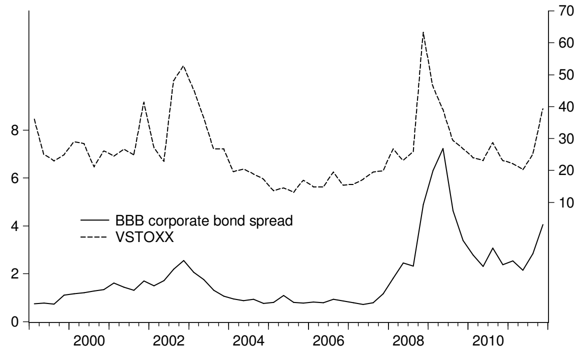


Figure 5: Corporate Bond Spread and Volatility

Note: BBB corporate bond spread over AAA government bonds (left) and implied 12 month volatility VSTOXX (right)

The development of GDP and employment largely reflects the behavior of the data for industry, but are smoother. We observe a growth slowdown following 2001 and with some time lag a reduction in employment. The effects of the Lehman bankruptcy are clearly visible although their magnitude is smaller compared with industry.

	GDP Euro area	GDP Netherlands	employment Netherlands	investments Netherlands
		1999-2007 levels		
MZ_α	-5.704	-4.111	-5.314	-1.309
MZ_t	-1.638	-1.227	-1.568	-0.550
KPSS	0.106	0.121*	0.094	0.150**
		first differences		
MZ_α	-8.244^{**}	-12.182^{**}	-22.968^{***}	-17.015^{***}
MZ_t	-2.030^{**}	-2.415^{**}	-3.385^{***}	-2.880^{***}
KPSS	0.132	0.169	0.141	0.354
		1999-2011 levels		
MZ_α	-4.436	-5.913	-6.865	-7.545
MZ_t	-1.364	-1.563	-1.817	-1.920
KPSS	0.133*	0.091	0.059	0.082
		first differences		
MZ_α	-14.301^{***}	-13.658^{**}	-28.854^{***}	-26.618^{***}
MZ_t	-2.636^{***}	-2.490^{**}	-3.787^{***}	-3.647^{***}
KPSS	0.230	0.226	0.129	0.079

Note: Test equations contain a constant and a linear trend. Null hypotheses for the MZ_α and MZ_t statistics is a unit root in the series and stationarity in case of the KPSS test. Long-run variances computed using a Parzen kernel with automatic bandwidth plug in. *(**,***) indicate whether the p-value of the test statistic is lower than 10% (5%, 1%).

Table 4: Unit root tests GDP data

In general, logged GDP or employment are time series that are likely to be non-stationary. Therefore, it seems appropriate to repeat here the same analyses as for industrial production. However, here our data sample contains considerably less observations. From 1999 to 2007 we are left with 36 quarters, the extended sample running through 2011 contains 16 more quarters of data. Unit root and cointegration tests rely exclusively on asymptotic distribution theory which makes inference with this number of observations highly disputable. Nevertheless, Table 4 gives the results for the same unit root tests as before for the data sample 1999 to 2007 and 2011.

If we trust the results in Table 4 despite the small number of observations, we arrive at the unsurprising result that the log-levels of our variables contain a unit root while their first differences do not. Only the KPSS test does not find a unit root in a number of level series. Testing for cointegration among our level series delivers mixed results. Using the Johansen testing procedures, the tests do not give any clear insights on possible cointegration. The Phillips and Ouliaris (1990) test indicates no cointegration. As we cannot judge reliably on these issues, we opt for using the data on GDP, employment and investments in first (log)differences in our subsequent analysis. Table 5 below gives a descriptive overview of the differenced data. We do so also to arrive at a data situation that is to some extent comparable to the industrial production analysis.

	GDP Euro area	GDP Netherlands	Employment Netherlands
mean	2.266	2.546	1.044
median	2.340	2.202	1.273
maximum	5.132	6.728	4.822
minimum	-0.188	-2.141	-2.605
std. dev.	1.382	2.070	1.732

Note: Continuously compounded annualized quarterly growth rates 1999 to 2007.

Table 5: Descriptive statistics

3 Models and Results

3.1 Industry

As already pointed out, we consider two data sets for the assessment of the effects of financial shocks. The first one is a stylized description of Dutch industry within Euro area financial and real developments. The data set contains growth in industrial production (Euro area and the Netherlands), growth in Dutch industry employment, the BBB corporate bond spread and volatility. The second data set is a more ad hoc empirical representation of the development in industry. It contains growth in industrial production (Euro area and the Netherlands), growth in turnover and new orders of capital goods, the bond spread and volatility.

Both data sets will be analyzed with standard VARs. The VAR for the first data set is most closely related to the analysis of Gilchrist et al. (2009) for the U.S. However, due to data limitation we cannot work within a data environment that is comparably rich. The VAR analysis for the second data set is more data driven and ad hoc. To the best of our knowledge the literature has not estimated a system of industry indicators within a financial framework. As such we see the analysis of these data more as a robustness check and will compare its results to the more conventional stylized economic model.

In both cases we end up with a reduced form VAR representation of the form

$$y_t = c + A(L)y_{t-1} + \varepsilon_t, \tag{1}$$

where y_t is a vector containing the variables of our two data sets, c is a vector of constants, $A(L)$ is a matrix lag polynomial of order p and ε_t a usual error term with $E(\varepsilon_t \varepsilon_t') = \Sigma$.

When confronting the model with our first data set, we encounter the problem of mixed frequencies. I.e. the data for employment are only available at the quarterly frequency, while the other series are observable each month. The literature has developed empirical models that are able to deal with such a data environment. Ghysels (2012) gives an overview about estimation procedures that are applicable to VARs. These include mixed frequency VARs (MF-VAR) based on state space models for latent processes or mixed data sampling (MIDAS) procedures. Recently, Chiu et al. (2011) proposed a Bayesian mixed frequency (BMF) algorithm. Here, we use an iterative procedure that implements the ideas of the latter into a usual OLS procedure.[10] This results in an estimator that involves only (a series of) ordinary least squares problems. It proceeds in a way comparable to the continuously updated (CUP) estimators proposed in Bai et al. (2009). In case of our second data set, the problem of mixed frequency data does not occur and we estimate the model by OLS.

3.2 GDP

The empirical approach considering our GDP data set follows the preceding subsection. The data set contains time series on GDP growth in the Euro area and the Netherlands, Dutch employment growth, the bond spread and the VSTOXX. As we only have quarterly observations for most of the series, we end up with considerably less observations. For the short sample period from 1999 to 2007 we have 36 quarters of data at hand while we have 52 for the longer sample.

Estimating a VAR by OLS in 5 variables with this number of observations is obviously critical. This is why we choose for a Bayesian approach following Bańbura et al. (2010). Their work shows that combining prior information with real data can prevent the problem of over fitting in case of many coefficients to be estimated with only few observations. Or put it differently, this approach allows coefficient to deviate from their prior only if there is strong data support for this.

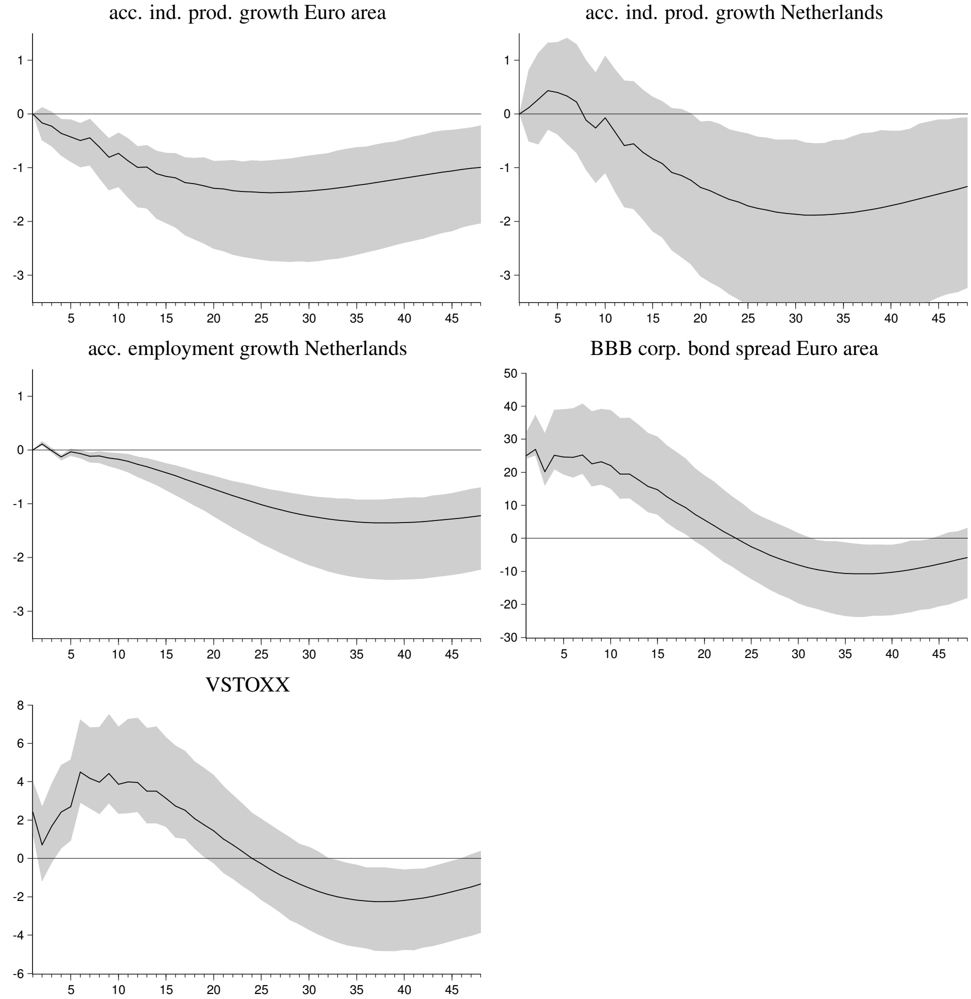
This leaves open the question what strong data support actually means. Loosely speaking, we have to determine how strong we weigh prior information and the real data. Technically, this boils down to choosing the hyper parameter λ in Bańbura et al. (2010) balancing between prior information and fitting the data. To choose this parameter we follow Giannone et al. (2012) who propose to select the hyper parameter by maximizing the marginal likelihood of the model. With respect to the prior information, we follow Bańbura et al. (2010). For the stationary variables in our VAR, the prior corresponds to a white noise process with constant mean. For variables containing a unit root, it corresponds to a random walk.

3.3 Results Industrial Production

We first discuss the results on the data set containing industrial production (Euro area, Netherlands), employment for the Netherlands, the BBB corporate bond spread and volatility. We discuss two types of financial shocks. First, a shock to the bond spread identified through a lower triangular Cholesky decomposition of the residuals' covariance matrix as in Gilchrist et al. (2010). As the bond spread is the second last in the ordering of our variables in the VAR, this decomposition results in an accompanying contemporaneous shock in volatility which is our last variable. This accompanying volatility shock is the result of the correlation of the residuals in the VAR's equations for the bond spread and volatility. In numbers, with a 25 basis points shock in the spread this boils down to an increase in volatility of about 2.5 percentage points. The second shock we study is a pure volatility shock, i.e. one that is equivalent to an orthogonal shock to the VAR's equation for the VSTOXX. We scaled this shock to the unconditional standard deviation in the estimation period of the VSTOXX of about 10 percentage points.

The results in Figure 6 give the accumulated impulse response functions to our first shock for industrial production and employment growth. I.e. the functions give the predicted level effects in the variables after the indicated period of time. As the bond spread and volatility were included in levels, the corresponding response functions do need to be accumulated to give level effects. The reported confidence bands were obtained through bootstrapping the estimated VAR model. As this

[10]See the Appendix A for details on the method.



Note: Accumulated impulse responses for growth in industrial production (Euro area and Netherlands, percent), employment industry (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Shaded area 95% confidence interval obtained from bootstrapping with 5,000 replications. Time axis in months. Data sample 1999 to 2007.

Figure 6: Impulse-responses VAR industry 1999-2007; shock in corporate bond spread

reflects estimation uncertainty emerging from uncertainty with respect to the model's parameters, we have to elaborate on one shortcoming of our approach. As said before, our monthly data for Dutch employment in industry are estimated through the algorithm explained in the appendix. Applying the bootstrap therefore reflects only uncertainty given the data. The displayed confidence bands have to be read this way to avoid any misinterpretation.

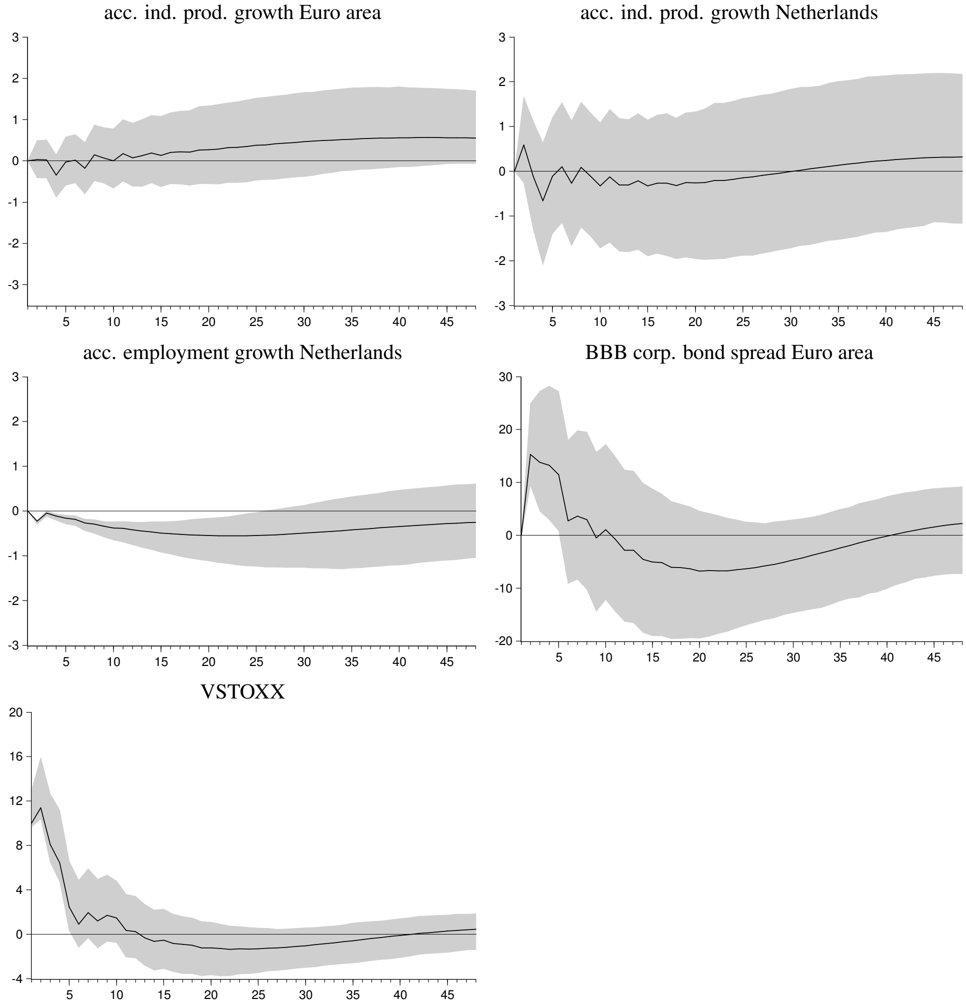
A shock in the corporate bond spread goes along with a contemporaneous positive shock in volatility. Given the behavior of the bond spread and volatility which is graphically represented in Figure 2 of Section 2, this positive correlation is not surprising. In times of higher spreads we usually experienced also higher volatility in capital markets, shocks as estimated by the model do follow this pattern. Both the spread and volatility remain significantly above their unconditional expected value for about 1.5 years. Volatility peaks after about half a year as it is endogenously driven up by the reaction of the system variables. The response functions display cyclical behavior. In the long run the responses almost return to the zero line although it takes more time than the 4 years displayed.

When looking at the real economic variables, we see that the most significant and clear cut reaction takes place in the Euro area industrial production. The effect of the financial shocks lead to significant reductions in production after 3 months. After four years, we end up with a 1% reduction in industrial production. For the Dutch economy, the effects are accompanied with higher uncertainty, which is reflected by the larger confidence bands. Industrial production effects become significantly negative only after about 20 months. After four years, industrial production is reduced by 1.35% compared with about 1% at the Euro area level. Employment in Dutch industry is significantly negatively affected as well. After four years, the number of employed workers in Dutch industry is reduced by about 1.2%. At first sight, there are two major differences with respect to the expected reduction in production. First, there is a counter intuitive increase in Dutch production during the first 3 month whereas Euro area level production decreases right from the beginning. Second, after about a year, the Dutch economy reacts stronger than its counterpart at the Euro area aggregate.

Given our data set, it is not straightforward to explain these differences. An explanation for the more emphasized reduction in the Netherlands could be greater dependence of the Dutch economy on international trade. It is well documented that trade reacts very sensitive to changes in conditions on capital markets (see e.g. Amiti and Weinstein (2011)). Altogether, it seems that the difference is hardly significant given the lower precision of the estimated effects for the Netherlands. We do not have a sound explanation for the initial positive but insignificant reaction of Dutch industrial production in response to the bond spread shock.

The estimates effects for industrial production in the Netherlands and the Euro area also differ with respects to their accuracy. Confidence bands for the accumulated responses are considerably wider in case of the Netherlands. As the bond spread and volatility are measuring conditions on Euro area wide capital markets, it is not surprising that the effects are estimated with higher accuracy at the Euro area level. The findings do indicate that Euro area wide movements in capital markets have a significant influence on Dutch production. The greater uncertainty in the estimates for the effects in the Netherlands is likely to reflect that other variables at the national level and uncorrelated with Euro are ones do play a role. As we did not include and identified them, uncertainty at the national level is greater compares with the Euro area. Any interpretation of our findings needs to take account of additional idiosyncratic uncertainty on our results.

Next, we consider the pure volatility shock in Figure 7. The reaction of our financial market variables is as follows. After the initial shock the bond spread increases to about 15 basis points endogenously. Afterwards we observe a quick decline in the significant realizations of the spread and volatility. Compared to the bond spread shock above, the responses for the financial variables are significantly different from zero for a much shorter period of time.



Note: Accumulated impulse responses for growth in industrial production (Euro area and Netherlands, percent), employment industry (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Shaded area 95% confidence interval obtained from bootstrapping with 5,000 replications. Time axis in months. Data sample 1999 to 2007.

Figure 7: Impulse-responses VAR industry 1999-2007; shock in volatility

If we look at the real economic variables, effects are clearly much less significant compared to the spread shock. Neither Euro area nor Dutch industrial production reacts significantly during the period of 4 years covered by the responses. After 4 years, we observe a slightly positive effect which is insignificant, however only just so in case of the Euro area. Dutch industry employment reacts significantly negative in the short run. But this is, as said above, only given the data which are interpolated and, hence, estimated. After 4 years the negative employment effect has almost vanished.

The confidence bands for the reaction in industrial production reveal a great deal of uncertainty in the results. If one were to draw just one conclusion from this analysis, it possibly should be that a pure volatility shock just leads to an increase in the uncertainty of the expected reaction of the VAR's variables. This conclusion is also confirmed by experimenting with the above spread shock. If one combines the spread shock of 25 basis points with various contemporaneous different volatility shocks, the following results emerge. The expected values of the shocks' effects as represented by the response functions in the economic variables do not change much along with the variation in the initial volatility shock. What does change enormously are the confidence bands of the response functions. They increase with the level of the initially accompanying volatility shock.

These results do not indicate that pure volatility shocks are to be neglected. Indeed, they pose severe consequences for both the researcher and the economy. The researcher is limited in the accuracy of her results, while practitioners relying on her results have to take account of great deal of uncertainty when making decisions.

To check our results for robustness, we employed two types of alternative estimates. The first one is a changed set in the VAR's variables. The second is an alternative estimation period. We deal in Section 4 with the latter, while we report here the results of the former. This is our second industrial production model. It includes besides production its leading indicator of new orders as well as turnover in Dutch industry. For both series we have chosen the narrow definition which corresponds to capital goods only. We do so as we expect new orders and turnover in capital goods to significantly depend on financial conditions as purchases of those goods are likely to be financed by some form of credit.

For this alternative VAR, we analyze the same shocks as above, i.e. a 25 basis points shock in the bond spread together with a contemporaneous volatility shock as well as the pure volatility shock. The corresponding impulse responses are to be found in Appendix B. Here we just mention the key results that compare to our first industrial production model. Euro area production reacts stronger to the spread shock as does Dutch production. After 12 months we arrive at a reduction of 1% and 0.7% respectively. After 4 years the effects are -1.5% and -1.7%. All values are significant at our 95% level and are to some extent larger than the results just presented above. Turnover is reduced significantly over a horizon of 4 years, while this is only temporarily true for new orders. Pure volatility shocks do not affect industrial production in any significant manner. The insignificant expected effects are even smaller than in the model above. The conclusion on uncertainty effects of volatility shocks is as before. Although the results do differ quantitatively, qualitatively we arrive at the same conclusions. Taking account of the uncertainty implied by the estimated confidence bands, the results from the two different models do not conflict with each other.

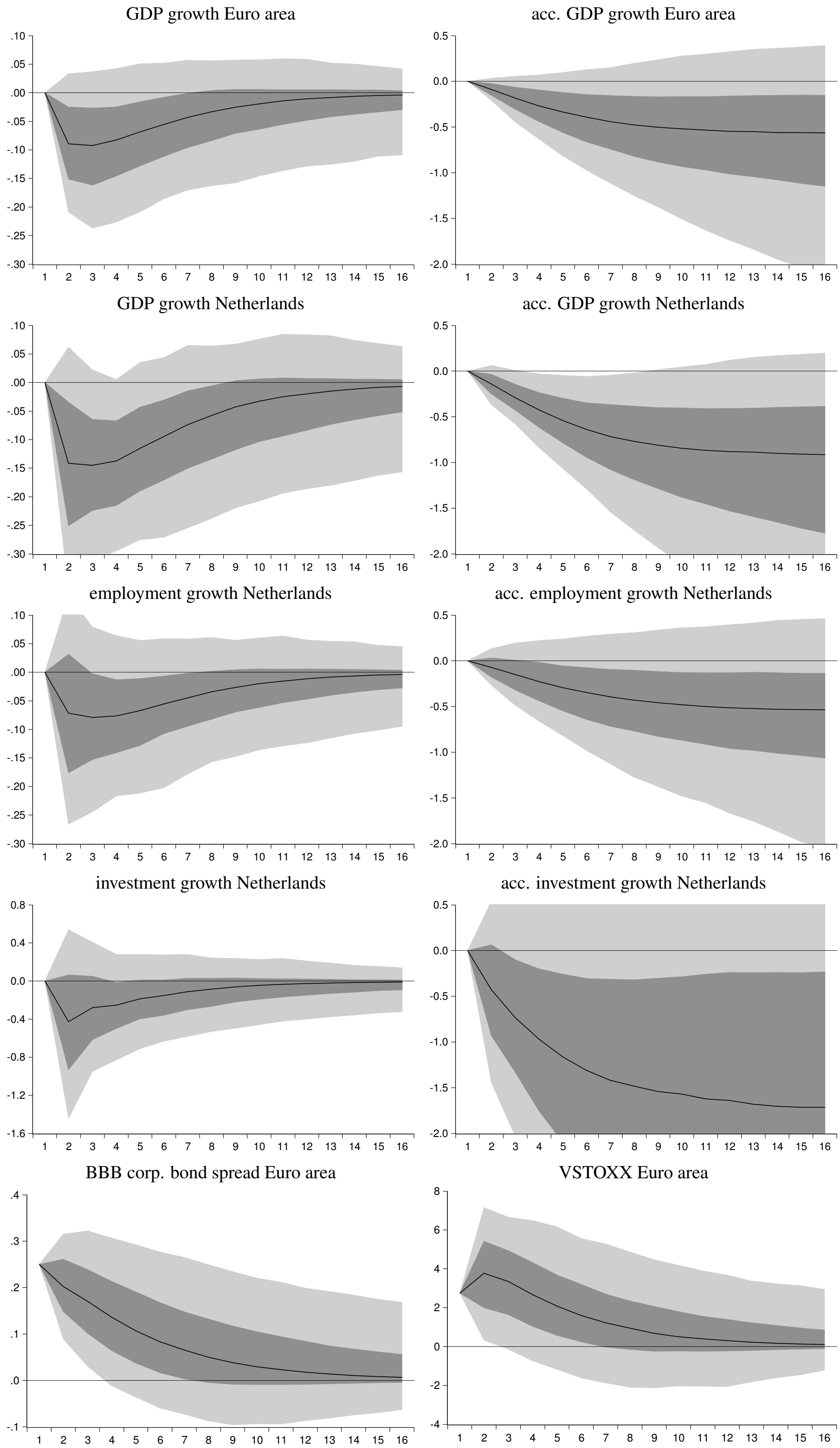
3.4 Results GDP

In this section we elaborate on our BVAR estimates for our aggregate model with GDP (Euro area and Netherlands), total employment in the Netherlands, the BBB corporate Bond spread and volatility (quarterly data). We repeat our analysis from the preceding section by considering a 25 basis points bond spread shock together with a contemporaneous shock in volatility. Additionally we also look at a pure volatility shock.

In Figure 8 we summarize our results in accumulated and non-accumulated impulse responses for the real economic variables GDP, Dutch employment and investments.[11] We also include non-accumulated responses, i.e. responses of the GDP growth rate, as this is a variable that usually receives much attention in the debate.

We elaborate first on the results following a 25 basis points bond spread shock. As is usual in BVAR analyses, we report error bands along sides the responses. We do so by considering 66% and 95% error bands. While the former is quite commonly reported in BVAR studies, the latter compares

[11] Ideally we would have included investment data already in our industrial production analysis. Unfortunately, investment data for industry are not even available at the quarterly frequency, not to speak about monthly data.



Note: Non-accumulated and accumulated impulse responses for growth in GDP (Euro area and Netherlands, percent), employment and investment growth (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Dark (light) shaded area 66% (90%) error bands. Time axis in quarters. Data sample 1999 to 2007.

Figure 8: Impulse-responses BVAR GDP 1999-2007; shock in corporate bond spread

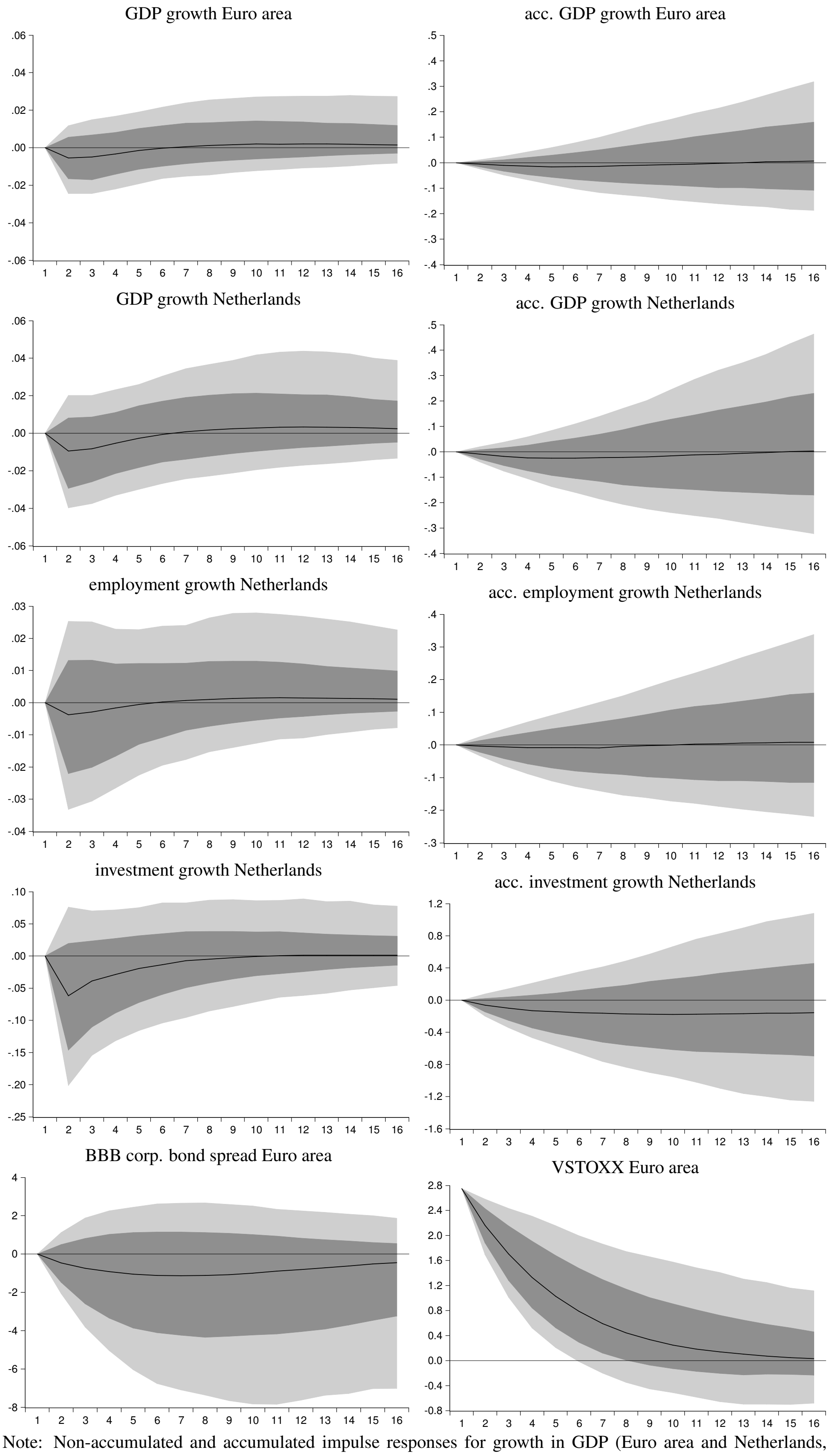
more to our OLS approach to industrial production above. Of course, conventional confidence bands do not directly compare to error bands in Bayesian analysis.

Overall we come to the conclusion that the effects of a bond spread shock on GDP and the variables on employment and investment of an corresponding level of aggregation are less dramatic compared with the industry level. GDP at the Euro area level and for the Netherlands is reduced by a total of about 0.6 and 0.9% respectively after 4 years. The GDP growth rate is hit hardest by a bit less than 0.1 and 0.15 percentage points after about 2 or 3 quarters. Comparing the results for Euro area and Dutch GDP, we again observe more pronounced effects for the Netherlands. As in the previous section, we conjecture that the greater dependence of the Dutch economy on international trade is the underlying reason for this. Unsurprisingly, the strongest negative effects are observed in investments. Investments in the Dutch economy suffer a total of -1.7% during 4 years after the shock. Investment growth is reduced in the peak by 0.4% two quarters after the shock, although there is large uncertainty on this particular number. Employment in the Netherlands reacts less drastically. In total after 4 years employment is reduced by about 0.5%; employment growth is hit hardest in the 3rd quarter after the shock by a contraction of about 0.08 percentage points. As would be expected, employment growth lags behind GDP growth due to sluggish employment adjustment.

There are a number of reasons why GDP reacts less dramatically to financial shocks than industrial production. First, GDP consists for a substantial part in government production. Government does not react directly to financial shocks, and may even try to counterbalance the shock by spending more. Second, non-exposed private sectors like the building industry or health care do not depend directly on foreign trade. So the impact of financial shocks on world trade is not felt directly by those sectors and they react with a bigger lag to a shock.

The results from the BVAR are in general less significant than the results from the models dealing with industrial production. This is of course due to the Bayesian approach where model uncertainty adds to the uncertainty in the estimated effects. However, our results are in line with what was to be expected from the results on industrial production. The smaller effects for the higher aggregated data could also be expected, as GDP and aggregated series on employment and investment contain sectors of the economy that are known to react slower than industry.

Our results on a pure volatility shock replicate our findings form the industry analysis. Figure 9 gives the impulse response functions for a shock in the VSTOXX of about 2.8 percentage points. Neither GDP nor Dutch employment seem to react strongly. Only for investment we observe a notable negative impact, although uncertainty on its estimate is large. We therefore stick to our previous conclusion that volatility shocks mainly increase uncertainty about future developments but not their expectations.



Note: Non-accumulated and accumulated impulse responses for growth in GDP (Euro area and Netherlands, percent), employment and investment growth (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Dark (light) shaded area 66% (90%) error bands. Time axis in quarters. Data sample 1999 to 2007.

Figure 9: Impulse-responses BVAR GDP 1999-2007; shock in volatility

4 Alternative Data Sample

Our previous estimation results are based on data up to the beginning of 2008, i.e. pre crisis data. We already elaborated on our choice of the estimation data sample and the underlying reasons. In this section we look at our models estimated for the extended data sample covering the period 1999 to 2011. This period covers the severe crisis period following the financial turmoil in 2008 and most prominently the bankruptcy of Lehman Brothers.

This shock has left its footprints in the data, which can clearly be seen from the figures in Section 2. The period beginning with 2008 is clearly distinct from the years before. First, the magnitude of financial shocks that occurred is expected to be a multitude of what we observe for the years prior to 2008. Second, from 2008 on the general fiscal and monetary environment changed significantly. Policy reacted to the financial shocks with enormous stimulus packages.[12] Monetary policy also changed substantially as central banks heavily intervened in various markets.[13] We have to consider these changes as being relevant to our analysis as the variables we included do typically not control for fiscal or monetary policy.

A VAR can in general be seen as a (log)linear approximation to reality around a steady state. If reality is linear, the approximation might be close to perfect. In case of non-linearities the approximation might be poor far away from the steady state. Additionally, the approximation is likely to depend on the steady state. Due to structural changes in policy, the steady state of our observed variables might be different before and after 2008. Hence, estimated dynamics might also differ.

Furthermore, our observed data for e.g. bond spreads might reflect different things before and after 2008. This is because markets were certainly influenced by central bank's interventions such as bond purchase programs. The bond spreads after 2008 were tremendously high, but might still be downward biased as e.g. the ECB stimulated demand in the bond markets. The announcements and the subsequent implementation of fiscal stimulus policies might have influenced expectations of participants in financial markets. Therefore, observable financial series might very well contain those expectations in addition to the information that they carried prior to 2008.

All these reasons make us doubt whether the model estimated with data up to 2007 is an appropriate description of the relationship between the data series from 2008 onwards. To get a grip on this issue, we re estimate our models from Section 3.3 and 3.4 using data from 1999 to 2011. To allow for a possible break in the models' steady states we introduce an exogenous dummy variable that allows the VAR's vector of constants to take a different value from January 2008 or quarter one 2008 onwards, depending on the data frequency.

Table 6 draws a comparison between the results from our models estimated over the two different periods of time. The financial shock considered is a 25 basis points shock to the bond spread and a contemporaneous volatility shock as before. Impulse response function can be found in Appendix C.1, C.2 and C.3.

Looking at the effects after 4 years of the bond spread shocks on the variables' levels, we see that they are estimated to be smaller using the extended data set. After 12 months the same impression emerges with the exception of the industrial production effect in the VAR containing new orders and turnover for capital goods. Inspecting the impulse response functions in the Appendix reveals that most results lose statistical significance at the longer time horizon beyond 2 years or even less.

The different results with respect to the bond spread may be caused by a number of reasons.

[12]For an overview on the various packages see e.g. In 't Veld and Roeger (2012).

[13]Notable interventions are measures as the covered bond purchase programs of the ECB initiated in the 2nd quarter of 2009 and the securities market program initiated in the 4th quarter of 2010.

Sample	1999 - 2007		1999 - 2011	
Effect after	12M	48M	12M	48M
Industry employment				
IP (Euro area)	-0.99%	-0.99%	-0.42%	-0.19%
IP (NL)	-0.59%	-1.35%	-0.05%	-0.015%
empl. (NL)	-0.27%	-1.22%	-0.15%	-0.22%
Industry (turnover, new orders)				
IP (Euro area)	-1.09	-1.52	-1.36%	-0.74%
IP (NL)	-0.74%	-1.72%	-0.95%	-0.55%
turnover (NL)	-2.45%	-4.53%	-1.34%	-1.58%
new orders (NL)	-3.79%	-1.56%	-0.40%	-0.57%
GDP BVAR				
GDP (Euro area)	-0.27%	-0.56%	-0.11%	-0.18%
GDP (NL)	–0.42%	-0.91%	-0.11%	-0.20%
empl. (NL)	-0.23%	-0.54%	-0.06%	-0.12%
inv. (NL)	-0.97%	-1.72%	-0.56%	-0.90%

Note: Comparison of model results across different sample periods. Level effects after 12 and 48 months respectively following a 25 basis points corporate bond spread shock identified through a Cholesky decomposition.

Table 6: Model results 1999 - 2007 vs. 1999 - 2011

First, the interference of the ECB with bond markets increased dramatically in the aftermath of the crisis. This substantially dampened the impact of the crisis on the spread. Second, the bond spread relates to a measure of risk-taking on bond markets. Bonds are not as important in Europe as in the U.S. as a financing device. In Europe, firms make more use of bank credit than in the U.S. Third, in the Netherlands firms initially thought that the crisis would be a short-run phenomenon, and that within a year or so labour market scarcity would redevelop. So initially they were hesitant to dismiss workers. This led to a large fall in labour productivity and also to a dampening of the fall in product demand, as compared to the Euro area. Figure 1 displays these differences between the Euro area and the Netherlands.

These results support our notion that the same shock analyzed with the same type of models over different estimation periods implies different outcomes. We conclude this section with the impression that the period beginning 2008 seems to governed by a different economic environment, which the model is not controlling for. The next section will discuss our findings and we will return to this issue.

5 Discussion

Given our results from the previous sections, we certainly need to discuss their content and their appropriateness. We need to compare our results for industrial production and GDP. We also need to compare these results to realized past developments. There are hardly any comparable studies for European countries but some studies for the U.S. economy do exist. This section will also compare our findings with those in the literature.

Looking at our models for industry and GDP, we saw that the estimated effects of a bond spread shock are overall larger for the industry than for aggregated GDP. This is rather unsurprising as industry is composed of sectors that are likely to adjust better to changes in the economic environment. Although the same sectors are, of course, part of GDP, GDP contains additional components that might react less. A good example is the public sector, which hardly reacts in a sizable manner to moderate financial shocks during normal times.

With respect to the statistical significance of our results we have to differentiate between industry and GDP estimates. Although effects in our industry model are significantly different from zero at the 95% confidence level, confidence bands are wide. This is especially true when looking at the longer horizon of the impulse response functions. Additionally, confidence bands seem to be larger for the estimated effects of the Dutch economy compared with Euro area aggregates. We believe that this is due to several reasons. First and in general, we use our data for the real economic variables in first differences. The first difference filter is known to filter out information at lower frequencies to some extent. However, we argued in Section 2 that it is necessary to difference the data. Second, our data sample covers just 9 years. It is natural that long run information is limited in such a short period of time. Finally, our financial variables are measured at the Euro area level. We do find them to significantly impact the Dutch economy. However, there might very well be other aspects of the Dutch economy that are not included and that limit the information content of Euro area aggregates for the Dutch economy.

Looking at our GDP results, we have to take account of the different estimation approach. Because of the limited number of observations for the quarterly series we chose to employ a Bayesian VAR to estimate the GDP-related model. By combining imprecise prior information with the data sample, we add model uncertainty as an additional source of uncertainty to our estimation problem. This leads to higher uncertainty about the effects of financial shocks as is clear from the error bands of the impulse responses. However, given the limitations from the data sample, it is not straightforward to prevent this.

We estimated our model using data for two different time periods. The first one up to the financial turmoil in the year 2008 and the second with data series running through to 2011. The striking difference in the results was that the real economic effects of equal sized bond spread shocks were larger in the former than in the latter data sample. Given the dramatic developments during and after 2008, this seems to be at odds with reality.

We elaborated on the possible reasons behind this result above. To summarize, we see this result as a classical example for the Lucas critique. The magnitude of the financial shocks in 2008 had undoubtedly a significant impact on fiscal and monetary policy which is reflected in the parameters of the models. As long as shocks to the model are too small to significantly change policy, evaluating their effect along the lines of this contribution might well be feasible.

Most of the empirical literature on the topic makes use of pre 2008 data. It might be interesting to compare our findings to what can be found in other studies. The most relevant estimates can be found in Gilchrist et al. (2009) and Antony et al. (2012) for industrial production in the U.S. and Germany respectively and Gilchrist et al. (2010) and Gilchrist and Zakrajsek (2012) for U.S. GDP. These studies use VAR models that are to some extent comparable to our approach.

Gilchrist et al. (2009) find a decline in industrial production of about 1% 4 years after a somewhat comparable bond spread shock. The authors use a composite bond spread index and analyze a shock that corresponds to a shock in the range of 10 to 50 basis points in the underlying spread measures. Their data sample is longer but also contains the years prior to 2008. Antony et al. (2012) find German industrial production to decline by about 1.3% after 4 years from a 25 basis points shock in the same bond spread measure and sample period as we use in the present analysis. Our results in this contribution are therefore at the upper bound of these estimates.

For GDP we can only draw comparisons with respect to U.S. results. Gilchrist et al. (2010) find a reaction of between -0.5% and -1% in GDP within 4 years after a 25 basis points shock in the U.S. corporate bond spread with pre crisis data. Gilchrist and Zakrajsek (2012) use data up to 2010 and come to the same conclusion as we do, i.e. that effects with such a data sample are estimated to be smaller. After 5 and 16 quarters their GDP effect is estimated by a -0.5% and -0.2% reduction in GDP.

6 Conclusion

The purpose of this contribution is to quantify the effects of financial shocks in the Euro area and in particular for the Dutch economy. Most of the existing literature based on time series methods has focused on the U.S., mainly due to the availability of longer time series. To deal with this issue we estimated VAR models for industrial production with monthly data and BVARs for quarterly GDP.

Overall, we find significant effects of financial shocks within the Euro area on both the Euro zone in total and on the Dutch economy. Following the literature cited in the introduction, we measured financial conditions by lower grade corporate bond spreads and implied stock market volatility. Shocks in bond spreads affect production, employment and investment negatively, both in a statistically and an economically significant way. Pure volatility shocks do have effects as well. However, these are distinct from bond spread shocks. Volatility does not significantly affect the expected economic development, but rather extends the range of possible developments.

Given the length of our data set we have to conclude that we can assess the impact of financial shocks only with limited precision. This is of particular importance if one wants to assess scenarios in the recent crises for the purpose of policy evaluation. Policy actions, let them be fiscal or monetary, can only be properly designed to the extent that the effects of shocks that they address are estimated precisely.

Furthermore, we find evidence that a typical VAR model does not seem to be suitable for the evaluation of large financial shocks. If we take our models estimated with data up to 2008 as the main result of this contribution, we have to draw the following conclusion. The models are estimated for a period of moderate financial shocks. Many of these originated from the bursting of the internet bubble 2001/2002. Bond spreads stood at around 200 basis points and shocks were small. If we look at September and October 2008, we find bond spreads of almost 700 basis points. Indeed the pure shock of the Lehman bankruptcy on the spread was around 180 basis points, which is a multiple of what has happened in our estimation period. This is certainly an extreme event.

Comparing our finding from impulse response analysis with what took place in reality after September 2008 is somewhat discouraging. Some back of the envelope calculations provide us with the following numbers for industrial production. A 180 basis points shock is about 7 times the 25 basis points shock in our impulse responses. The expected value for the loss in industrial production for the Netherlands would then be around 4.2 and 9.7% after 12 and 48 months.[14] In reality, however, we witnessed a decline in Dutch industrial production of 17% within 7 months beginning with September 2008.

We have to conclude that the estimated models do not fully cover the effects of extreme shocks on financial markets. This holds both for the dynamics of the development as well as the expected magnitude. Taking the confidence bands for our model predictions into account, we see that the realization of the Lehman shock is not beyond them, but was unexpected large. Future research in this area might indeed be necessary to cover these shortcomings.

[14]The Lehman shock is $\frac{180}{25}$ times our 25 basis points shock which needs to be multiplied by the entries in Table 6 of -0.59 and -1.35%.

References

Aghion, P., P. Bacchetta and A. Banerjee, 2001, Currency crises and monetary policy in an economy with credit constraints, *European Economic Review*, vol. 45, no. 7, pp. 1121–1150.

Aghion, P., P. Bacchetta and A. Banerjee, 2004a, A corporate balance-sheet approach to currency crises, *Journal of Economic Theory*, vol. 119, no. 1, pp. 6–30.

Aghion, P., P. Bacchetta and A. Banerjee, 2004b, Financial development and the instability of open economies, *Journal of Monetary Economics*, vol. 51, no. 6, pp. 1077–1106.

Altunbaş, Y., O. Fazylov and P. Molyneux, 2002, Evidence on the bank lending channel in Europe, *Journal of Banking & Finance*, vol. 26, no. 11, pp. 2093–2110.

Amiti, M. and D. Weinstein, 2011, Exports and financial shocks, *Quarterly Journal of Economics*, vol. 126, no. 4, pp. 1841–1877.

Antony, J., T. Klarl and A. Maußner, 2012, Supranational and national shock absorption policies: Financial shocks and german industrial production, mimeo, CPB and University of Augsburg.

Bai, J., C. Kao and S. Ng, 2009, Panel cointegration with global stochastic trends, *Journal of Econometrics*, vol. 149, pp. 82–99.

Bańbura, M., D. Giannone and L. Reichlin, 2010, Large Bayesian vector auto regressions, *Journal of Applied Econometrics*, vol. 25, no. 1, pp. 71–92.

Beaton, K. and B. Desroches, 2011, Financial spillovers across countries: the case of Canada and the United States, Discussion Paper 2011-1, Bank of Canada.

Bernanke, B.S. and C.S. Lown, 1991, The credit crunch, *Brookings Papers on Economic Activity*, vol. 2, pp. 205–239.

Bernanke, B.S., M. Gertler and S. Gilchrist, 1996, The financial accelerator and the flight to quality, *The Review of Economics and Statistics*, vol. 78, no. 1, pp. 1–15.

Bernanke, B.S., M. Gertler and S. Gilchrist, 1999, The financial accelerator in a quantitative business cycle framework, in J.B. Taylor and M. Woodford, eds., *Handbook of Macroeconomics*, vol. 1C, chap. 21, pp. 1341–1393, Elsevier, 1st ed.

Bloom, N., 2009, The impact of uncertainty shocks, *Econometrica*, vol. 77, no. 3, pp. 623–685.

Bloom, N., S. Bond and J. van Reenen, 2007, Uncertainty and investment dynamics, *The Review of Economic Studies*, vol. 74, no. 2, pp. 391–415.

Boissay, F., 2006, Credit chains and the propagation of financial distress, Working Paper Series 573, ECB.

Bussiére, M., A. Chudik and A. Mehl, 2011, Does the Euro make a difference? Spatiotemporal transmission of global shocks to real effective exchange rates in an infinite var, ECB Working Paper 1292, ECB.

Caballero, R.J. and A. Krishnamurthy, 2001, International and domestic collateral constraints in a model of emerging market crises, *Journal of Monetary Economics*, vol. 48, no. 3, pp. 513–548.

Caballero, R.J. and A. Krishnamurthy, 2003, Excessive dollar debt: Financial development and underinsurance, *The Journal of Finance*, vol. 58, no. 2, pp. 867–893.

Cagetti, M., 2003, Wealth accumulation over the life cycle and precautionary savings, *Journal of Business & Economic Statistics*, vol. 21, no. 3, pp. 339–353.

Caruana, J., 2010, Macroprudential policy: Working towards a new consensus, remarks at the high-level meeting on the emerging framework for financial regulation and monetary policy jointly organised by the bis financial stability institute and the imf institute, washington dc, 23 april 2010., Tech. rep., BIS and IMF Institute.

Chen, Q., D. Gray, H. NDiaye, P.and Oura and N. Tamirisa, 2010, International transmission of bank and corporate distress, IMF Working Paper 10/124, IMF.

Chiu, C.W., B. Eraker, A.T. Foerster, T.B. Kim and H.D. Seoane, 2011, Estimating VAR's sampled at mixed or irregular spaced frequencies: A Bayesian approach, Research Working Paper RW 11-11, Federal Reserve Bank of Kansas City.

Chudik, A. and Fratzscher, 2011, Identifying the global transmission of the 2007-2009 financial crisis in a GVAR model, *European Economic Review*, vol. 55, pp. 325 – 339.

Cooley, T.F. and V. Quadrini, 2006, Monetary policy and the financial decisions of firms, *Economic Theory*, vol. 27, no. 1, pp. 243–270.

Eickmeier, S. and T. Ng, 2011, How do credit supply shocks propagate internationally? A GVAR approach, CEPR Discussion Paper 8720, CEPR.

Faust, J., S. Gilchrist, J.H. Wright and E. Zakrajsek, 2011, Credit spreads as predictors of real-time economic activity: A Bayesian model-averaging approach, NBER Working Paper 16725., NBER.

Fazzari, S.M., R.G. Hubbard and B.C. Petersen, 1988, Financing constraints and corporate investment, *Brookings Papers on Economic Activity*, vol. 1, pp. 141–206.

Fornari, F. and L. Stracca, 2013, What does a financial shock do? First international evidence, Working Paper 1522, ECB.

Fostel, A. and J. Geanakoplos, 2008, Leverage cycles and the anxious economy, *The American Economic Review*, vol. 98, no. 4, pp. 1211–1244.

Galesi, A. and S. Sgherri, 2009, Regional financial spillovers across Europe: A global VAR analysis, IMF Working Paper 09/23, IMF.

Ghysels, E., 2012, Macroeconomics and the reality of mixed frequency data, mimeo, Department of Economics, University of North Carolina.

Giannone, D., M. Lenza and G.E. Primiceri, 2012, Prior selection for vector autoregressions, NBER Working Paper 18467, NBER.

Gilchrist, S., V. Yankov and E. Zakrajšek, 2009, Credit market shocks and economic fluctuations: Evidence from corporate bond and stock markets, *Journal of Monetary Economics*, vol. 56, no. 4, pp. 471–493.

Gilchrist, S., J. Sim and E. Zakrajsek, 2010, Uncertainty, financial frictions and investment, mimeo, Boston University and Federal Reserve Board.

Gilchrist, S. and E. Zakrajsek, 2008, Linkages between the financial and the real sectors, mimeo, Federal Reserve Board.

Gilchrist, S. and E. Zakrajsek, 2012, Credit spreads and business cycle fluctuations, *American Economic Review*, vol. 102, no. 4, pp. 1692–1720.

Gourinchas, P.O. and J.A. Parker, 2002, Consumption over the life cycle, *Econometrica*, vol. 70, pp. 47–89.

Hamilton, J.D., 1994, *Time Series Analysis*, Princeton University Press.

Kiyotaki, N. and J. Moore, 1997, Credit cycles, *Journal of Political Economy*, vol. 105, no. 2, pp. 211–248.

Kyle, A.S. and W. Xiong, 2001, Contagion as a wealth effect, *The Journal of Finance*, vol. 56, no. 4, pp. 1401–1440.

Lorenzoni, G., 2008, Inefficient credit booms, *The Review of Economic Studies*, vol. 75, no. 3, pp. 809–833.

Manova, K., 2008, Credit constraints, heterogeneous firms and international trade, NBER Working Paper 14531, NBER.

Matsuyama, K., 2007, Credit traps and credit cycles, *The American Economic Review*, vol. 97, no. 1, pp. 503–516.

Mody and Taylor, 2004, Financial predictors of real activity and the financial accelerator, *Economics Letters*, vol. 82, pp. 167–172.

Ng, S. and P. Perron, 2001, Lag length selection and the construction of unit root tests with good size and power, *Econometrica*, vol. 69, pp. 1519–1554.

Paasche, B., 2001, Credit constraints and international financial crises, *Journal of Monetary Economics*, vol. 48, no. 3, pp. 623–650.

Peek, J. and E. Rosengren, 1995, The capital crunch: Neither a borrower nor a lender be, *Journal of Money, Credit and Banking*, vol. 27, no. 3, pp. 625–638.

Phillips, P.C.B. and S. Ouliaris, 1990, Asymptotic properties of residual based tests for cointegration, *Econometrica*, vol. 58, no. 1, pp. 165–93.

Schneider, M. and A. Tornell, 2004, Balance sheet effects, bailout guarantees and financial crises, *The Review of Economic Studies*, vol. 71, no. 3, pp. 883–913.

Thakor, A.V., 1996, Capital requirements, monetary policy, and aggregate bank lending: Theory and empirical evidence, *The Journal of Finance*, vol. 51, no. 1, pp. 279–324.

Veld, J. in 't and W. Roeger, 2012, Evaluating the macroeconomic effects of government support measures to financial institutions in the EU, European Economy - Economic Papers 453, Directorate General Economic and Monetary Affairs (DG ECFIN), European Commission.

Xu, T., 2010, The role of credit in international business cycles, Tech. rep., mimeo.

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Appendices

A Mixed Frequencies

This appendix gives the details on our procedure to estimate a VAR with data observable at different frequencies based on Chiu et al. (2011). The algorithm iterates over the following steps until the estimates of the VAR's parameters converge.

Step 1: Chose starting values for the missing observations in y_t. In our case we chose monthly growth rates for employment that correspond to the observed quarterly growth rate spread evenly over the three month interval.

Step 2: Estimate the parameters in c and $A(L)$ by OLS.

Step 3: Compute fitted values with the estimates obtained from Step 2 for the missing observations.

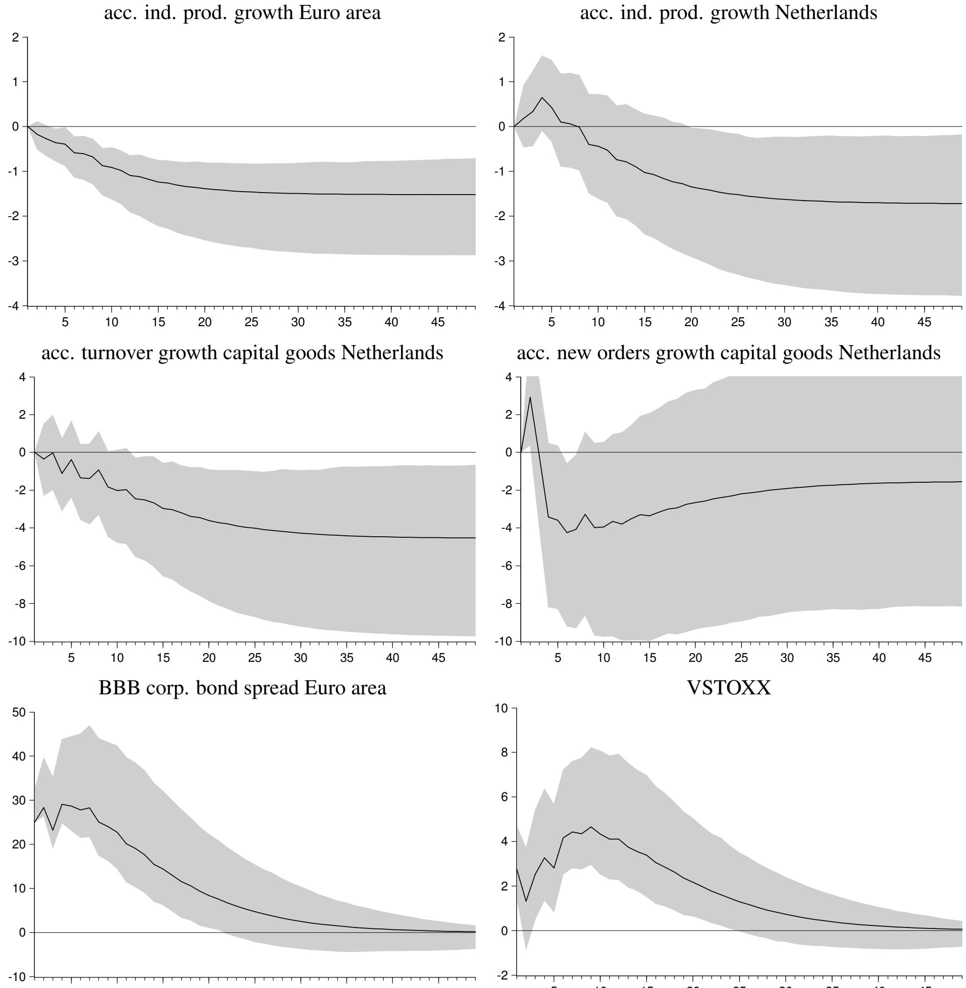
Step 4: Check accuracy of fitted values and correct if necessary. In our case, we observe the growth rate for employment growth only over the time horizon of one quarter. We add up the fitted values for the corresponding three month of the quarter. If both numbers deviate from each other, we shift every monthly fitted value by a third of the discrepancy.

Step 5: Iterate over Steps 2 and 4 until the estimates for c and $A(L)$ converge.

B Industrial Production with Turnover and New Orders

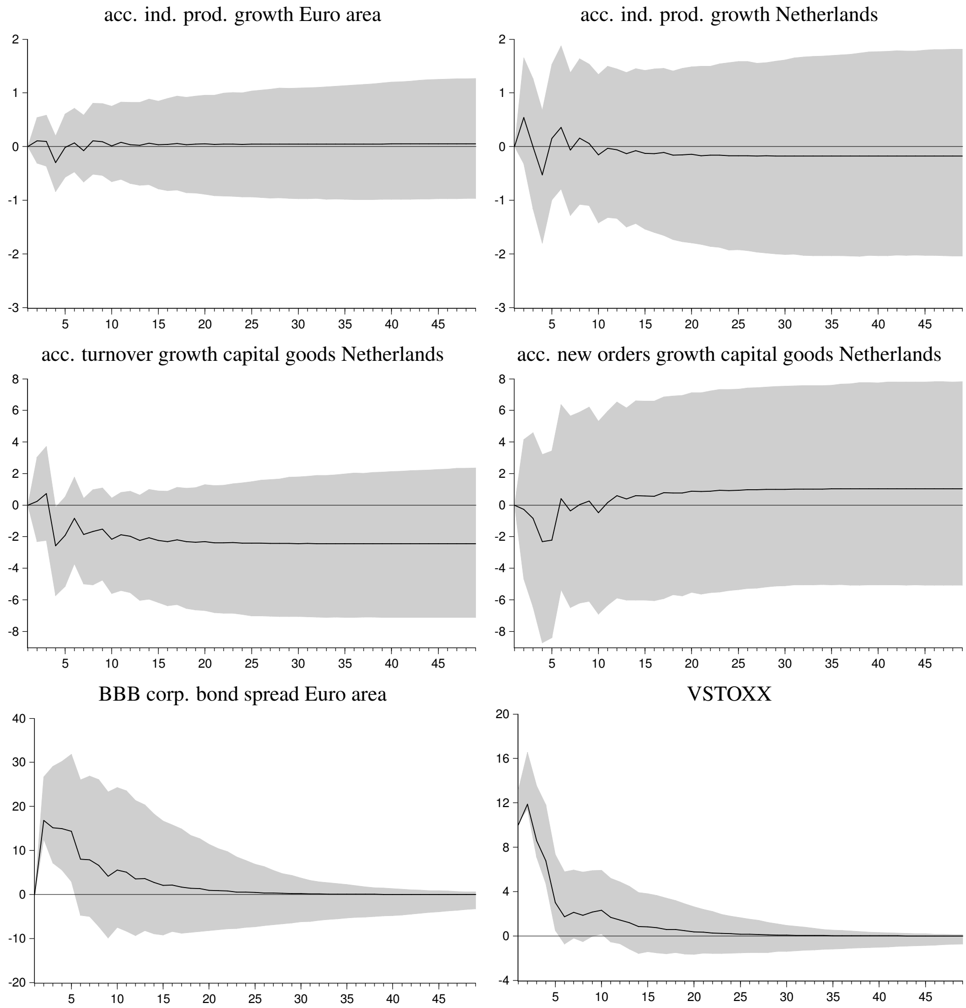
This appendix gives results on an alternative data set in which we replace employment in Dutch industry with turnover and new orders for capital goods. The total data set thus includes industrial production in the Euro area, Dutch industrial production, Dutch turnover in capital goods, Dutch new orders, the BBB corporate bond spread and volatility. Again, we look first at a shock to the spread, using a Cholesky decomposition of the residual covariance matrix as in Gilchrist et al. (2010) and second, at a pure volatility shock.

The results show that the general response characteristic for Euro production and Dutch production are similar to the case in which we do include Dutch employment data. The response pattern for Dutch industrial production is similar to the situation in Figure 6, in which production at first goes up in expectation, to turn negative only after half a year. In addition, the two new series, turnover and new orders, react negatively to the spread shock as well. However, their response paths show large confidence bands. A pure volatility shock, displayed in Figure 11, again mostly increases the uncertainty surrounding the spread shock (compare Figure 7).



Note: Accumulated impulse responses for growth in industrial production (Euro area and Netherlands, percent), turnover and new orders capital goods (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Shaded area 95% confidence interval obtained from bootstrapping with 5,000 replications. Time axis in months. Data sample 1999 to 2007.

Figure 10: Impulse-responses VAR industry 1999-2007; shock in corporate bond spread



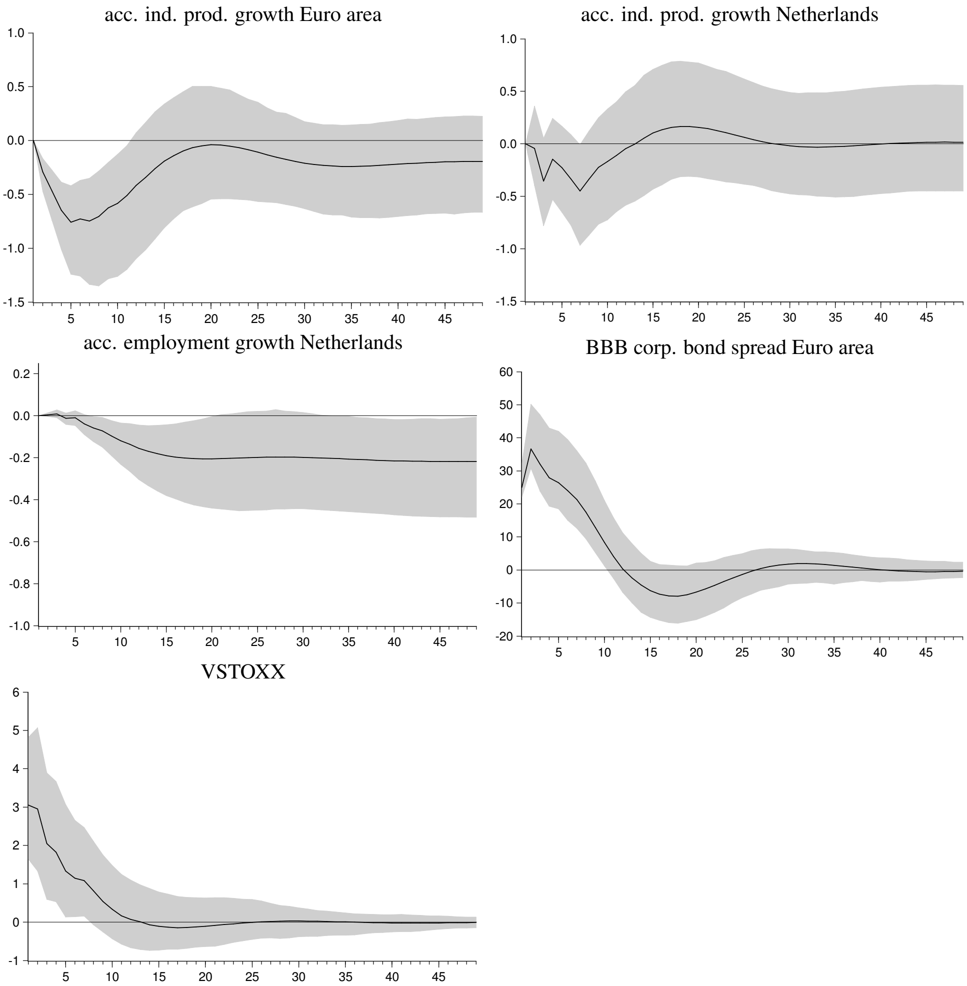
Note: Accumulated impulse responses for growth in industrial production (Euro area and Netherlands, percent), turnover and new orders capital goods (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Shaded area 95% confidence interval obtained from bootstrapping with 5,000 replications. Time axis in months. Data sample 1999 to 2007.

Figure 11: Impulse-responses VAR industry 1999-2007; shock in volatility

C Estimation Results over 1999-2011

C.1 Industrial Production with Employment

This appendix displays the results of the impulse responses for the Dutch industry over the period 1999-2011, using employment data. The comparison is between Figure 12 below and Figure 6 in the main text.

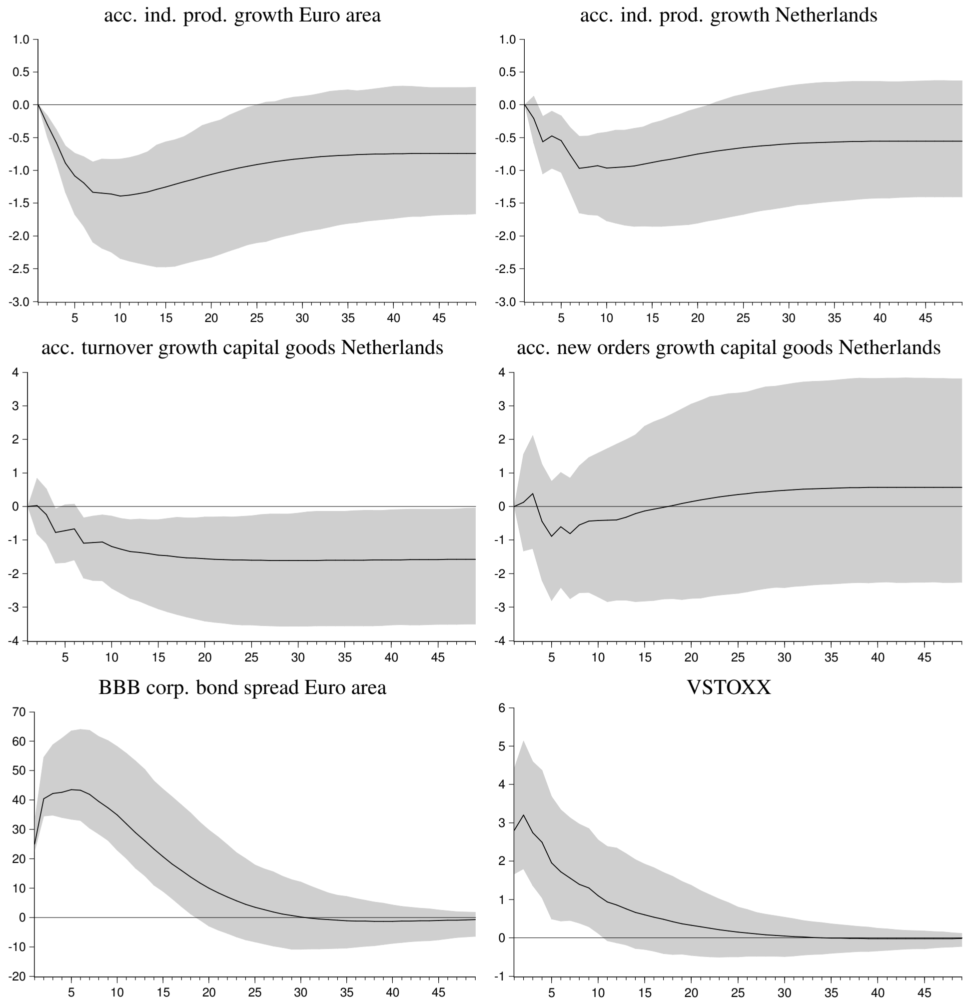


Note: Accumulated impulse responses for growth in industrial production (Euro area and Netherlands, percent), employment industry (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Shaded area 95% confidence interval obtained from bootstrapping with 5,000 replications. Time axis in months. Data sample 1999 to 2011.

Figure 12: Impulse-responses VAR industry 1999-2011; shock in corporate bond spread

C.2 Industrial Production with Turnover and New Orders

We now turn to the industry VAR in production, turnover and new orders growth. Figure 13 displays the impulse responses that correspond to the ones in Figure 10.

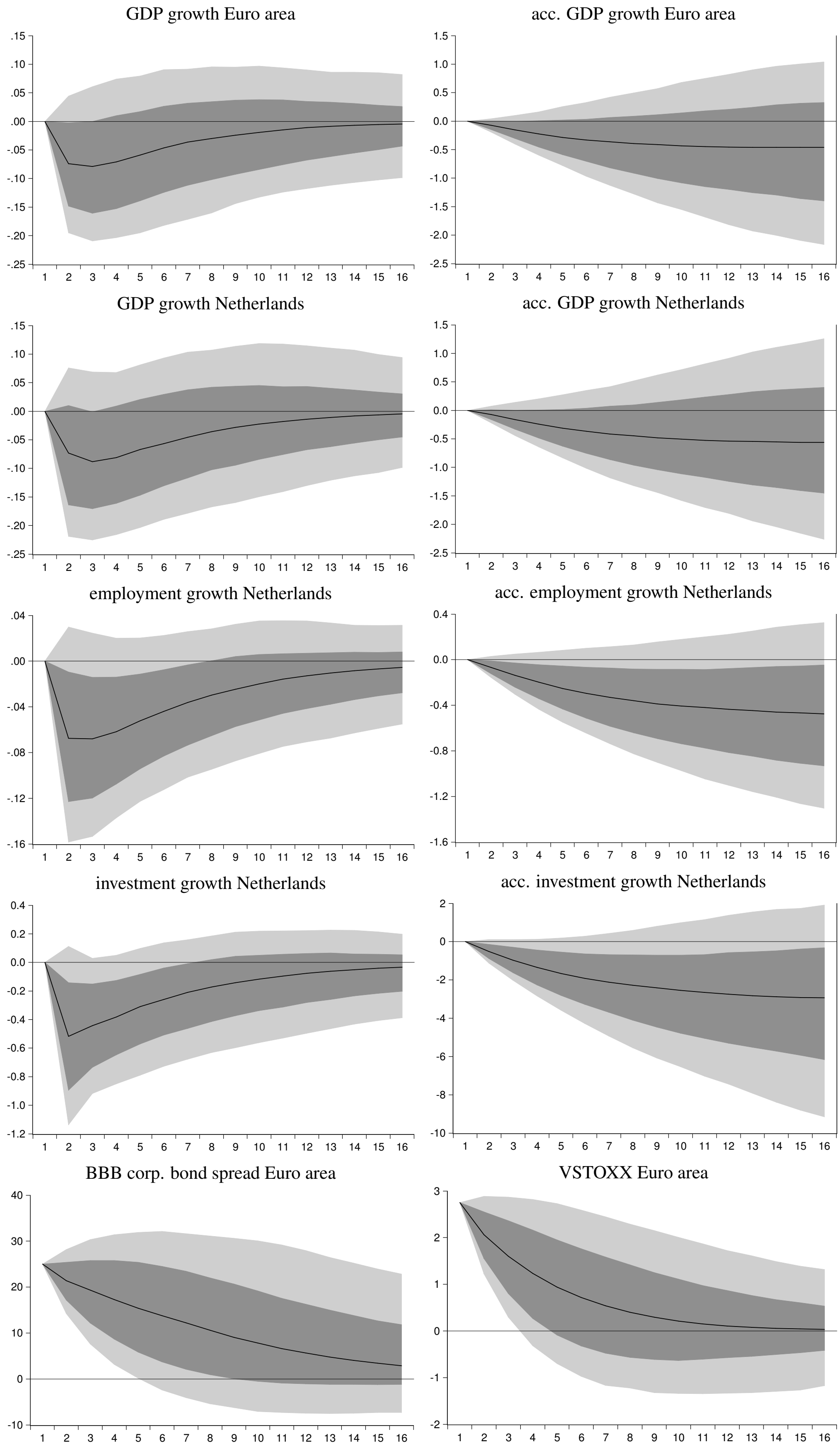


Note: Accumulated impulse responses for growth in industrial production (Euro area and Netherlands, percent), turnover and new orders capital goods (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Shaded area 95% confidence interval obtained from bootstrapping with 5,000 replications. Time axis in months. Data sample 1999 to 2011.

Figure 13: Impulse-responses VAR industry 1999-2011; shock in corporate bond spread

C.3 GDP

Figure 14 gives the impulse responses to a bond spread shock using the model estimates for the extended data set. It compares to Figure 8



Note: Non-accumulated and accumulated impulse responses for growth in GDP (Euro area and Netherlands, percent), employment and investment growth (Netherlands, percent), impulse responses for BBB corporate bond spreads (basis points) and VSTOXX (Euro area). Dark (light) shaded area 66% (90%) error bands. Time axis in quarters. Data sample 1999 to 2007.

Figure 14: Impulse-responses BVAR GDP 1999-2011; shock in corporate bond spread

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