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Effects of US Policy Uncertainty on Swedish GDP Growth

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National Institute of Economic Research

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Abstract

In this paper, we study the effects of US policy uncertainty – measured as the policy uncertainty index of Baker *et al.* (2013) – on Swedish GDP growth. Another source of spillovers of shocks to small open economies is thereby examined. We apply both Bayesian VAR models and spectral analysis to quarterly data from 1988 to 2013. Results show that increasing US policy uncertainty has significant negative effects on Swedish GDP growth. The effect seems to primarily stem from effects on investment growth and export growth. Our findings could prove useful to those who analyse and forecast the Swedish economy and potentially also other similar small open economies.

JEL classification code: C32, F43

Keywords: Spillovers, Small open economy, Political uncertainty index, Bayesian VAR, Spectral analysis

Sammanfattning

I denna studie undersöks effekterna på svensk BNP-tillväxt av förändringar i amerikansk politisk osäkerhet – här mätt enligt ett index framtaget av Baker *et al.* (2013). På så sätt studeras en ny källa till spridningseffekter av störningar till små öppna ekonomier. Vi använder både bayesianska VAR-modeller och spektralanalys på kvartalsdata 1988 till 2013. Ökad amerikansk politisk osäkerhet visar sig ha signifikant negativ effekt på svensk BNP-tillväxt. I synnerhet verkar förändringar i politisk osäkerhet hålla tillbaka investerings- och exporttillväxt. Resultaten i denna studie bedöms bidra till förbättrade prognoser och analyser av svensk ekonomi och eventuellt även andra liknande små öppna ekonomier.

Contents

1. Introduction

Over the last few years, there have been several occasions where policymaking in the United States has been associated with substantial uncertainty. To a large extent, this uncertainty has stemmed from the federal government with recurring conflicts concerning the budget and the debt ceiling. During the fall of 2013, the problems related to these issues were acute. The federal government suffered a partial shutdown due to the disagreement regarding the budget for 2014 and it took significant political effort to raise the debt ceiling.

The inability of the political system to provide a reasonably predictable environment has had consequences in several dimensions. For example, in August 2011, Standard and Poors downgraded the long-term credit rating of the US federal government to AA+.[1] It is also reasonable to assume that the political turmoil has had real economic effects – it is agreed upon by most economists that uncertainty holds back business investment and household consumption.[2] In an economically integrated world, it is likely that increased policy uncertainty in the United States has consequences also abroad. This means that a country such as Sweden – which can be seen as a classic example of a small open economy, with exports constituting approximately 50 percent of GDP – could find its real economy affected by US policy uncertainty.

The purpose of this paper is to empirically investigate whether US policy uncertainty affects the Swedish real economy and, if so, quantify the effects. If effects can be established, this can be relevant information to Swedish policy makers as well as forecasters and analysts. More specifically, we employ the policy uncertainty index of Baker *et al.* (2013) as the measure of US policy uncertainty and assess its importance for Swedish GDP growth. We are accordingly contributing to a fairly large and di-

[1] The downgrade was partly motivated the following way in a press release: "*More broadly, the downgrade reflects our view that the effectiveness, stability, and predictability of American policymaking and political institutions have weakened at a time of ongoing fiscal and economic challenges…*" (Standard and Poors, 2011).

[2] In light of increasing uncertainty, households tend to increase their saving and businesses to reduce their investment; see, for example, Leland (1968), Bernanke (1983), Ferderer (1993) and Bloom (2009).

verse literature on "spillovers" between countries and/or regions; see, for example, Cromwell (1992), Pesaran *et al.* (2004), Galvão *et al.* (2007), Österholm and Zettelmeyer (2008), Bagliano and Morana (2010), Erten (2012) and Österholm and Stockhammar (2014). Relying on the policy uncertainty index of Baker *et al.* (2013) for our analysis, our study is related to that of the International Monetary Fund (2013). But while that study investigated the effect of US policy uncertainty on GDP growth in broad regions such as Asia, Latin America and Sub-Saharan Africa, we focus on the consequences for the small open economy of Sweden. In addition, we employ a completely different methodological framework. Initially, we conduct analysis in a bivariate setting using *i)* a Bayesian VAR (BVAR) model and *ii)* spectral analysis. Analysis in the frequency domain using various spectral density tools has proved powerful in highlighting lead-lag relationships between variables; see, for example, Iacobucci (2005). In order to control for other potentially relevant information, we augment the BVAR analysis so that the model includes seven variables; this way we are less likely to overstate the importance of policy uncertainty. Moreover, we try to assess through which channels the Swedish economy is affected by a shock to the policy uncertainty index. Finally, we look at the estimated effects of US policy uncertainty on Swedish industrial production in both a smaller (with two variables) and a larger (with seven variables) BVAR using data on a monthly frequency.

Our results show that US policy uncertainty affects Swedish GDP growth. Regardless of whether the smaller or larger of the BVAR model is employed, impulse response functions indicate that Swedish GDP growth is significantly reduced by US policy uncertainty shocks. The maximum effect is very similar in the two models; in response to a policy uncertainty index shock of one standard deviation, the maximum effect is a decrease in GDP growth of a touch more than 0.1 percentage point after one to two quarters. The spectral analysis confirms the results, showing that the US policy uncertainty index leads Swedish GDP by approximately 1.8 quarters at peak coherency frequency. Our analysis also indicates that the effects on the Swedish economy arise through negative responses to investment growth and export growth. The impact and lead structure of the monthly US policy uncertainty index on Swedish industrial production are also very similar to the results from quarterly data.

The rest of this paper is organised as follows: Section 2 briefly describes the policy uncertainty index of Baker *et al.* (2013). In Section 3, we conduct our empirical analysis, first in a bivariate setting and then using a larger number of variables; the section ends with some sensitivity analysis. Finally, Section 4 concludes.

2. Policy uncertainty

The US economic policy index proposed by Baker *et al.* (2013) consists of three main components: *i)* frequency of news reference to fiscal and monetary policies, *ii)* upcoming expirations of federal tax code provisions and *iii)* the disagreement among economic forecasters over future inflation and government purchases.

The frequency of news reference to economic policies is measured using ten large newspapers. A count of articles containing keywords such as "uncertainty", "economy", "congress", "deficit", "Federal reserve" and "legislation" – as well as the derivations or roots of these words – is conducted on a monthly basis. The results are then divided by the total number of articles the same month and the ratio reflects the monthly share of articles containing uncertainty augmented words.

Turning to the second component of the index, this is based on scheduled expirations of federal tax code provisions. Such expirations constitute a source of uncertainty to both businesses and households. The present value over a ten-year time frame is calculated using a discount rate of 50 percent per year.

The third component of the index utilizes data from the Federal Reserve Bank of Philadelphia's *Survey of Professional Forecasters*. Quarterly data from the survey are employed and two variables are taken into account: The first variable measures the dispersion of forecasts for consumer price inflation and the second variable measures federal and state purchases, expressed as a percentage of federal and state GDP. The interquartile range of the inflation forecasts is used as a measure of dispersion of inflation. For the government purchases, the interquartile range of four-quarter-ahead forecasts is divided by their median and multiplied by a five-year moving average for the nominal purchases to nominal US GDP.

To construct the overall policy uncertainty index each component is first normalised by its own standard deviation. The index is then calculated as the weighted average using weights 1/2 on the news component and 1/6 on each of the other components (tax expirations, inflation- and government purchases forecast disagreement). The preferred weights are claimed to roughly reflect the distribution of specific sources of policy related uncertainty. The authors showed that the index is relatively robust to other weightings.

3. Empirical analysis

We now turn to the empirical part of the paper, where focus initially is on bivariate analysis using only the policy uncertainty index and Swedish GDP growth.

3.1 Bivariate analysis

Throughout the paper, we use quarterly data from 1988Q1 to 2013Q2 for the analysis. Quarterly observations on the policy uncertainty index are generated by taking averages of the original monthly observations. Swedish GDP growth is calculated based on seasonally adjusted real GDP. Data are shown in Figure A1 in the Appendix.

3.1.1 A BIVARIATE BAYESIAN VAR

We initially employ a BVAR model to assess the effect of the policy uncertainty index on Swedish real GDP growth. The model in its general form is given by

$$\mathbf{G}(L)(\mathbf{x}_t - \boldsymbol{\mu}) = \boldsymbol{\eta}_t, \qquad (1)$$

where $\mathbf{G}(L) = \mathbf{I} - \mathbf{G}_1 L - \ldots - \mathbf{G}_m L^m$ is a lag polynomial of order *m*, $\mathbf{x}_t$ is an *n*x1 vector of stationary variables, $\boldsymbol{\mu}$ is an *n*x1 vector describing the steady-state values of the variables in the system and $\boldsymbol{\eta}_t$ is an *n*x1 vector of *iid* error terms fulfilling $E(\boldsymbol{\eta}_t) = \mathbf{0}$ and $E(\boldsymbol{\eta}_t \boldsymbol{\eta}_t') = \boldsymbol{\Sigma}$. As can be seen from equation (1), the specification of the model is slightly unconventional as it is expressed in deviation from the steady state. This specification of the BVAR – which was developed by Villani (2009) – has the benefit that an informative prior distribution for $\boldsymbol{\mu}$ often can often be specified. This has, not surprisingly, been shown to be beneficial for forecasting performance; see, for example, Beechey and Österholm (2010).[3]

The priors on the parameters of the model used in this paper follow those in Villani (2009). The prior on $\boldsymbol{\Sigma}$ is given by $p(\boldsymbol{\Sigma}) \propto |\boldsymbol{\Sigma}|^{-(n+1)/2}$ and the prior on $vec(\mathbf{G})$, where $\mathbf{G} = (\mathbf{G}_1 \quad \ldots \quad \mathbf{G}_m)'$, is given by $vec(\mathbf{G}) \sim N_{mn^2}(\boldsymbol{\theta}_{\mathbf{G}}, \boldsymbol{\Omega}_{\mathbf{G}})$.[4] Finally, the prior on $\boldsymbol{\mu}$ is given by $\boldsymbol{\mu} \sim N_n(\boldsymbol{\theta}_{\boldsymbol{\mu}}, \boldsymbol{\Omega}_{\boldsymbol{\mu}})$ and is specified in detail in Table A1 in the Appendix. As can be seen, the prior mean for the policy uncertainty index is centred on 100. This is based on the fact that Baker *et al.* (2013) normalise the index to have a mean of 100 over the period 1985 to 2009. The prior for Swedish GDP growth is the same as that used in Österholm (2010). The hyperparameters of the model are uncontroversial and follow the literature.[5] Finally, the lag length in the model is set to $m = 4$.

We initially define the vector

$$\mathbf{x}_t = \begin{pmatrix} p_t^{US} & y_t \end{pmatrix}', \tag{2}$$

where p_t^{US} is the policy uncertainty index and y_t is the percentage change (quarter-on-quarter) in Swedish real GDP. Since the United States can be

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[3] As shown by Villani (2009), structural breaks – in terms of a shift in the unconditional mean – can also be taken into account in the model. This can be a useful feature and has been employed empirically by for example Beechey and Österholm (2010) to address various countries' adoption of inflation targets. In the analysis in this paper though, we have less of a reason to believe that structural breaks that affect the univariate properties of a variable or the relationship between variables in a quantitatively meaningful way have occurred during the sample. We hence do not allow for any structural breaks.

[4] It can here be noted that the priors on the dynamics are modified slightly relative to the traditional Minnesota prior. Rather than a prior mean on the first own lag equal to 1 and zero on all other lags (which is the traditional specification), the prior mean on the first own lag is here set equal to 0.9 for variables that are modelled in levels and 0 for variables that are expressed as growth rates; all subsequent lags have a prior mean of zero. The reason for this is that the traditional specification is theoretically inconsistent with the mean-adjusted model, as it takes its starting point in a univariate random walk and such a process does not have a well-defined unconditional mean.

[5] See, for example, Doan (1992) and Villani (2009) where the overall tightness is set to 0.2, the cross-variable tightness to 0.5 and the lag decay parameter to 1.

described as a large closed economy and Sweden as a small open economy, we will in all the analysis which relies on BVARs treat the US variables as block exogenous with respect to the Swedish variables. This block exogeneity is achieved with an additional hyperparameter which shrinks the parameters on the Swedish variables in the US equations to zero, see Villani and Warne (2003) for details.

Impulse response functions are given in Figure A2 in the Appendix and show that a one standard deviation[6] shock to the policy uncertainty index significantly reduces Swedish GDP growth with a fairly short delay.[7] The maximum effect can be found after two quarters where growth is reduced by 0.13 percentage points. The policy uncertainty index has had some big movements, for example between the second and third quarter 2011 the index rose by 69 units, from 147 to 216, meaning that the estimated reduction in Swedish GDP growth is quantitatively meaningful.[8] The variance decomposition is shown in Figure A3. As would be expected, most of the forecast error variance in Swedish GDP growth is due to the own shocks. However, as can be seen from the figure, a non-trivial amount is due to the US policy uncertainty shocks.

3.1.2 SPECTRAL ANALYSIS

In the frequency domain, the variance of a time series is decomposed according to periodicity. This may reveal important features of univariate or bivariate time series, not apparent in the time domain.

Frequency domain techniques allow for studying correlation differentiated by frequency. In practice, several cross-spectral functions are necessary to describe the comovements of two time series in the frequency domain. The cross-spectrum is most easily studied through the so called phase and the coherency functions. They are both derived from the cross-spectrum defined as the Fourier transform of the cross-covariance function $\gamma_{1,2}(j)$, namely

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[6] The standard deviation is 17.6 units.

[7] The impulse response functions – and the variance decompositions discussed later – are calculated using the Cholesky decomposition of the covariance matrix. The order of the variables is the same as that given in equation (2).

[8] 69 units is a shock with a magnitude of almost four standard deviations.

$$f_{1,2}(w) = \frac{1}{2\pi}\sum_{j=-\infty}^{\infty}\gamma_{1,2}(j)e^{-iwj}. \tag{3}$$

The cross-spectrum can be decomposed into one real part, called the co-spectrum, $c_{1,2}(w)$, and one imaginary part called the quadrature spectrum, $q_{1,2}(w)$. The phase spectrum is then defined as

$$\phi_{1,2}(w) = \tan^{-1}\left[\frac{-q_{1,2}(w)}{c_{1,2}(w)}\right], \tag{4}$$

and the (squared) coherency spectrum as

$$K^2_{1,2}(w) = \frac{A^2_{1,2}(w)}{f_1(w)f_2(w)} \tag{5}$$

with $A^2_{1,2}(w) = \sqrt{c^2_{1,2}(w) + q^2_{1,2}(w)}$ being the so called cross-amplitude spectrum and $f_1(w)$ and $f_2(w)$ the univariate spectral densities $f_k(w) = \frac{1}{2\pi}\sum_{j=-\infty}^{\infty}\gamma_k(j)e^{-iwj}, k = 1,2.$

The coherency is essentially the standardized cross-amplitude function and is analogous to the coefficient of determination, R^2, in the time domain. Cross-spectral analysis thus decomposes the series into individual cyclical components. The coherency is the squared correlation coefficient between two time series $y_{1,t}$ and $y_{2,t}$ at frequency w. Clearly, $0 \le K^2_{1,2}(w) \le 1$. A value of $K^2_{1,2}(w)$ close to one implies a strong linear relationship of the two time series at frequency w. The corresponding phase indicates at what lag this correlation occurs. It is only of interest to study the phase at frequencies where the coherency is large. Trends in the phase spectrum reveal information of the lead or lag relationship. If the trend is linear, the slope is the length of the lead or the lag. A nonlinear phase spectrum indicates varying lead or lag lengths.

National product series, such as GDP, are typically considered to have a unit root (Granger, 1966). Trends and unit roots show up as low or infinite frequency variations in the spectral density. Standard analysis requires stationarity and hence economic time series are detrended prior to further analysis. Here, Swedish GDP in levels has a unit root according to the Augmented Dickey-Fuller test; see Table A2. Done properly, detrending eliminates an infinite peak at zero frequency. Given a finite time series, it is impossible to design an ideal filter, and one has to make a good approximation. The most widely used detrending filters are the ones suggested by Hodrick and Prescott (1997), Beveridge and Nelson (1981) and Baxter and King (1999). The first difference filter is also commonly applied. However, none of these filters take the highly possible event of heteroscedasticity into consideration. This is surprising because in spectral analysis contributions to the variance at specific frequencies are of prime interest. Neglecting heteroscedasticity will distort frequency domain results; see, for example, the discussion in Engle (1974). Here, at both the US policy uncertainty index and the log difference of Swedish GDP are heteroscedastic; see Table A3. Because of this, the heteroscedasticity removing filter of Stockhammar and Öller (2012) will be considered here.[9] The same filter was used in Stockhammar and Öller (2011) prior to the distributional analysis of several GDP series.

The frequency to focus on in the phase spectrum is the peak coherency frequency. The top panel of Figure A4 shows that the squared coherency peaks at frequency $w = 0.41$, where $K_{1,2}^2(0.41) = 0.49$. This peak coherency frequency corresponds to a relatively linear (positive) part of the phase spectrum; see the bottom panel of Figure A4. The slope is estimated using linear regression on the frequency of interest and four observations on each side. The coherency is also rather high at high frequencies. At this frequency, the trend in the phase spectra is negative hence indicating a feedback. Put in practice, the phase spectrum for the filtered series indicates that the political uncertainty index leads Swedish GDP growth at the highest coherency frequency by approximately 1.8 quarters. The *p*-value of the slope parameter, and hence the measure of phase shift, is 0.00. Using the raw series, as in the Bayesian VAR models, the phase shift is approximately 1.7 quarters at peak coherency frequency, see Figure A5.

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[9] The results are relatively robust (coefficients have the same signs and are still significant) even when other filters are applied.

3.2 Analysis using a larger Bayesian VAR

Our analysis has so far been conducted in a bivariate setting. However, in order to not overstate the importance of the policy uncertainty index we want to control for other information that might be relevant when explaining Swedish GDP growth that the policy uncertainty index might be correlated with. Two obvious candidates are US GDP growth and the US high yield bond spread, both of which are commonly used in this type of modelling. We choose to address this issue by taking Österholm's (2010) model used to study the effects of the financial crisis on the Swedish economy and augmenting it with the policy uncertainty index. This means that we define the vector $\mathbf{x}_t$ of stationary variables as

$$\mathbf{x}_t = \begin{pmatrix} y_t^{US} & p_t^{US} & HY_t^{US} & y_t & HC_t & BC_t & FI_t \end{pmatrix}', \qquad (6)$$

where p_t^{US} and y_t are defined as in equation (2) above, y_t^{US} is the percentage change (quarter-on-quarter) in seasonally adjusted US real GDP and HY_t^{US} the high-yield corporate bond spread in the United States.[10] Data are shown in Figure A1 and results from unit root tests can be found in Table 2 in the Appendix. Both real and financial effects that the US has on the Swedish economy should be captured by this specification. In addition to y_t, we now have the following variables for the Swedish economy: HC_t is a household confidence measure based on the *Economic Tendency Survey* conducted by the National Institute of Economic Research (NIER) and BC_t is a confidence indicator for the manufacturing industry based on the same survey.[11] Finally, FI_t is a Swedish financial conditions index.[12] Priors are

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[10] The high-yield bond spread is sometimes interpreted as reflecting risk appetite; see, for example, Levy Yeyati and González Rozada (2005) and Österholm and Zettelmeyer (2008). It has also been shown to have predictive power for the US real economy; see, for example, Mody and Taylor (2003).

[11] In Österholm's (2010) model, business confidence was given by a variable based on a dynamic factor model; see Hansson *et al*. (2005) for details. Since the National Institute of Economic Research has stopped publishing this variable, we here instead use the confidence indicator for the manufacturing industry.

[12] The financial conditions index was developed by Österholm (2010). For examples of other financial conditions indicies and their applications, see, for example, Mayes and Virén (2001), Swiston (2008) and Angelopoulou *et al*. (2013). A good overview is provided in Hatzius *et al*. (2010).

given in Table A1 in the Appendix and follow those employed in Österholm (2010).[13]

Impulse response functions and a variance decomposition are given in Figures A6 and A7 in the Appendix.[14] Impulse response functions are almost exclusively in line with what we would expect based on economic theory. It can first be noted that a shock to US GDP growth decreases policy uncertainty, the high yield bond spread and the financial conditions index whereas it increases Swedish GDP growth, household confidence and business confidence. Looking at the effects that policy uncertainty shocks have on the variables in the system, we note that the effects typically have the correct sign but that they are not always significant. Turning to the issue of primary interest, it can be seen that the maximum effect on Swedish GDP growth of a one standard deviation shock to policy uncertainty is -0.11 percent. This is reached after one quarter and is significantly different from zero. A shock to the high yield bond spread decreases GDP growth in both the United States and Sweden; it also significantly lowers household and business confidence and causes a deterioration of Swedish financial conditions (that is, an increase in the financial conditions index).

Turning next to the shocks to Swedish variables, it can initially be noted that they have no effect on the US variables; this is of course due to the block exogeneity assumption described in Section 3.1.1. Shocks to Swedish GDP growth significantly raise business confidence but, perhaps somewhat surprisingly, has no significant effect on household confidence.[15] A shock to household confidence significantly raises Swedish GDP growth and lowers the financial index. Similarly, a shock to the business confidence raises Swedish GDP growth and household confidence and lowers the financial index. Finally, a shock to the financial index lowers Swedish GDP growth, household confidence and business confidence. Summing up the impulse responses, we conclude that the model generally behaves very well. This is of practical interest to both forecasters

[13] It can be noted that the confidence indicator for the manufacturing industry and the financial index both have a mean of 100 over the sample by construction.

[14] As in Section 3.1.1, the impulse response functions and the variance decomposition are calculated using the Cholesky decomposition. The standard deviation to the shock of the policy uncertainty equation is 16.0 in this specification of the BVAR.

[15] The point estimate has the expected sign though.

and analysts since the model then could be used both for forecasting and scenario analysis.

3.3 Sensitivity analysis

3.3.1 ALTERNATIVE SPECIFICATIONS OF THE LARGER BAYESIAN VAR

Based on the above results, we believe that it is reasonable to conclude that US policy uncertainty does have effects on Swedish GDP growth. We want to be as sure as possible though that the relationship we have found is an economically meaningful one. One way to assess this is to investigate the different channels discussed in the introduction. To recapitulate, US policy uncertainty could hold back both business investment and household consumption in Sweden. This could happen with a fairly short lag since forward looking businesses and households in Sweden realise that the policy uncertainty will have economic consequences for the United States which, in an economically integrated world, will affect the Swedish economy through weaker exports.

We accordingly estimate three additional BVAR models with seven variables each to see which, if any, of these channels which appear to be at work. The specifications are given by equation (6) but instead of having Swedish GDP growth in the model, we include *i)* investment growth, *ii)* household consumption growth and *iii)* export growth one at a time. Impulse response functions for these three models are given in Figures A8 to A10 in the Appendix. As before, the models appear well behaved in general. Concerning the effect of US policy uncertainty shocks on the Swedish investment growth, household consumption growth and export growth, we can see that for household consumption growth, the effect is not significant (although the point estimates indicate a negative effect). For investment growth and export growth, on the other hand, there is a significant negative effect, supporting the importance of these channels. These results provide further support for our conclusion that US policy uncertainty is a relevant variable to take into account when analysing Swedish GDP growth.[16]

3.3.2 MONTHLY DATA – EFFECTS ON SWEDISH INDUSTRIAL PRODUCTION

It might also be useful to estimate the model using monthly data, thus utilizing the potentially greater variation of the higher frequency data. Instead of GDP growth, we now make use of industrial production in the United States and in Sweden (percentage change, year-on-year). Impulse response functions for the bivariate model and the model with seven variables are shown in Figures A11 and A12. The maximum effect on Swedish industrial production of a one standard deviation shock to policy uncertainty are in both models approximately -0,6 percent and in both models the effect is significantly different from zero. The maximum effect is reached after 10 months (in the bivariate model) and 8 months (in the model with seven variables). The results are thus very similar to the results from the quarterly model. In addition, the results conform well to the ones from the frequency domain where the phase shift is 7.4 months at peak coherency frequency; see Figures A13 and A14. Judging by the impulse response functions in Figure A12, a shock to US industrial production has a significant effect on Swedish industrial production and also increases both household confidence and business confidence in Sweden. A shock to the high yield bond spread significantly decreases industrial production

[16] We have also conducted further sensitivity analysis using quarterly data. First, the US policy uncertainty index in the BVAR with seven variables was replaced with the European policy uncertainty index of Bloom *et al*. (2013). Since data were available for a shorter time period, the model was then estimated on the sample 1997Q1-2013Q2. Results from these estimations show that European policy uncertainty affects Swedish GDP growth in a negative way. This finding does not come as a complete surprise since it has been shown previously that the European policy uncertainty index affects the Swedish economy (Österholm and Stockhammar, 2014). Second, we replaced Swedish GDP growth in the BVAR with seven variables with goods exports to four major recipients of Swedish goods exports – namely the United States, Norway, Germany and the United Kingdom – thereby hoping to be able to draw conclusions concerning the channels through which US policy uncertainty works. (The series were used one at a time, that is, we estimated four different models with seven variables each.) Due to data availability, we also in this case had to rely on a shorter sample, 1995Q2-2013Q2. Results from this exercise are, however, not very encouraging. In none of the four models is the effect of a shock to policy uncertainty found to have a significant effect on Swedish goods exports. We believe that this largely is a data issue. Not only is the sample shorter than in our main analysis, it is also the case that the series with goods exports growth are substantially more volatile than both GDP growth and the growth of total exports. Finally, in order to even further try to make sure that the importance of US policy uncertainty has not been overstated, we extended the number of variables in the BVAR beyond seven by also including three additional variables in the US block of the model, namely the unemployment rate, CPI inflation and the three month treasury bill rate. Judging by the impulse response functions from this ten-variable BVAR, US policy uncertainty shocks still have a significantly negative effect on Swedish GDP growth. None of the results described in this footnote are reported in detail but are available from the authors upon request.

in both the United States and Sweden. The results from the monthly model are thus very similar to those from the quarterly model.

4. Conclusions

In this paper, we have investigated whether the US policy uncertainty index of Baker *et al.* (2013) has effects on Swedish GDP growth. An additional source of spillovers of shocks to small open economies, here exemplified by Sweden, has thereby been examined. Impulse response functions from BVAR models suggest that shocks to the policy uncertainty index have a significant negative effect on Swedish GDP growth. The maximum effect is reached after one to two quarters in the different models. The effect seems to primarily stem from effects on investment growth and export growth. Our findings from the BVAR models are confirmed by analysis conducted in the frequency domain which suggests that the political uncertainty index leads Swedish GDP growth at the highest coherency frequency by approximately 1.8 quarters. Estimated effects using monthly data are very similar.

The fact that another source of spillovers from the United States to Sweden has been established could prove useful to those who analyse and forecast the Swedish economy and perhaps also other similar small open economies. It also seems like relevant information to policymakers. We do of course not believe that the economy can be fine-tuned; the size of the effects of US policy uncertainty on Swedish GDP growth is – as illustrated by the impulse response functions – uncertain and there is also substantial uncertainty surrounding the transmission mechanisms of monetary and fiscal policy. We nevertheless argue that a more expansionary economic policy could be considered by Swedish policymakers in light of increasing US policy uncertainty.

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Appendix

Table A1. Steady-state priors for the Bayesian VARs.

Variable	Prior interval
y_t^{US}	(0.50, 0.75)
p_t^{US}	(95.0,105.0)
HY_t^{US}	(3.0, 6.0)
y_t	(0.50, 0.75)
HC_t	(-5.0, 5.0)
BC_t	(95.0, 105.0)
FI_t	(95.0, 105.0)

Note: Ninety-five percent prior probability intervals for parameters determining the unconditional means. Prior distributions are all assumed to be normal. Variables are defined in equations (2) and (6).

Table A2. Results from Augmented Dickey-Fuller tests.

Variable	p-value
X_t^{US}	0.85
y_t^{US}	0.00
p_t^{US}	0.00
HY_t^{US}	0.01
X_t	0.97
y_t	0.00
HC_t	0.03
BC_t	0.01
FI_t	0.00

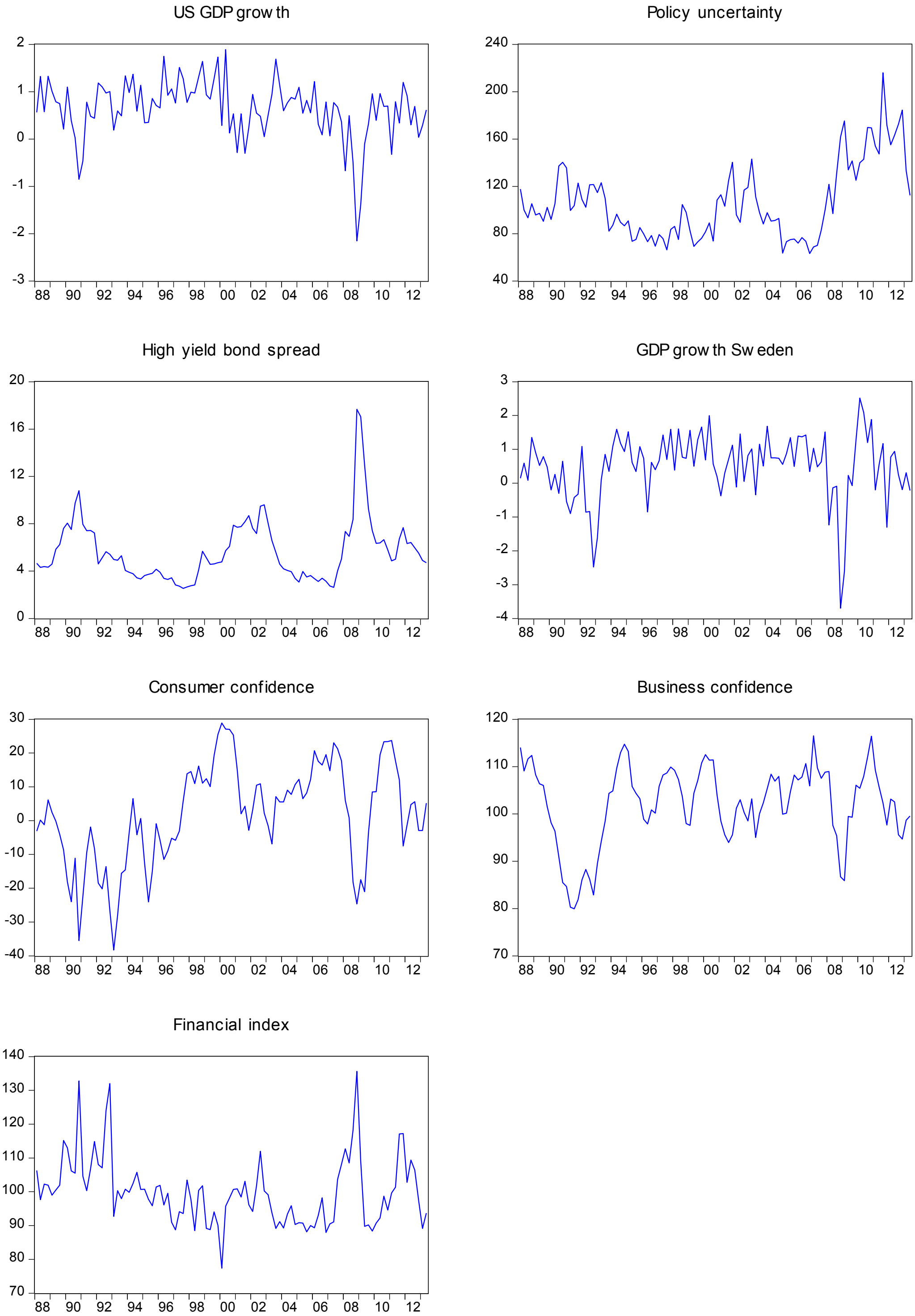
Note: Variables are defined in equations (2) and (6). X_t^{US} and X_t denote the levels of US and Swedish GDP, respectively. That is, $y_t = (X_t - X_{t-1}) / X_{t-1}$.

Table A3. Results from ARCH-LM tests.

Variable	p-value
p_t^{US}	0.00
$\ln(X_t)$	0.00
Δp_t^{US}	0.31
$\Delta \ln(X_t)$	0.02
Filtered p_t^{US}	0.41
Filtered $\Delta \ln(X_t)$	0.65

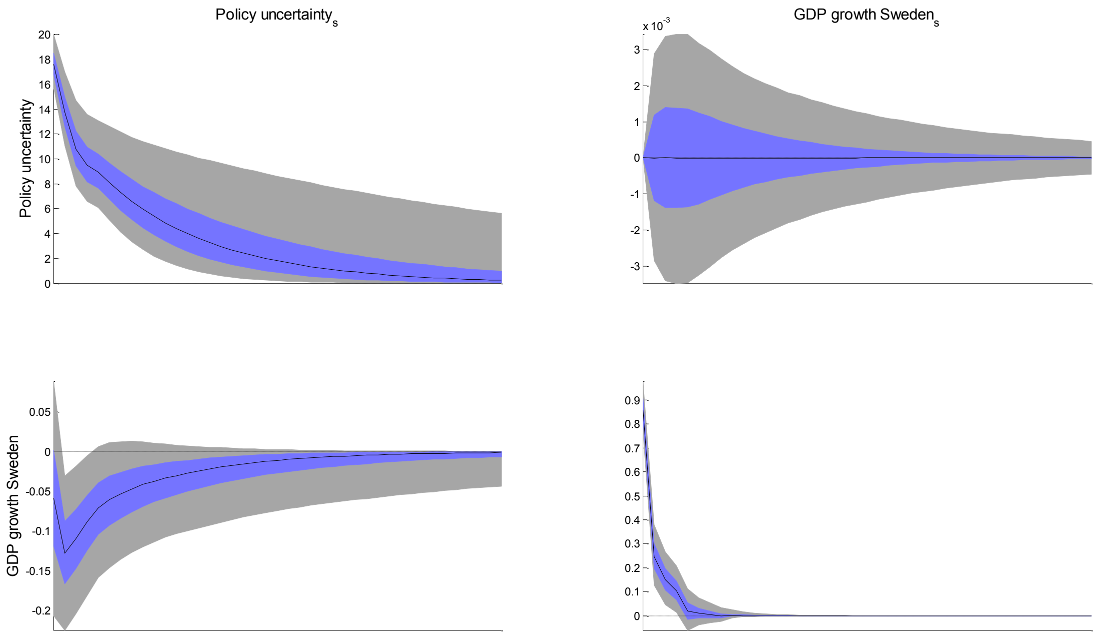
Note: p_t^{US} is the US policy uncertainty index. X_t is the level of Swedish GDP. The filtered data have been filtered using the heteroscedasticity removing filter of Stockhammar and Öller (2012).

Figure A1. Data.



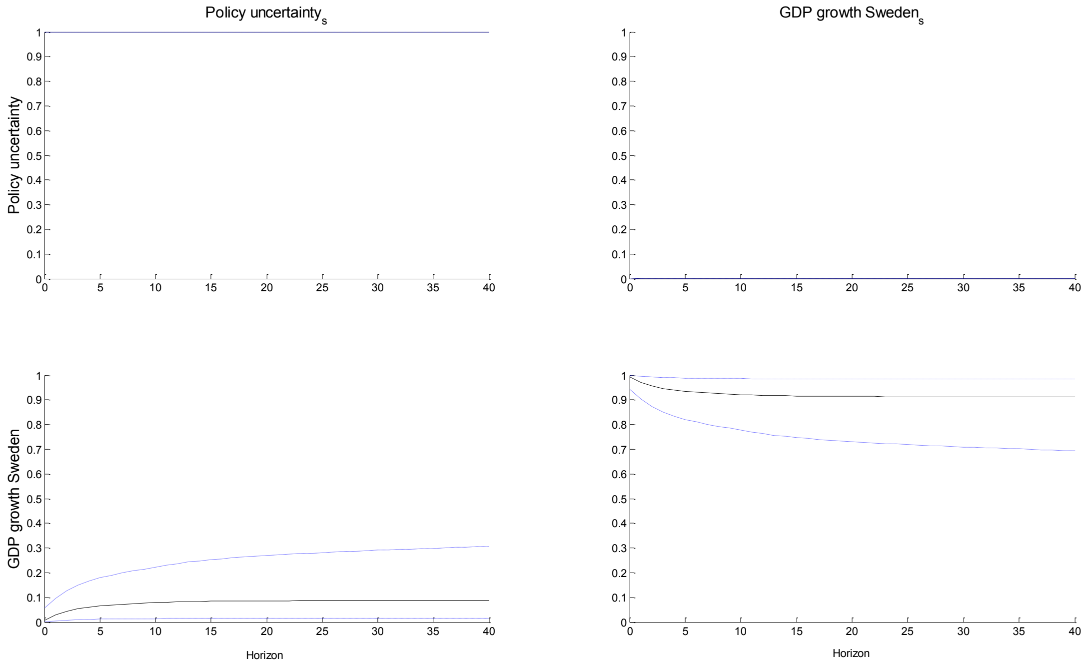
Note: US and Swedish GDP growth are measured in percent. Policy uncertainty, consumer confidence, business confidence and the financial index are all indices. The high yield bond spread is measured in percentage points.

Figure A2. Impulse response functions from bivariate Bayesian VAR.



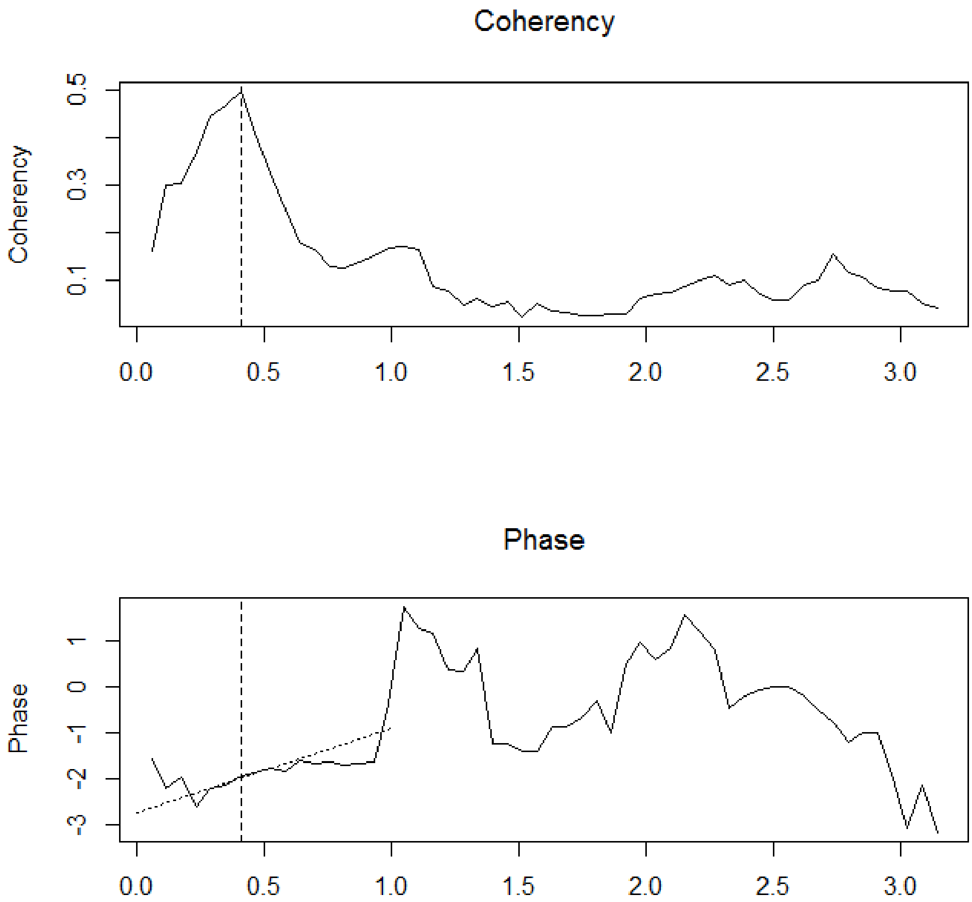
Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 quarters.

Figure A3. Variance decomposition from bivariate Bayesian VAR.



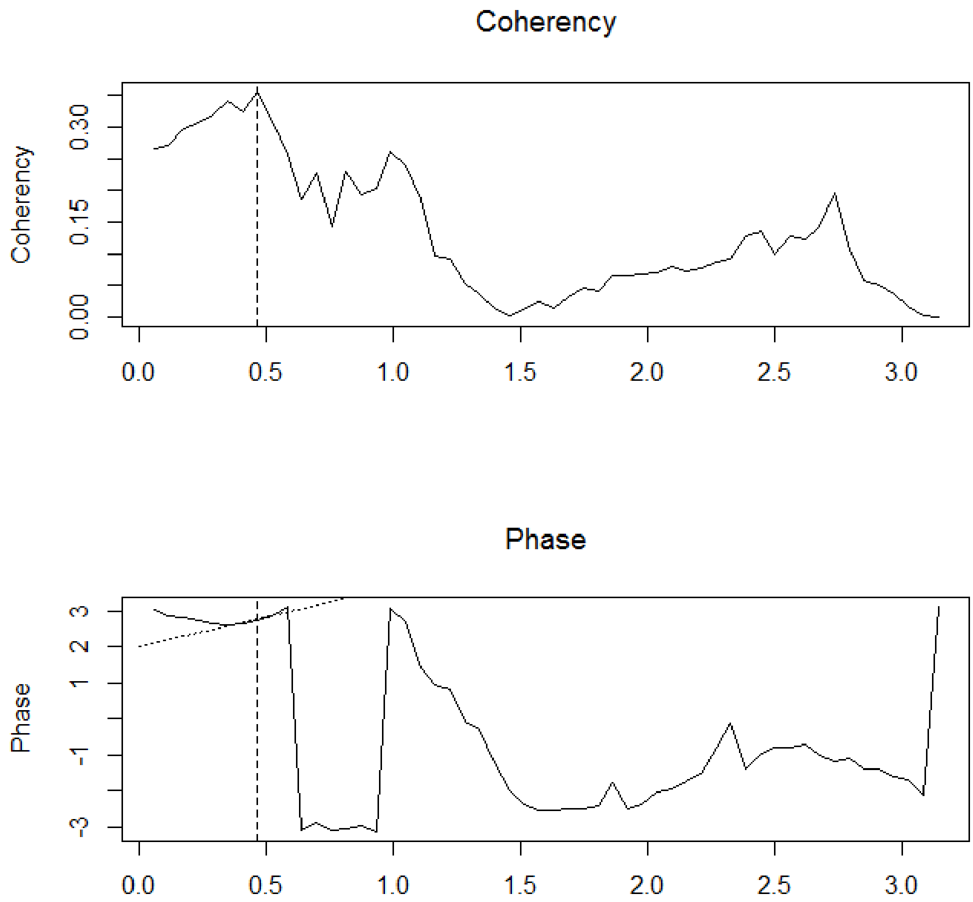
Note: Black line is the median. Dashed lines provide 90% confidence band. Maximum horizon is 40 quarters.

Figure A4. The coherency and phase spectra for US policy uncertainty and Swedish GDP growth, quarterly data (filtered series).



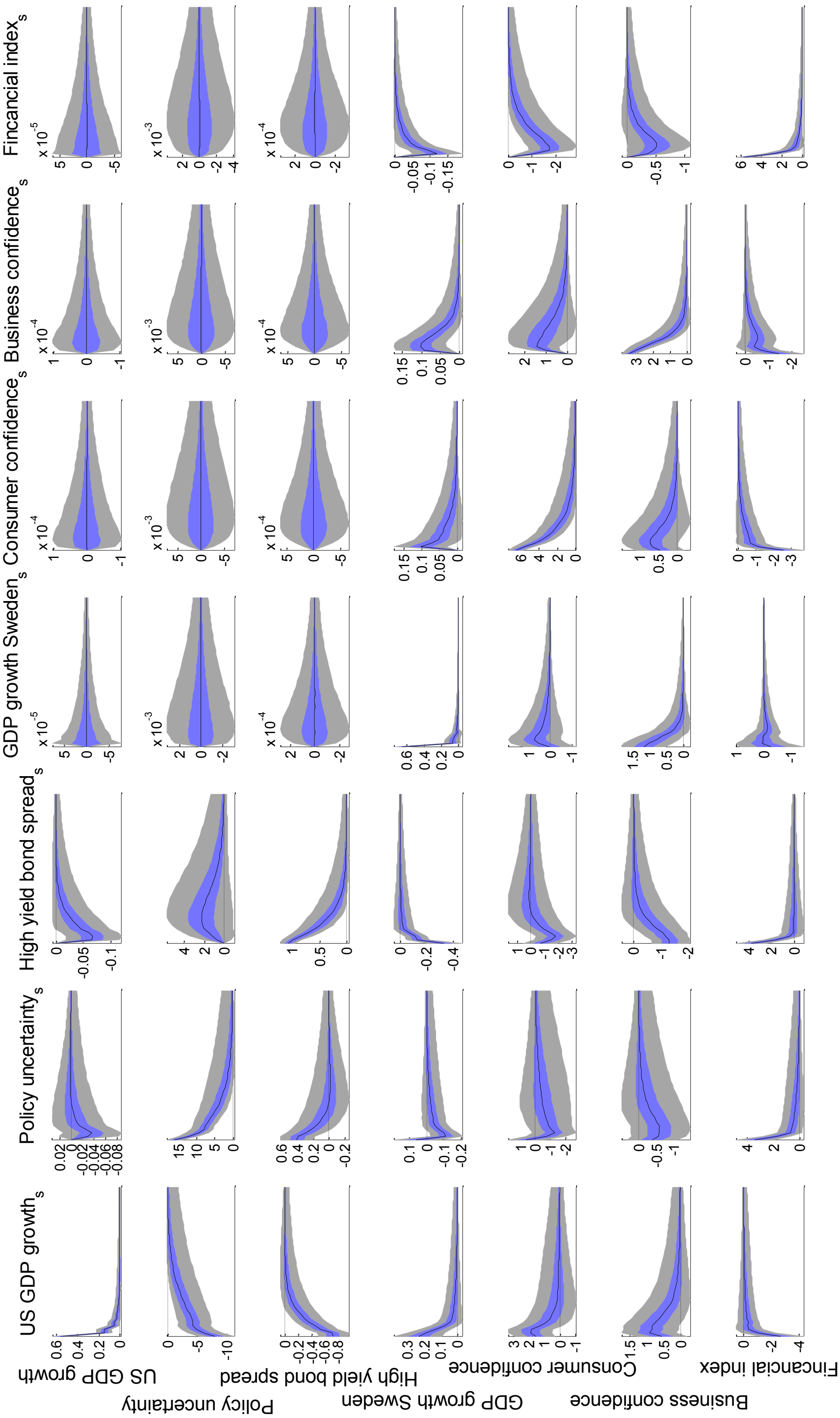
Note: The data have been filtered using the heteroscedasticity removing filter of Stockhammar and Öller (2012).

Figure A5. The coherency and phase spectra for US policy uncertainty and Swedish GDP growth, quarterly data (raw series).



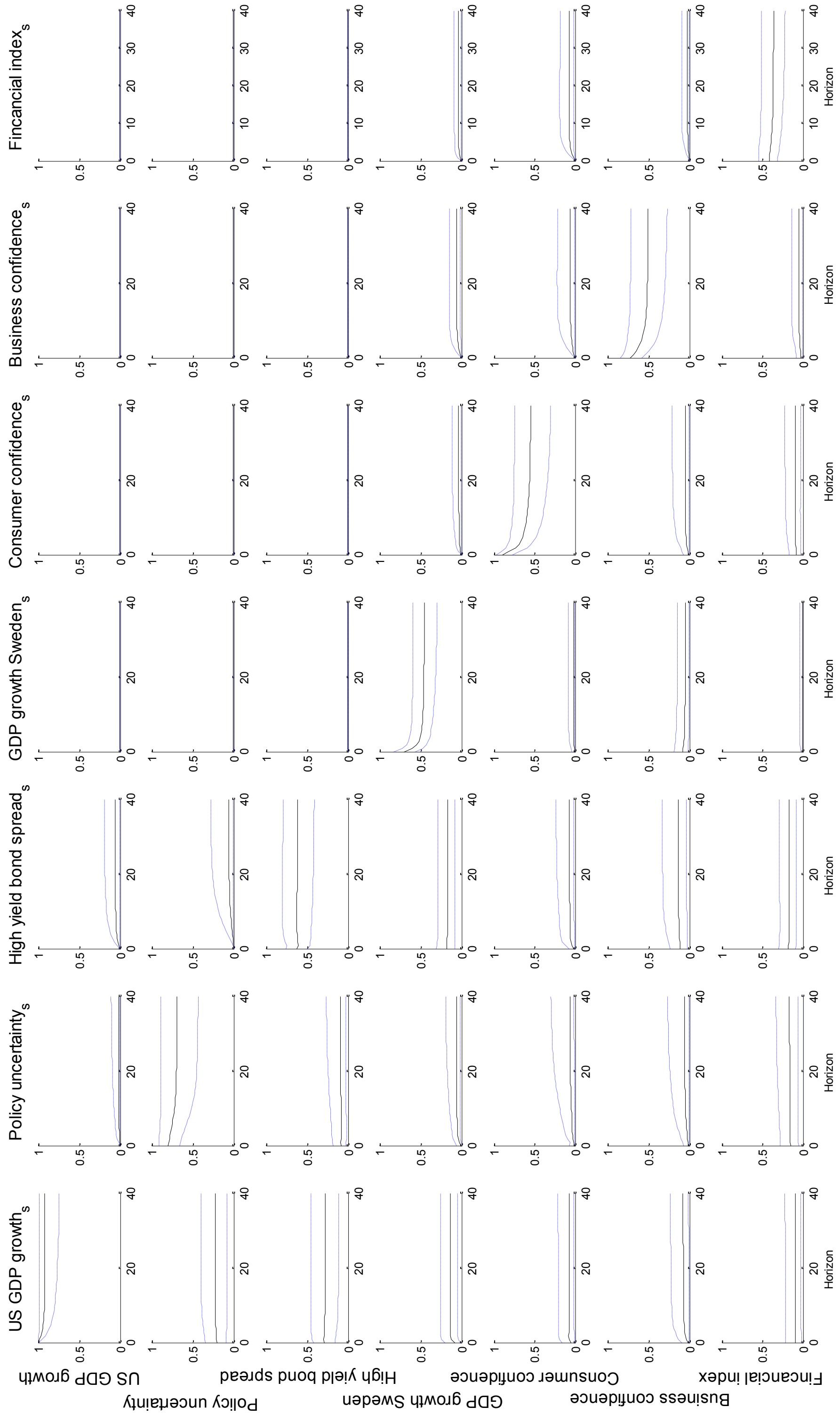
Note: The raw series have been used, i.e. the US policy uncertainty index and the Swedish GDP growth.

Figure A6. Impulse response functions from Bayesian VAR with seven variables.



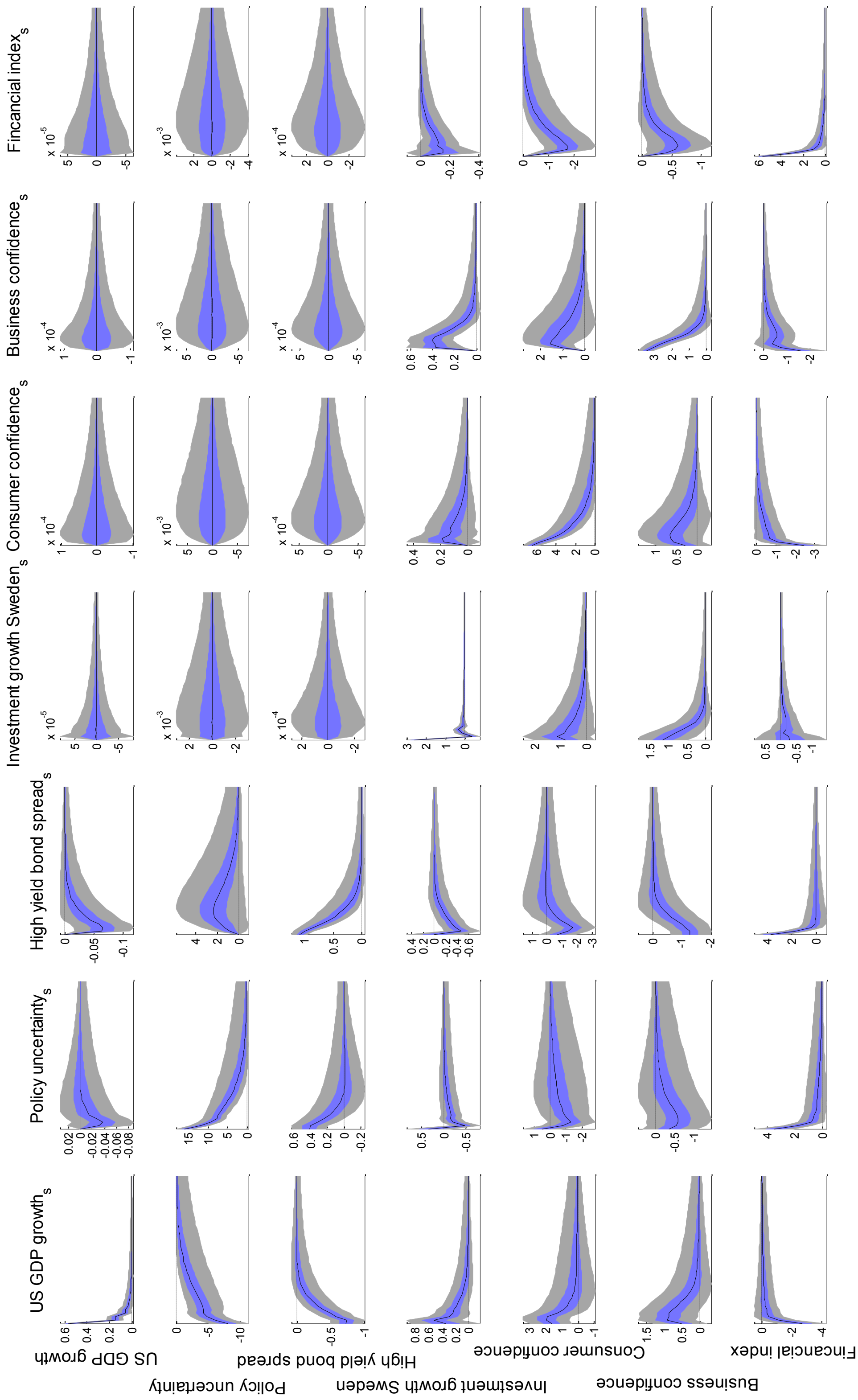
Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 quarters.

Figure A7. Variance decomposition from Bayesian VAR with seven variables.



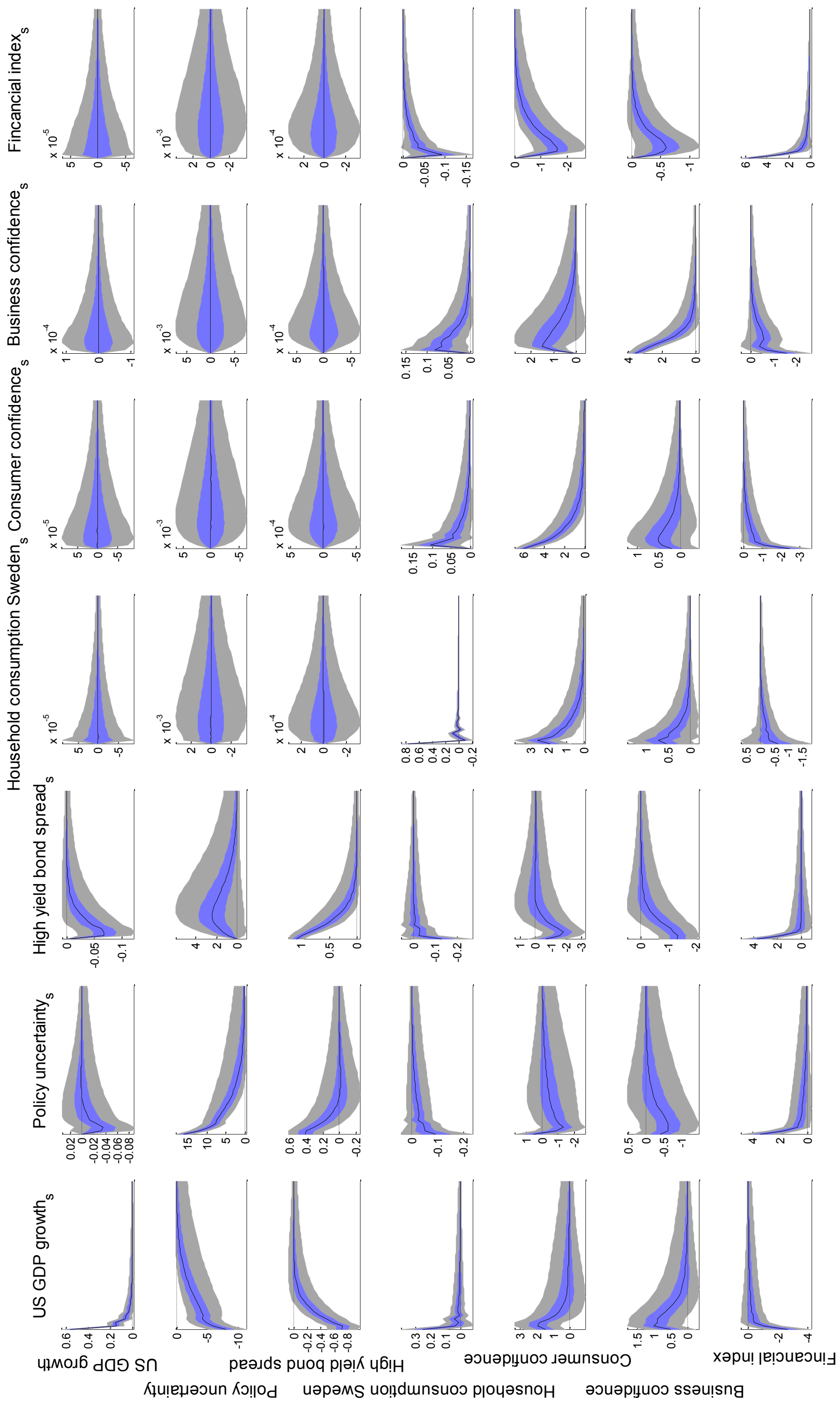
Note: Black line is the median. Dashed lines provide 90% confidence band. Maximum horizon is 40 quarters.

Figure A8. Impulse response functions from Bayesian VAR with seven variables using Swedish investment growth.



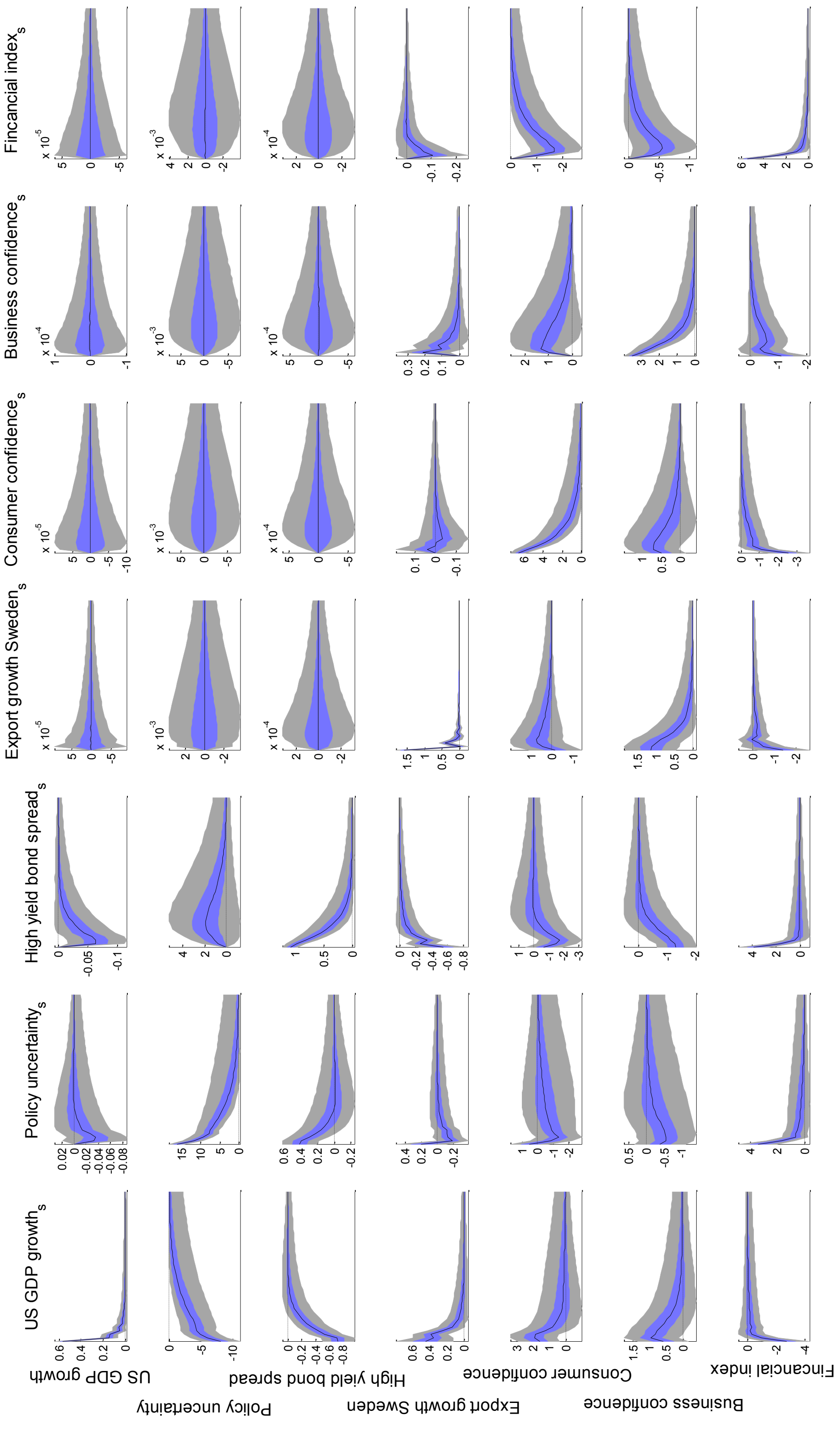
Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 quarters.

Figure A9. Impulse response functions from Bayesian VAR with seven variables using Swedish household consumption growth.



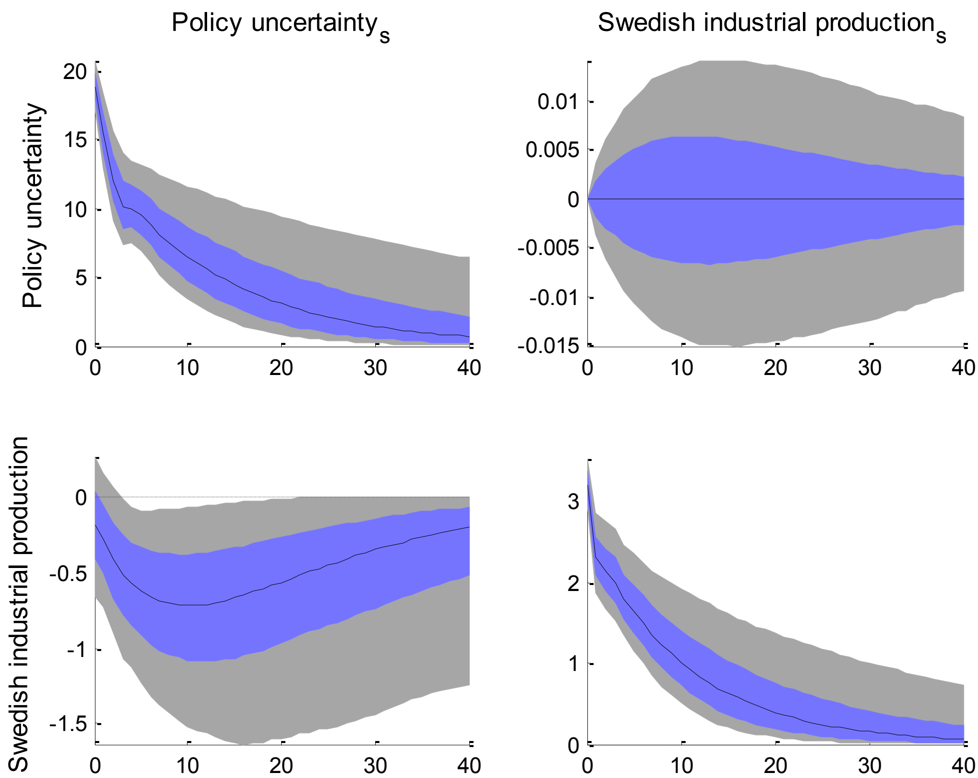
Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 quarters.

Figure A10. Impulse response functions from Bayesian VAR with seven variables using Swedish export growth.



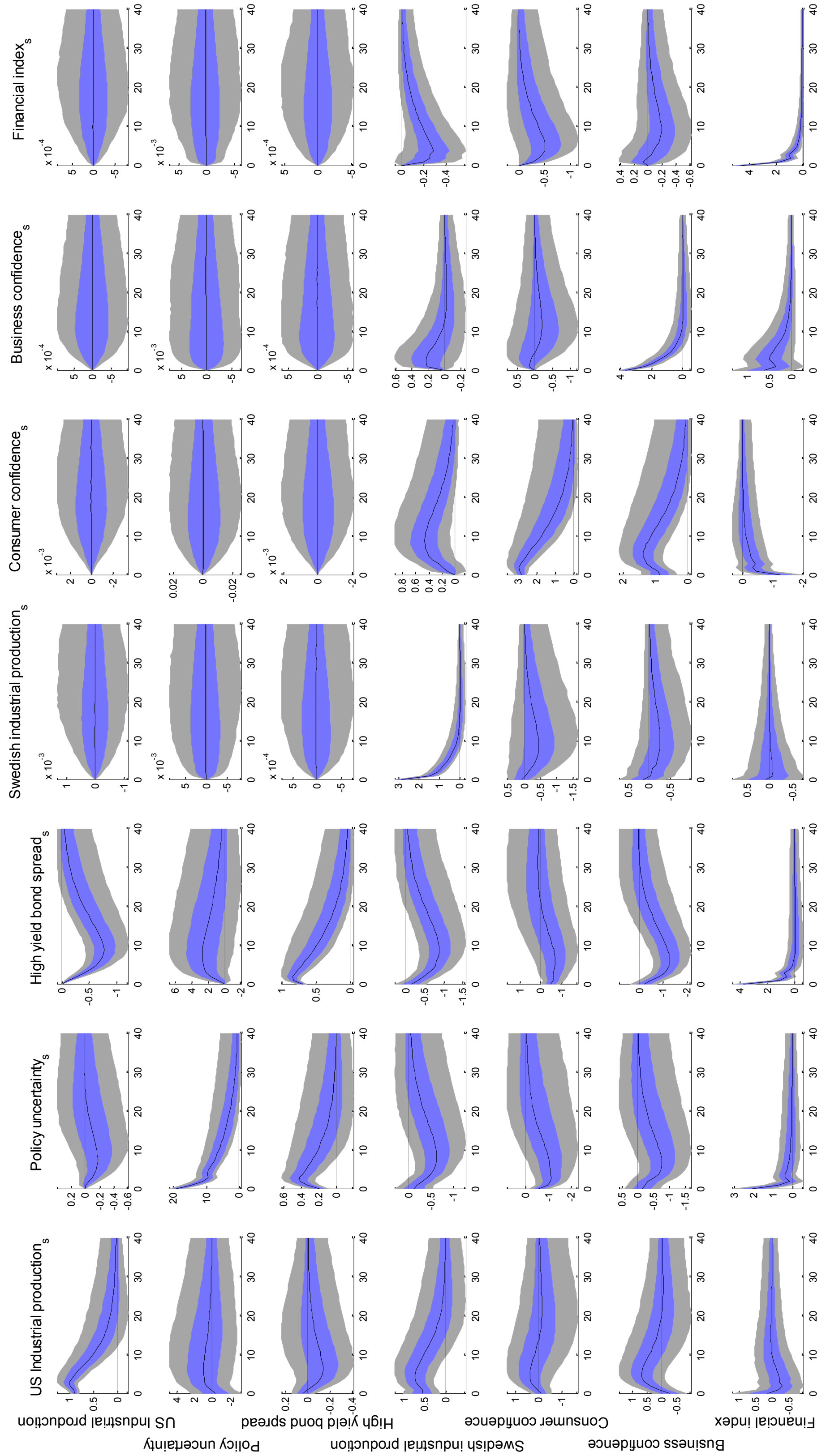
Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 quarters.

Figure A11. Impulse response functions from a bivariate Bayesian VAR using monthly data.



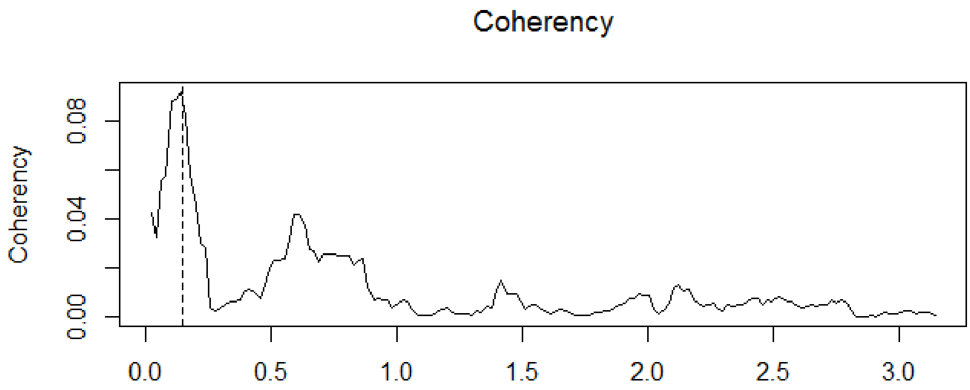
Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 months.

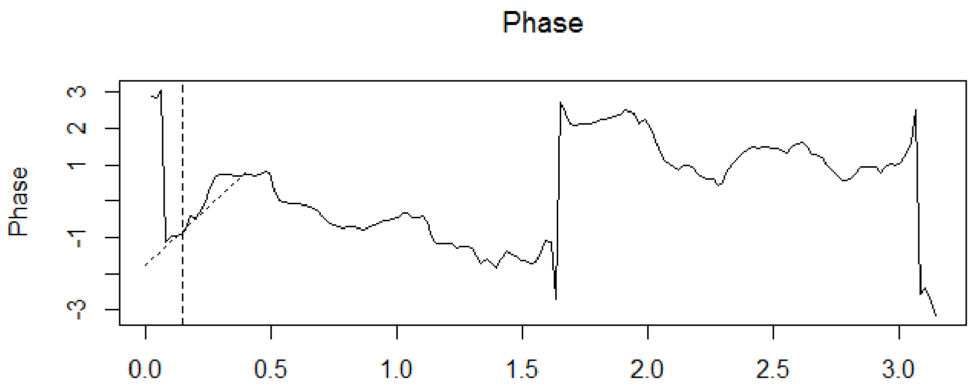
Figure A12. Impulse response functions from Bayesian VAR with seven variables using monthly data.



Note: Shocks in columns, responses in rows. Black line is the median. Coloured bands are 50% and 90% confidence bands. Maximum horizon is 40 months.

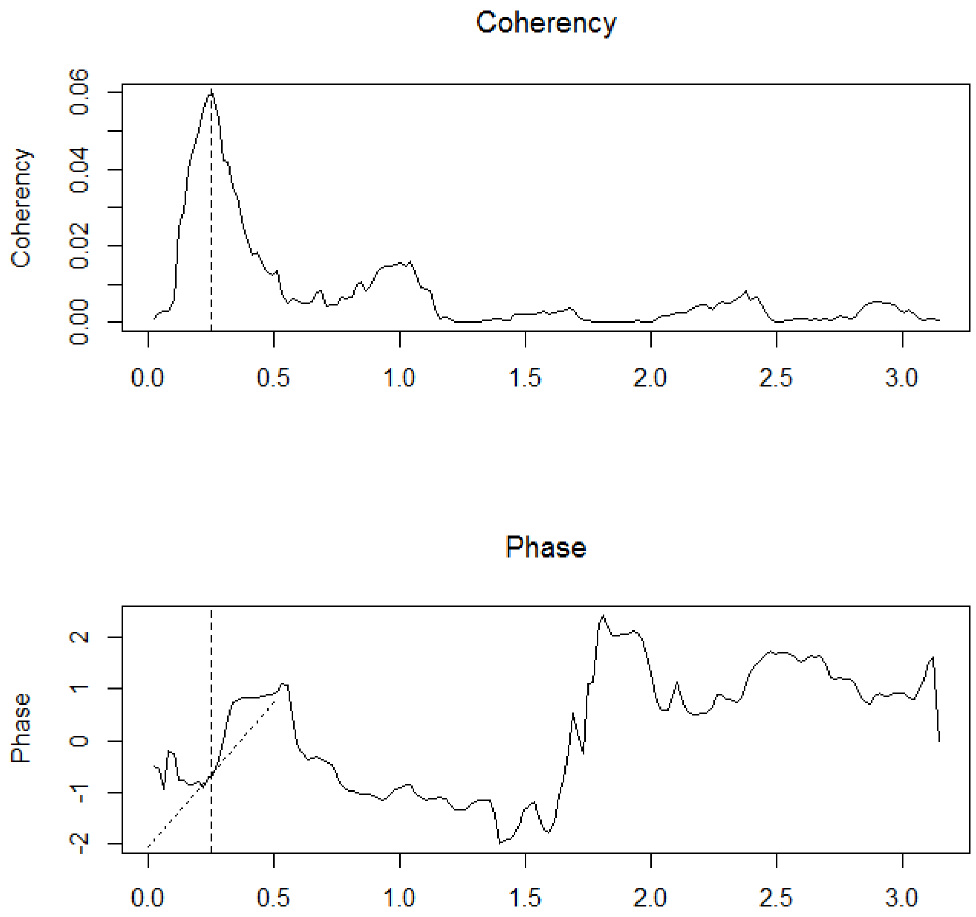
Figure A13. The coherency and phase spectra for US policy uncertainty and Swedish industrial production, monthly data (filtered series).





Note: The monthly data of the US policy uncertainty index and Swedish industrial production have been filtered using the heteroscedasticity removing filter of Stockhammar and Öller (2012).

Figure A14. The coherency and phase spectra, for US policy uncertainty and Swedish industrial production monthly data (raw series).



Note: The raw monthly series have been used, i.e. the US policy uncertainty index and the Swedish industrial production.

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