Unconventional Monetary Policy, Fiscal Side Effects and Euro Area (Im)balances

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APPENDIX

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Appendix A : Data description

The dataset used for the analysis is assembled from different sources. Table A.1 contains a detailed description of the original data that we use, including the source (with respective mnemonics), the available sample period and the underlying frequency. If applicable, we also outline how we transform the original data to obtain the data used in our analysis.

Table A.1: Data construction and sources

Variable	Construction and source
Average euro area sovereign bond yields	*Source:* own computations based on sovereign bond yields from datastream. Synthetic two year and ten year yields for euro area bonds are computed as GDP-weighted averages of all individual member countries for which yields of the respective maturity are available at a certain point in time (see below). Only Greece is excluded as it went through debt restructuring over the sample period. Yields of member states that enter the monetary union over the sample are included once the country is part of the euro area. Results are robust to including all available yields right from the start of the sample. *Available for:* 1999M01 - 2016M11. *Frequency:* Daily.
Sovereign bond yields and sovereign bond spreads	*Source:* Datastream, 2yr and 10yr yield to redemption of sovereign bonds if available, Austria: TROE2YT, TROE10T, Belgium: TRBG2YT, TRBG10T, Finland: TRFN2YT, TRFN10T, France: TRFR2YT, TRFR10T, Germany: TRBD2YT, TRBD10T, Ireland: TRIE2YT, TRIE10T, Italy: TRIT2YT, TRIT10T, Netherlands: TRNL2YT, TRNL10T, Portugal: TRPT2YT, TRPT10T, Spain: TRES2YT, TRES10T, Greece: TRGR2YT, TRGR10T, Latvia: TRLV2YT, TRLV10T, Lithuania: TRLT10T, Malta: TRMT10T, Slovakia: TRSK2YT, TRSK10T, Slovenia: TRSI2YT, TRSI10T, Cyprus: TRCP2YT. Spreads are computed as the difference in yields of bonds of different maturities to German bonds with the same maturity. *Available for:* 1999M01 - 2016M11, with shorter samples for some bonds. TROE2YT starts in 2003M2, TRBG2YT in 2005M01, TRSK2YT and TRSK10T in 2004M01, TRLV2YT and TRLV10T in 2004M10, TRSI2YT and TRSI10T in 2007M04, TRMT10T in 2008M02, TRLT10T in 2003M04, TRGR2YT in 2004M07, TRGR10T in 2000M01. TRCP2YT available from 2012M04 until 2015M07. *Frequency:* Daily.

BBB-AAA spread and corporate bond yields	*Source:* Datastream. Yields to redemption of euro area benchmark corporate bonds with 2year and 10 year maturity. BBB 2 year (TRECLYB), BBB 10 year (TRECLYJ), A 2 year (TRECAYB), A 10 year (TRECAYJ), AA 2 year (TRECBYB), AA 10 year (TRECBYJ), AA 2 year (TRECCYB), AA 10 year (TRECCYJ). The BBB-AAA corporate bond spread is computed as the difference between the 2 year BBB and the 2 year AAA rate. As the 2 year AAA rate is available only until April 2016, we extrapolate it for the rest of the sample using the basis point variation in the 2 year AA rate. *Available for:* 2002M04 - 2016M11. *Frequency:* Daily.
Credit to non-financial corporations	*Source:* ECB data warehouse. Financial transaction data (flows) for euro area (changing composition). Series key: credit to non-financial corporations 117.BSI.M.U2.N.A.A20.A.4.U2.2240.Z01.E. The series contains flows that we sum to obtain credit volumes and then seasonally adjust in EVIEWS with X-ARIMA-12. *Available for:* 1999M01 - 2016M11. *Frequency:* Monthly.
Consumer Prices	*Source:* Datastream, Index of consumer prices, seasonally adjusted if available, else we seasonally adjust in EVIEWS with X-ARIMA-12. Euro area: EKCONPRCF, Austria: OECPALLRF, Belgium: BGCONPRCF, Finland: FNCONPRCF, France: FRCONPRCE, Germany: BDCONPRCE, Ireland: IRCONPRCF, Italy: ITCONPRCF, Netherlands: NLCONPRCF, Portugal: PTCONPRCF, Spain: ESCONPRCF, Greece: GRCONPRCF, Latvia: LVCONPRCF, Lithuania: LNCONPRCF, Malta: MACPHARMF, Slovakia: SJCONPRCF, Slovenia: SXCONPRCF, Cyprus: CPCONPRCF. *Available for:* 1999M01 - 2016M11 and 2000M01 - 2016M11 for Slovakia. *Frequency:* Monthly.
Industrial Production	*Source:* Datastream, Index of industrial production or manufacturing production, respectively, seasonally adjusted if available, else seasonally adjusted in EVIEWS with X-ARIMA-12. Euro area: EKCIND..G, Austria: OEESIMANG, Belgium: BGIPMAN.G, Finland: FNIPTOT.G, France: FRIPTOT.G, Germany: BDIPTOT.G, Ireland: IRIPTOT.G, Italy: ITIPTOT.G, Netherlands: NLESIMANG, Portugal: PTESIMANG, Spain: ESIPTOT.G, Greece: GRIPMAN.G, Latvia: LVIPTOT.G, Lithuania: LNCIND..G, Malta: MAIPTOT.G, Slovakia: SJIPTOT.G, Slovenia: SXI66..BH, Cyprus: CPIPTOT.H. *Available for:* 1999M01 - 2016M11. BGIPMAN.G, PTESIMANG, NLESIMANG, LVIPTOT.G, MAIPTOT.G start in 2000M01 *Frequency:* Monthly.
Unemployment Rate	*Source:* Eurostat dataset [une_rt_m]s, Unemployment as percentage of active population - monthly average, seasonally adjusted, for euro area aggregate and individual countries. Euro area total: EA19. *Available for:* 1999M01 - 2016M11. Data for Estonia, Cyprus and Malta start in 2000M02. *Frequency:* Monthly.

Inflation Expectations	*Source:* Datastream. Survey data from Centre for European Economic Research (ZEW) based on opinions of financial market analysts (EMZEWCP.R). 2 year (EURIS2Y), 5 year (EURIS5Y), and 10 year (EURIS10) inflation swap rates. The response of the five year five year forward rate is computed from responses of the 5 year and the 10 year swap: $5x5 = \frac{(1+10yr)^{10}}{(1+5yr)^{5}}^{\frac{1}{5}} - 1$. *Available for:* 2008M07 - 2016M11. *Frequency:* Daily.
Interest Rates and Futures	*Source:* Datastream. Euro short term repo (eurepo) - middle rate (EURORPS), Euribor 3m delayed (euribor) - offered rate (EIBOR3M), Liffe - 3 MTH euribor continuous 2nd future - sett. price (LEICS00(PS)), Liffe - 3 MTH euribor continuous future - sett. price (LEICS20(PS)), Liffe - 3 MTH euribor continuous 5th future - sett. price (LEICS50(PS)), Overnight Index Swap (OIS) 3 month - middle rate (OIEUR3M), OIS 12 month - middle rate (OIEUR1Y). *Available for:* 1999M01 - 2016M11. *Frequency:* Daily.
Exchange Rate	*Source:* Datastream. US $ to EURO (WMR&DS) - exchange rate (USEURSP). *Available for:* 1999M01 - 2016M11. *Frequency:* Daily.
Stock price index	*Source:* Datastream. Euro Stoxx 50 price index (DJES50I). *Available for:* 1999M01 - 2016M11. *Frequency:* Daily.
Unemployment Dispersion	Standard deviation of monthly changes of unemployment rates between euro area countries. *Available for:* 1999M01 - 2016M11. *Frequency:* Monthly.
Government budget balance	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], General government Net lending (+) /net borrowing (-) for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs. *Available for:* 1999M01 - 2016M11, starting in 2001M03 for Austria, and in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg. *Frequency:* Monthly.
Government debt-to-GDP	*Source:* Eurostat dataset quarterly government debt [gov_10q_ggdebt], Government consolidated gross debt, Percentage of gross domestic product for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. *Available for:* 2000M03 - 2016M11, starting in 1999M03 for Belgium and Spain, and in 2000M12 for Luxembourg and Malta. *Frequency:* Monthly.

Government total revenue	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], Total general government revenue for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs. *Available for:* 1999M01 - 2016M11, starting in 2001M03 for Austria, and in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg. *Frequency:* Monthly.
Government total expenditure	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], Total general government expenditure for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs. *Available for:* 1999M01 - 2016M11, starting in 2001M03 for Austria, and in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg. *Frequency:* Monthly.
Government net interest payments	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], Interest, payable (D41PAY) - Interest, receviable (D41REC) for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs, starting in 2001M03 for Austria, in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg, and in 2003M03 for Lithuania. *Available for:* 1999M01 - 2016M11. *Frequency:* Monthly.
Government consumption	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], Compensation of employees, payable (D1PAY) + Intermediate consumption (P2) for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs. *Available for:* 1999M01 - 2016M11, starting in 2001M03 for Austria, and in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg. *Frequency:* Monthly.

Government social benefits	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], Social benefits other than social transfers in kind and social transfers in kind purchased market production, payable (D62_D632PAY) for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs. *Available for:* 1999M01 - 2016M11, starting in 2001M03 for Austria, and in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg. *Frequency:* Monthly.
Government investment	*Source:* Eurostat dataset quarterly non-financial accounts for general government [gov_10q_ggnfa], Gross fixed capital formation (P51G) for euro area aggregate and individual countries. Euro area total: EA19. Quarterly data is seasonally adjusted with X-ARIMA-12 and then linearly interpolated to the monthly frequency in EVIEWS. Resulting monthly series are converted to real terms using euro area and individual country CPIs. *Available for:* 1999M01 - 2016M11, starting in 2001M03 for Austria, and in 2002M03 for euro area, Germany, Estonia, Ireland, Luxembourg. *Frequency:* Monthly.
Trade balances versus rest of the euro area	*Source:* Eurostat dataset trade by BEC product group since 1999 [ext_st_28msbec], Exports - Imports, Total - All products, Partner Euro area (19 countries), for individual countries. Monthly Data is seasonally adjusted with X-ARIMA-12, multiplied by three and divided by countries' quarterly GDP linearly interpolated to monthly frequency. *Available for:* 1999M01 - 2016M11, starting in 2000M01 for Malte, no GDP is available for Slovakia which is therefore excluded. *Frequency:* Monthly.
Surprise component in economic data releases	*Source:* Bloomberg. Difference between the first-released data and the expected value (median expectation of a panel of experts surveyed by Bloomberg). The difference is divided by its standard deviation. Variables from the following countries are included: Euro Area, Germany, France, Italy, Spain, the UK, and the US. The included variables for each country is given in Table A.2. *Available for:* 1999M01 - 2016M11. *Frequency:* Daily. The list of economic data releases used is reported in Table A.2.

Table A.2: List of economic data releases included in equation (4)

Euro area	**France**	**Germany**
EC Bus. Climate Ind.	CPI YoY	CPI YoY
Current Account Net WDA SA	CPI MoM	CPI MoM
EC Cons. Conf. Ind.	Cons. Conf. Ind.	Manu. Ord. YoY NSA
CPI YoY	Bus. Conf. Ind. (Manu.)	Manu. Ord. MoM SA
CPI MoM	Prod. Outlook Ind.	Trade Bal. Exp. MoM SA
BOP CA Net NSA	Bus. Sent. Ind.	Trade Bal. Imp. MoM SA
New Orders (Manu.) YoY	Cons. Spending MoM	Trade Bal. EUR NSA
GFCF QoQ	CPI ex Tobacco	Retail Sales NSA YoY
EC Serv. Conf. Ind.	real GDP QoQ	Retail Sales SWDA MoM
Markit Comp. PMI SA	real GDP YoY	Prod. Prices MoM
Markit Serv. PMI SA	ML & OS Unemployment Rate	Ind. Prod. YoY NSA WDA
Retail Sales Vol. YoY WDA	Markit Manu. PMI SA	Ind. Prod.n MoM SA
Retail Sales Vol. MoM SA	Markit Serv. PMI SA	Ind. Prod. YoY SA
ZEW Exp. of Econ. Growth	PPI MoM	Unem. Rate SA
Trade Bal. with non EZ	PPI YoY	Unem. Change SA
M3 Money Supply 3 M. MA	Jobseekers Total SA	Ifo Pan Bus. Climate
PPI Industry Ex Constr.YoY	Trade Balance EUR	Ifo Pan Bus. Expectations
PPI Industry Ex Constr. MoM	Manu. Prod. MoM SA	Current Account EUR
Unem. Rate	Own-Comp. Prod. Outlook	Import Price Index MoM
GDP SA QoQ (real SA)		Markit Manu. PMI SA
		GDP Priv.Cons. QoQ
		GDP GFCF QoQ
		GDP Inv. in Const. QoQ
Italy	**UK**	**Spain**
CPI NIC Incl Tbc. YoY NSA	CPI Core YoY	CPI YoY
CPI NIC Incl Tbc. MoM NSA	GDP YoY	CPI Core YoY
Cons. Conf. Ind. SA	GDP MoM	PPI MoM
Bus. Conf. Manu. Sector	Ret. Sales Ex Auto. YoY SA	Trade Balance EUR
Hourly Wages MoM SA	Ret. Sales Ex Auto. MoM SA	Unem. MoM Net Change
Ind. Orders YoY NSA	PPI Manu.Prod. YoY NSA	Avg LC per Worker YoY
Ind. Orders MoM SA	PPI Manu. Prod. MoM NSA	PMI Manu. SA
Ind. Prod. YoY WDA	PPI Input Prices MoM NSA	
Ind. Prod. MoM SA	PPI Input Prices YoY NSA	
Ind. Prod. YoY	Ind. Prod. YoY SA	
Ind. Sales YoY	Unem. Rate SA (Change)	
Ind. Sales MoM SA	Markit/CIPS Const. PMI SA	
Manu. PMI SA	Markit/CIPS Serv PMI SA	
Serv. PMI SA	Govt. Budget Balance	
PPI Manu. MoM	Priv. Cons. QoQ	
PPI Manu. YoY	House Price Ind. MoM SA	
PPI Manu. YoY	Cons. Conf. Ind.	

Priv. Cons. QoQ SA WDA	Gov. Spending QoQ	
Retail Sales MoM SA		
Retail Sales YoY		
Trade Balance Total		
Unem. Rate SA		
Real GDP YoY SA WDA		
Trade Balance Non EU NSA		
US		
CPI YoY NSA	CPI Ex. Fd. & En. YoY NSA	Pers. Cons. Exp. CPI YoY SA
CPI MoM SA	UM Cons. Conf. Ind.	Gov. Budget Balance
Cons. Spend. GR MoM SA	Markit Manu. PMI SA	Ind. Prod. MoM SA
Core PPI	PPI - Fin. Goods	In. Jobless Claims SA
Housing Starts/Permits	Diff. between Exp. and Imp.	GDP QoQ SAAR
PPI Fin. Goods SA MoM%	Cap. Util.n % of Tot. Cap.	Bus. Inventories MoM SA
Avg. H Earnings YoY% SA	Avg. H Earnings MoM% SA	Constr. Spend. MoM SA
Dur. Goods Orders MoM SA	CB Leading Ind. MoM	Production Nonfarm QoQ SA

Source, sample and frequency are discussed at the end of Table A.2

Table A.3: ECB Monetary Policy Announcements used

Date	Policy Announcement / Date of Council Meeting
	Conventional Monetary Policy
Council Meetings:	*2000*: 05.01., 20.01., 03.02., 17.02., 02.03., 16.03., 30.03., 13.04., 27.04., 11.05., 25.05., 08.06., 21.06., 06.07., 20.07., 03.08., 31.08., 14.09., 05.10., 19.10., 02.11., 16.11., 30.11., 14.12. *2001*: 04.01., 18.01., 01.02., 15.02., 01.03., 15.03., 29.03., 11.04., 26.04., 10.05., 23.05., 07.06., 21.06., 05.07., 19.07., 02.08., 30.08., 13.09., 17.09., 27.09., 11.10., 25.10., 08.11., 06.12. *2002*: 03.01., 07.02., 07.03., 04.04., 02.05., 06.06., 04.07., 01.08., 12.09., 10.10., 07.11., 05.12. *2003*: 09.01., 06.02., 06.03., 03.04., 08.05., 05.06., 10.07., 31.07., 04.09., 02.10., 06.11., 04.12. *2004*: 08.01., 05.02., 04.03., 01.04., 06.05., 03.06., 01.07., 05.08., 02.09., 07.10., 04.11., 02.12. *2005*: 13.01., 03.02., 03.03., 07.04., 04.05., 02.06., 07.07., 04.08., 01.09., 06.10., 03.11., 01.12. *2006*: 12.01., 02.02., 02.03., 06.04., 04.05., 08.06., 06.07., 03.08., 31.08., 05.10., 02.11., 07.12. *2007*: 11.01., 08.02., 08.03., 12.04., 10.05., 06.06., 05.07.
	Unconventional Monetary Policy: Phase 1
22.08.2007	Supplementary liquidity-providing longer-term refinancing operation (LTRO) with a maturity of three months
28.03.2008	LTROs with a maturity of six months
29.09.2008	Special term refinancing operation
08.10.2008	Fixed rate tender procedure with full allotment on the main refinancing operation(MROs)
15.10.2008	List of assets eligible as collateral in Eurosystem credit operations extended
07.05.2009	LTROs with a maturity of one year
04.06.2009	Details on Purchase program for covered bonds (CBPP)
03.12.2009	Phasing out of 6-month LTROs, indexation of new one year LTROs
04.03.2010	Phasing out of 3-month LTROs, indexation of six month LTROs
10.05.2010	Securities Markets Program (SMP)
28.07.2010	Risk control measures in collateral framework reviewed
03.03.2011	Further LTROs
09.06.2011	MROs as fixed rate tender procedures with full allotment (FRFA) for as long as necessary, at least until October 2011
04.08.2011	Further LTROs with a maturity of three and six months
08.08.2011	ECB will actively implement its Securities Market Program

06.10.2011	New covered bond purchase program (CBPP2)
08.12.2011	Two additional LTROs with a maturity of three years
21.12.2011	Results of first three year LTRO
09.02.2012	ECB's Governing Council approves eligibility criteria for additional credit claims
28.02.2012	Results of second three year LTRO
06.06.2012	FRFA on MROs as long as necessary, and at least until January 2013
26.07.2012	'Whatever it takes...' speech by ECB President Mario Draghi in London
02.08.2012	Outright Monetary Transactions program (OMT)
06.09.2012	Technical features of OMT
06.12.2012	FRFA on MROs as long as necessary, and at least until July 2013
22.03.2013	Collateral rule changes for some uncovered government guaranteed bank bonds
02.05.2013	FRFA on MROs as long as necessary, and at least until July 2014
04.07.2013	Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time (open-ended forward guidance)
08.11.2013	FRFA on MROs as long as necessary, and at least until July 2015

Unconventional Monetary Policy: Phase 2

05.06.2014	Targeted longer-term refinancing operations (TLTROs)
03.07.2014	Details on TLTROs published, deposit rate –0.1
04.09.2014	Deposit rate –0.2
22.01.2015	Announcement of expanded asset purchase programme (APP)
16.07.2015	Reaffirmation that purchases are intended to run until end of September 2016
31.08.2015	New category of assets added as eligible collateral
03.09.2015	Increase in PSPP issue share limit
23.09.2015	Eurosystem adjust purchase process in ABS programme
22.10.2015	Questions on requirements for APP extension answered
09.11.2015	Increase in PSPP issue share limit enlarges purchasable universe
03.12.2015	APP extended until March 2017,deposit rate –0.3
21.01.2016	Review and possibly reconsider monetary policy stance at next meeting
10.03.2016	New targeted longer-term refinancing operations (TLTRO II), APP expanded, corporate bonds added to APP, deposit rate –0.4
21.04.2016	Details on implementation of APP expansion
03.05.2016	Legal acts relating to TLTRO II is published
02.06.2016	Details on corporate sector purchase programme (CSPP) published
21.07.2016	Confirmation that APP at 80 billion per month to run at least until March 2017
08.09.2016	Council meeting confirming continuation of APP

05.10.2016	Changes to collateral eligibility criteria and risk control measures for unsecured bank bonds
20.10.2016	Council meeting confirming continuation of APP

Appendix B : Tests on structural breaks

We conduct a battery of tests and robustness checks to study whether the baseline VAR model displays structural breaks. We first carry out tests on each individual equation of the model. We then jointly test for structural breaks in the entire multivariate reduced form model rather than equation by equation. Last, we estimate impulse responses adding interaction terms that allow for a structural break. Overall, we find that only some of the single equations might have been subject to structural breaks around the beginning of the unconventional monetary policy period, that the multivariate model seems stable, and that the effect of potential breaks on the impulse responses is small. We take the results as suggesting that the linear model offers a good approximation of the dynamics of the system.

We carry out two separate tests in addressing possible breaks for each equation of the reduced form model. We first run a Chow test for the null hypothesis that no break occurred in 2007M8. This point in time coincides with the beginning of the ECB unconventional monetary policy. Then, for each equation we carry out the cumulative sum (CUMSUM) test originally proposed by Brown et al. (1975), assessing whether the recursively estimated innovations in each equation display behaviour suggesting structural breaks.

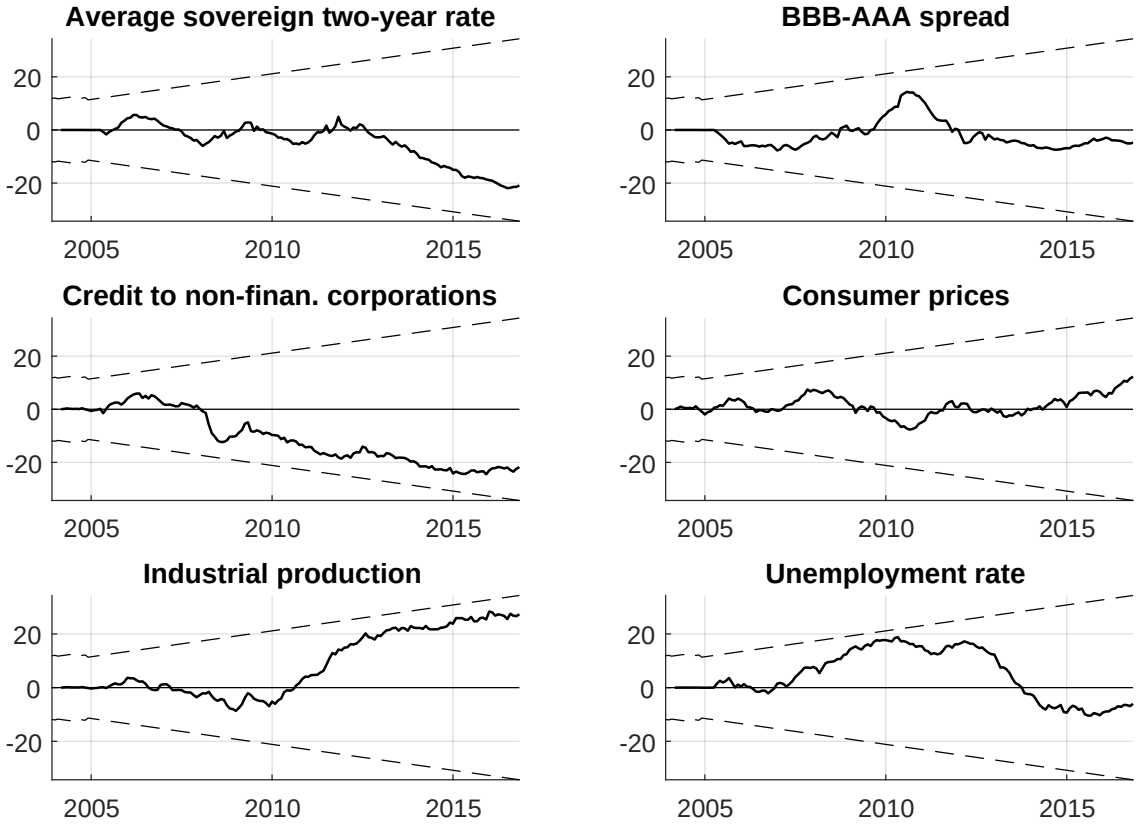
The results for the Chow tests are shown in Table B.1, while the results from the CUMSUM analysis are reported in Figure B.1. Overall, the results are mixed. The Chow tests suggest the presence of structural breaks for four equations of the VAR model, as indicated by the low p-value for the second, third, fifth and sixth equation of the VAR. On the contrary, the CUMSUM test finds that the estimated innovations are always inside the error bands, providing no evidence in favour of breaks.

Table B.1: Chow tests on each equation of the baseline VAR

Break point: 2007M8			
Null Hypothesis: No breaks at specified breakpoint			
VAR equation	*Dependent variable*	*F-statistic*	*p-value*
1	Average sovereign two-year rate	0.96	0.53
2	BBB-AAA corporate bond spread	1.63	0.03
3	Credit to non-financial corporations	4.67	0.00
4	Consumer prices	0.38	0.99
5	Industrial production	1.47	0.07
6	Unemployment rate	1.94	0.01

We then study to what extent the possible presence of structural breaks in some equations maps into breaks for the entire reduced form model, and in which period. To do so we use the Chow test for multivariate dynamic models. As discussed by Candelon and Lütkepohl (2001), in a multivariate framework the asymptotic distributions for the test statistics can be particularly misleading in small samples, whereas the bootstrapped version of the test performs more accurately. We follow their procedure and calculate bootstrapped p-values for the test statistics. We refer to Candelon and Lütkepohl (2001) and Lütkepohl and Krätzig (2004) for a description of the test and of the bootstrap.

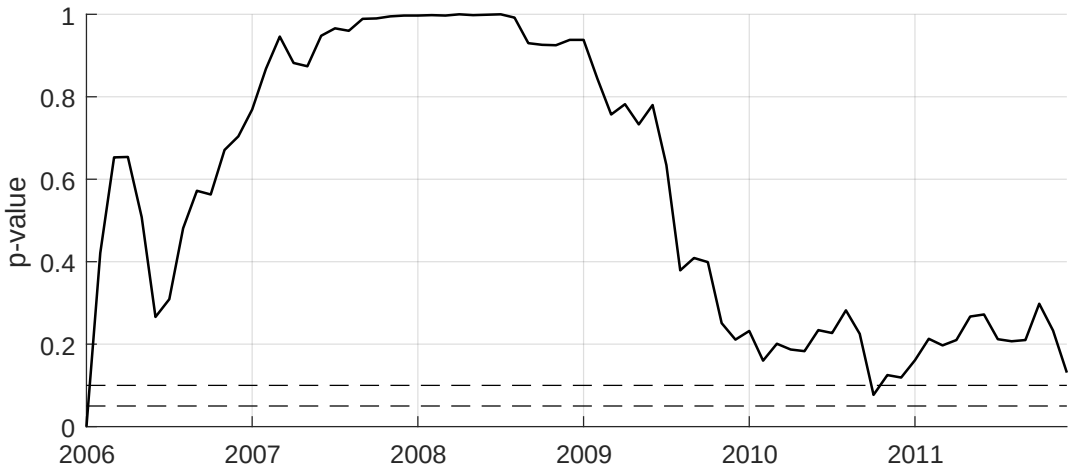
Figure B.1: Cumulative Sum test on each equation of the baseline VAR



We implement the multivariate Chow tests as follows. We first select the subperiod between 2006M1 and 2011M12 as the period within which we assess the presence of a single structural break, and then run the test for each month within this period. For each month, we split the sample period from 2002M5 until 3 months before the candidate break, and from 3 months after the candidate break until 2016M11. We then compute the break-point Chow test statistics and calculate the p-value using 1000 bootstrap repetitions.

The results of the analysis are shown in Figure B.2. The figure reports

Figure B.2: Break-point Chow test on the multivariate model



Notes: p-values are computed using 1000 bootstrapped draws, as in Candelon and Lütkepohl (2001). The test is run for each month within the period 2005M1 through 2011M12.

the p-value computed for each month within the period considered, together with the 0.05 and the 0.10 critical values. The tests find p-values that are largely above the critical values for most of the considered break points, hence failing to reject the null hypothesis of no break. There is some evidence of a break in at the beginning of the break point window and in 2010. However, the former point is most likely due to the small number of observations in the first part of the sample as the p-value quickly increases afterwards, and the latter point is only significant at the 10% level. Moreover, the results should be treated with caution because, as discussed by Kilian and Lütkepohl (2017), in finite sample the break tests of the type discussed by Candelon and Lütkepohl (2001) are prone to rejecting the null hypothesis of no break even when the null hypothesis is true.

To study to what extent a possible break around the beginning of the

unconventional policy affects the impulse responses we modify the baseline version of the model from equation (1) in the paper by adding interaction terms. We use a general framework that allows for a break in the constant, in the autoregressive parameters and in the covariance matrix of the innovations. The model is written as

$$y_t = c + \Pi(L)y_{t-1} + d_t[\tilde{c} + \tilde{\Pi}(L)y_{t-1}] + u_t, \tag{B.1}$$

with $u_t \sim N(0, \Sigma + \tilde{\Sigma}d_t)$ and d_t a dummy variable taking value of one after a pre-selected sample break, an zero otherwise. The model is estimated and identified as in the paper, treating phase 1 and phase 2 of ECB unconventional monetary policy separately (see Section 2.3 of the paper).

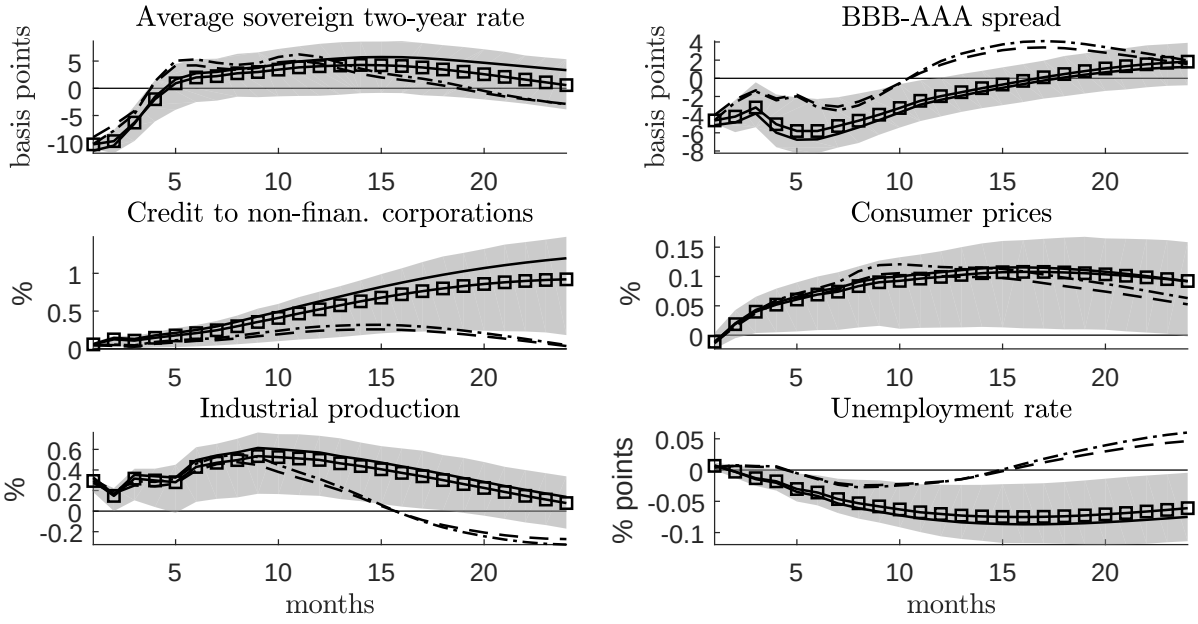
The results are shown in Figure B.3. We report the impulse responses computed when allowing for a change only in the constant terms, only in the autoregressive components, only in the covariance matrix, or in all three sets of parameters. Such approach allows exploring which component of the reduced form model potentially contributes to the presence of breaks in the impulse responses. Figure B.3 shows the results using 2007M8 as a break point, which is the break point considered also in Table B.1. The impulse responses estimated from the interacted model are largely inside the estimated confidence band from the linear model. Some divergence is documented when allowing for the autoregressive components to change, although the differences emerge only at longer horizons. Within the first

year from the shock all impulse responses from the interacted models fall within the confidence bands of the linear VAR.

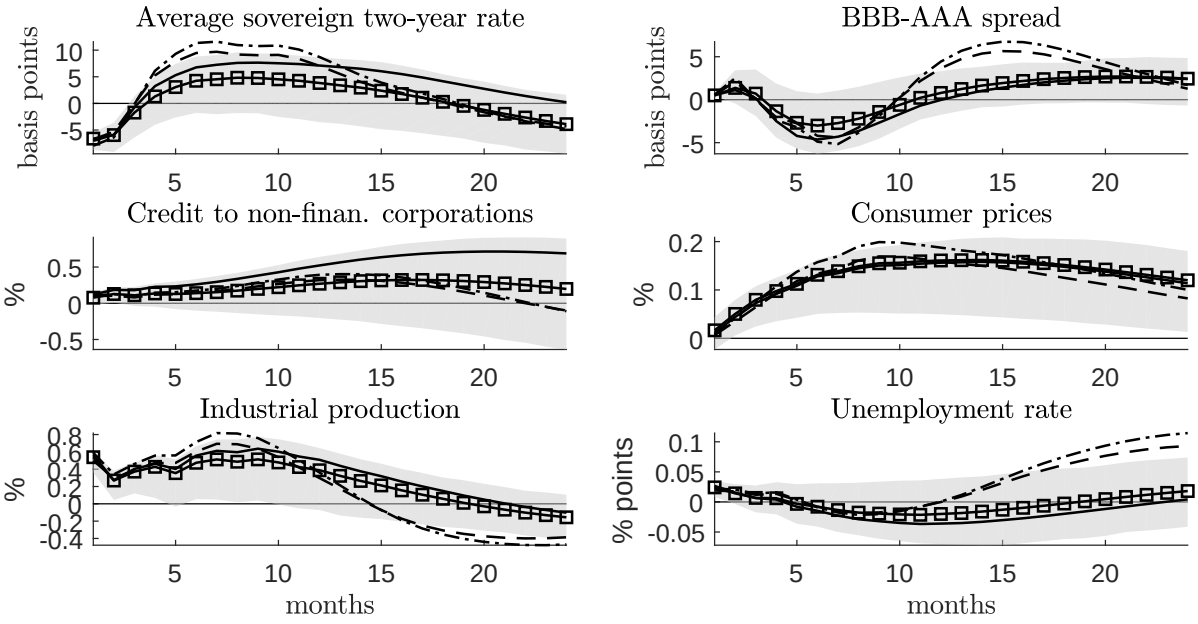
Overall, having found that a potential structural break between the conventional and the unconventional period matters only for specific equations, rather than for full reduced form model or for the impulse response dynamics, we base the analysis of the paper on a linear specification of the VAR model. Robustness checks in Appendix E show that the results of the analysis also hold when estimating the linear reduced form model using data only for the unconventional period.

Figure B.3: Modelling an interaction term (breakpoint 2007M8)

(A) Phase I of unconventional monetary policy



(B) Phase II of unconventional monetary policy



Notes: The shaded area shows the confidence bands from the baseline specification from Figure 1 in the paper. The point estimates refer to impulse responses computed from model (B.1), allowing for a structural break in the constant term (solid line), autoregressive parameters (dashed dotted line), covariance matrix of the VAR innovations (squared line) or all three sets of parameters (dashed line).

Appendix C : A Bayesian analysis

In Section 3.2 of the paper we discuss the effects of the monetary shocks on fiscal variables, and remark that the responses tend to materialize in the medium horizon. In this appendix we assess the robustness of these results by estimating the model with eight lags and adopting a Bayesian approach to the estimation.

As discussed in Section 2 of the paper, the model consists of two key equations, namely equation (1) and equation (8). We replicate them here for convenience:

$$y_t = c + \Pi(L)y_{t-1} + u_t, \tag{C.1}$$

$$w_{it}^M = \phi_i^{(3)} + \psi_i^{(3)} m_t^M + \eta_{it}^{(3)}, \quad i = 1, ..., k, \tag{C.2}$$

with $u_t \sim N(0, \Sigma)$. Equation (C.1) shows the reduced form model, while equation (C.2) shows the equations estimated for the identification of the model. In (C.2), m_t^M is the monthly instrument and w_{it}^M is either the VAR innovation u_{it} or the monthly aggregation w_{it}^D of the daily variable of interest, depending on the original frequency of variable i (see Section 2.3 for a discussion). The frequentist estimation of the model takes 5 steps:

1. estimate model (C.1) and obtain $\hat{c}, \hat{\Pi}(L), \hat{\Sigma}, \{\hat{u}_t\}_{t=1}^T$;

2. for each $i = 1, ..., k$, use the data $\{w_{it}^D\}_{t=1}^T$ and the estimated residuals $\{\hat{u}_t\}_{t=1}^T$ to construct $\{w_{it}^M\}_{t=1}^T$;

3. for each $i = 1, ..., k$, estimate model (C.2) and obtain $\{\hat{\psi}_i^{(3)}\}_{i=1}^k$;

4. combine $\{\hat{\psi}_i^{(3)}\}_{i=1}^k$ into the relative impulse vector $\hat{\tilde{b}}^m = (1, \hat{\psi}_2^{(3)}/\hat{\psi}_1^{(3)}, ..., \hat{\psi}_k^{(3)}/\hat{\psi}_1^{(3)})'$ and convert it into the impulse vector $\hat{b}^m$ using $\hat{\Sigma}$;

5. use $\hat{b}^m$ and $\hat{\Pi}(L)$ to compute impulse responses to a one standard deviation shock.

We estimate the model with Bayesian methods using the popular independent Normal-inverse Wishart prior on the parameters in model (C.1), and using uninformative priors on the parameters in (C.2). The estimation builds on two results, which we take from the literature:

1. after rewriting model (C.1) as $Y = \tilde{\Pi}X + U$ with $\tilde{\Pi} = [c, \Pi_1, ..., \Pi_p]$ and defining $\iota = vec(\tilde{\Pi})$, prior beliefs $\iota \sim N(\mu_\iota, V_\iota)$ and $\Sigma \sim iW(S_\Sigma, v_\Sigma)$ lead to the conditional posterior distributions $\iota|Y, \Sigma \sim N(\mu_\iota^*, V_\iota^*)$ and $\Sigma|Y, \iota \sim iW(S_\Sigma^*, v_\Sigma^*)$ with $V_\iota^* = [V_\iota^{-1} + (XX' \otimes \Sigma^{-1})]^{-1}$, $\mu_\iota^* = V_\iota^*[V_\iota^{-1}\mu_\iota + (X \otimes \Sigma^{-1})vec(Y)]$, $S_\Sigma^* = S_\iota + (Y - \tilde{\Pi}X)(Y - \tilde{\Pi}X)'$ and $v_\Sigma^* = v_\Sigma + T$. Hence, the joint posterior distribution $p(\iota, \Sigma|Y)$ can be explored numerically using the Gibbs sampler (see Koop et al., 2010);

2. in the linear model taking the general form $z = W\gamma + \nu$ with $\nu \sim N(0, h^{-1})$, prior beliefs $\gamma|h \sim N(\mu_\gamma, h^{-1}V_\gamma)$ and $h \sim \Gamma(s_h, v_h)$ jointly considered with the uninformative specification $v_h = 0$ and $V_\gamma = cI$ with $c \to 0$ lead to the marginal posterior $\gamma_i|z \sim t(\hat{\gamma}_i, s^2\hat{V}_{ii}, N)$, with N the number of observations in z minus the number of elements in γ, $\hat{\gamma}_i$ the i^{th} element of the least square estimate of γ and s^2 the consistent

estimator of the variance of ν (see Koop, 2003).

Our Bayesian estimation of the model makes use of the above results, after acknowledging that the observations used in the linear model $z = W\gamma + \nu$ depend on the posterior draws from model (C.1).

More precisely, we estimate the model following eight steps:

1. set the hyperparameters μ_ι, V_ι, S_Σ and υ_Σ;

2. simulate numerically from the joint posterior distribution $p(\iota, \Sigma|Y)$ and store draws $\{\iota_d, \Sigma_d\}_{d=1}^{D}$;

3. for draw d and for each equation i of the VAR, set $\{w_{it}^{M,d}\}_{t=1}^{T}$ of model (C.2) to either $\{w_{it}^{D}\}_{t=1}^{T}$ or to the i^{th} VAR innovations corresponding to ι_d, depending on the frequency of variable i;

4. for each $i = 1, ..., k$, compute the OLS estimates $\hat{\psi}_i^{(3),d}$ and $s_d^2\hat{V}_{ii,d}$;

5. for each $i = 1, ..., k$, generate one draw $\psi_i^{(3),d}$ from the posterior $\psi_i^{(3)} \sim t(\hat{\psi}_i^{(3),d}, s_d^2\hat{V}_{ii,d}, N)$;

6. use $\{\psi_i^{(3),d}\}_{i=1}^{k}$ to compute the relative impulse vector $\hat{b}^{m,d}$ and convert it into the impulse vector $b^{m,d}$ using the estimate of Σ consistent with the VAR innovations implied by ι_d;

7. compute the impulse response associated with ι_d and $b^{m,d}$;

8. replicate steps 3 to 7 for each draw $d = 1, ..., D$.

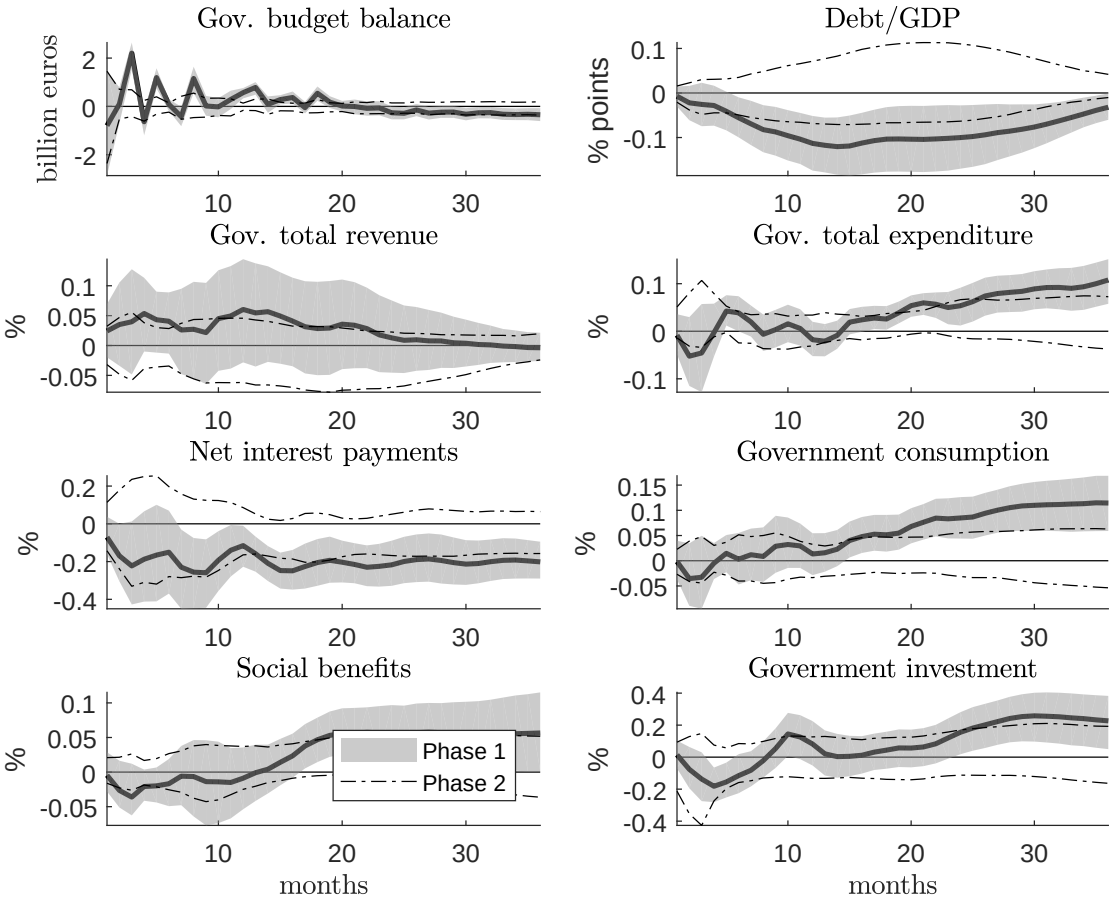
The above approach to the Bayesian estimation of proxy SVAR models builds on Rogers et al. (forthcoming). We depart from their contribution

and use the traditional independent Normal-inverse Wishart prior for the VAR parameters rather than a diffuse prior. In addition, we do not further restrict the draws such that selected sign restrictions are satisfied. Our approach also differs from Caldara and Herbst (forthcoming) in that we do not combine the VAR model and the auxiliary regressions (C.2) together, but keep them separate, as in the original specification of the proxy VAR methodology by Stock and Watson (2012) and Mertens and Ravn (2013).

In our application, we set the hyperparameters μ_ι such that the prior distribution on each equation of the VAR is a white noise process, and set V_ι such that the variance on "own lags" and lags of "other variables" are treated asymmetrically (see Koop et al., 2010, Canova, 2007). We run the Gibbs sampler for 4000 draws and burn in the first 2000.

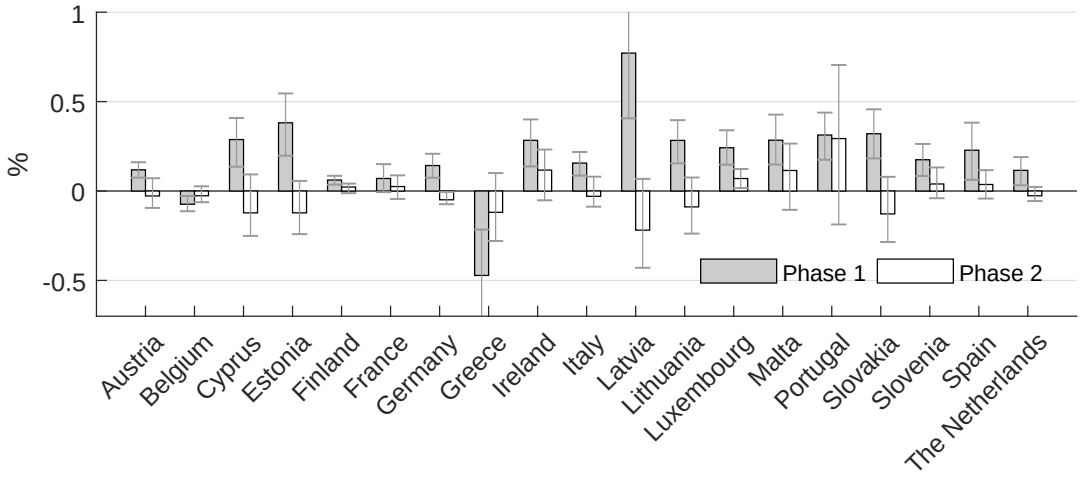
The results of the analysis are documented in Figures C.1 and C.2. As expected, the Bayesian framework allows us to increase the lag length and still estimate the effects of monetary policy with precision. The increases and the peak effects take place earlier, and more responses are statistically significant. This supports our result from Section 3.2.

Figure C.1: Robustness: variables from Figure 4 using Bayesian estimation with eight lags



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% Bayesian credible sets obtained using 2000 posterior draws. The shaded area and the continuous line show the credible set and the pointwise median response for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the credible set for a shock from the second phase.

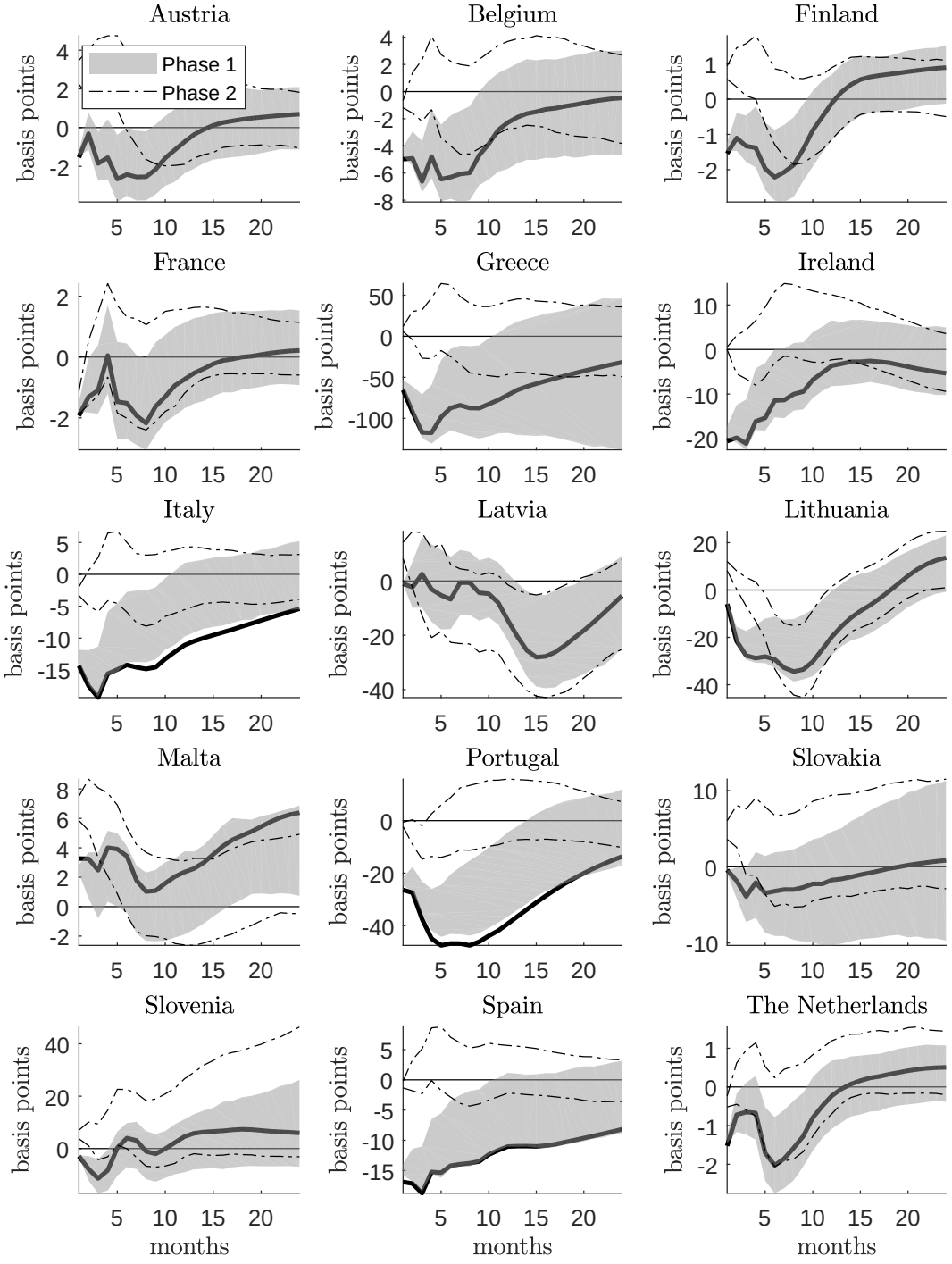
Figure C.2: Robustness: government consumption from Figure 5 using Bayesian estimation with eight lags



Notes: The figure shows the peak responses of country-specific government consumption after a one standard deviation expansionary monetary policy shock, along with 90% Bayesian credible sets obtained using 2000 posterior draws. The shaded area shows the pointwise median response for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the pointwise median response for a shock from the second phase. The peaks are reached after the following months from the shock (phase 1-2): Aut 26-7; Bel 6-6; Cyp 7-35; Est 11-30; Fin 28-22; Fra 3-4; Ger 33-1; Gre 7-7; Ire 18-2; Ita 4-6; Lat 12-29; Lit 8-34; Lux 8-7; Mal 9-7; Por 35-2; Svk 11-4; Svn 35-14; Spa 33-1; Nld 35-13.

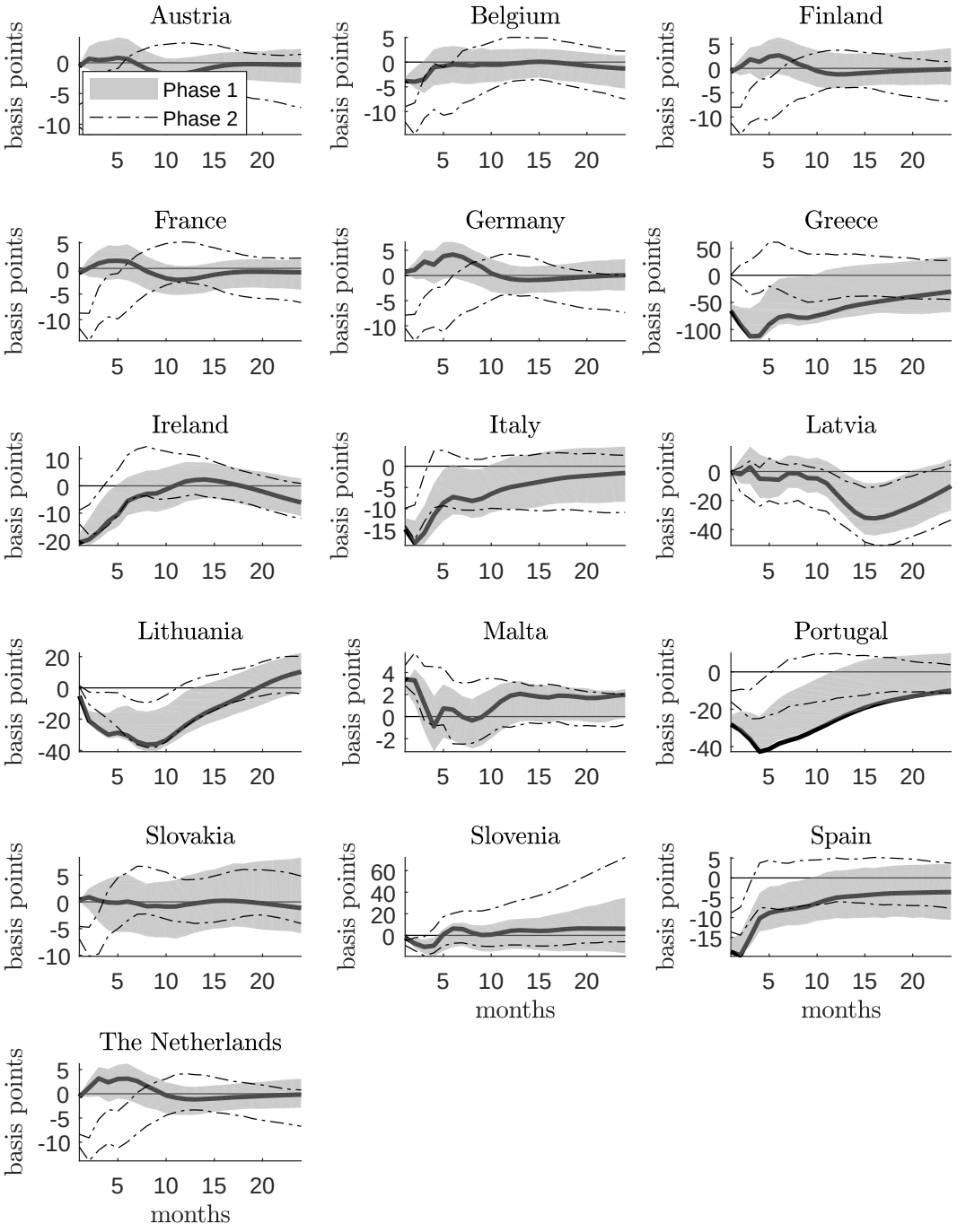
Appendix D : Responses behind the peak effects

Figure D.1: Spreads versus Germany on ten-year government bonds - impulse responses behind Figure 2



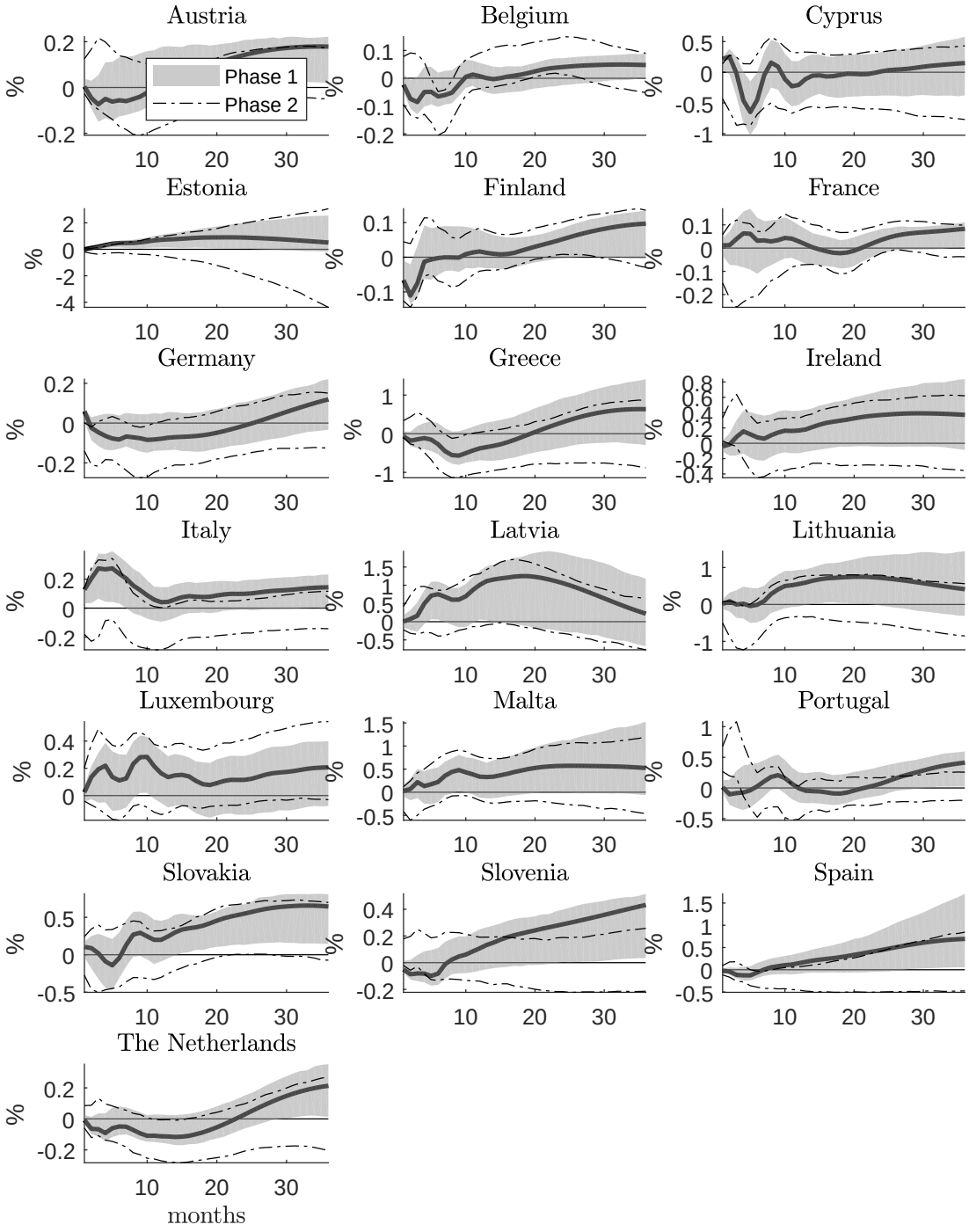
Notes: The figure shows the impulse responses of country-specific spreads versus Germany of ten-year government bonds after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure D.2: Yields on ten-year government bonds - impulse responses behind Figure 2



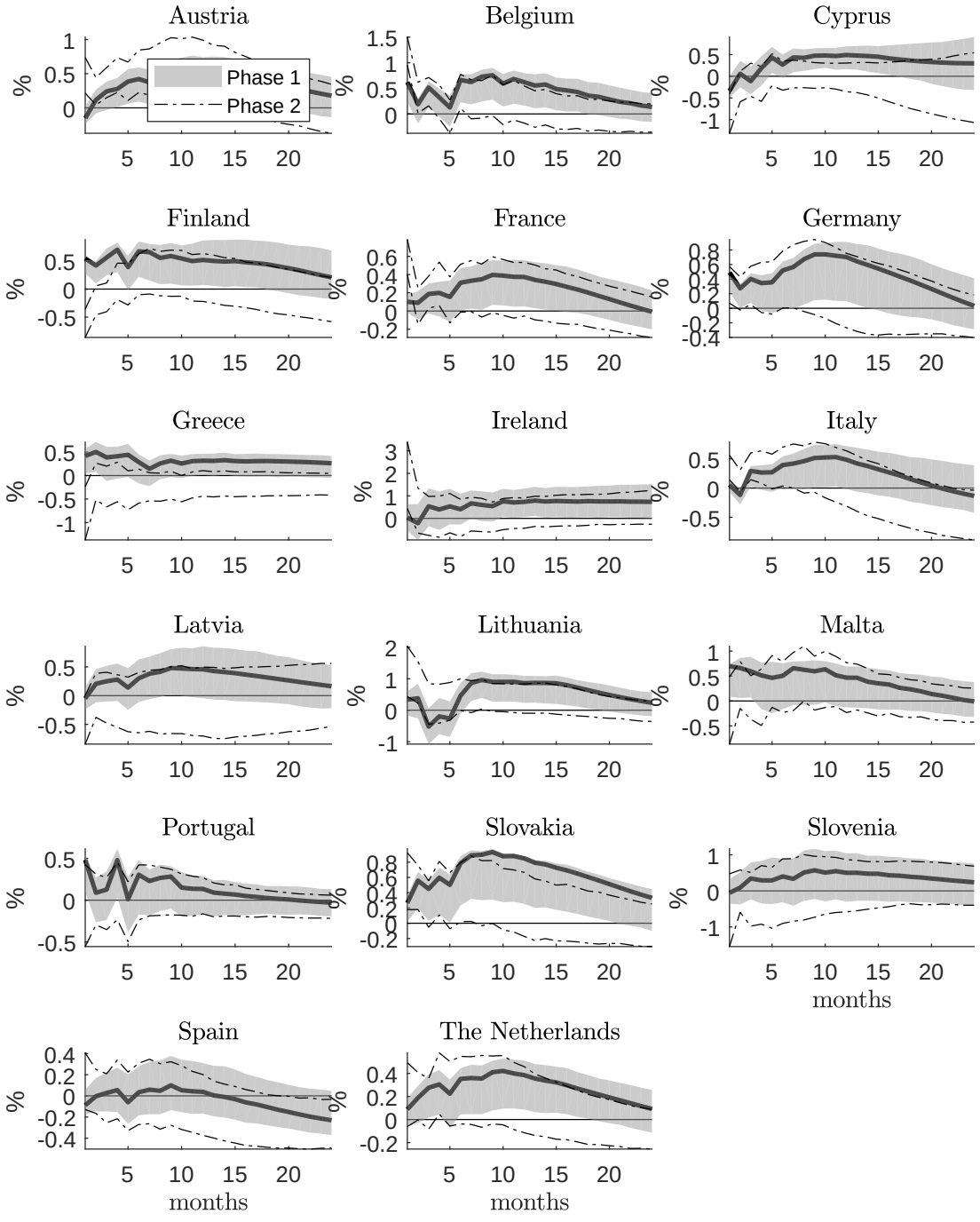
Notes: The figure shows the impulse responses of country-specific yields on ten-year government bonds after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure D.3: Government consumption - impulse responses behind Figure 5



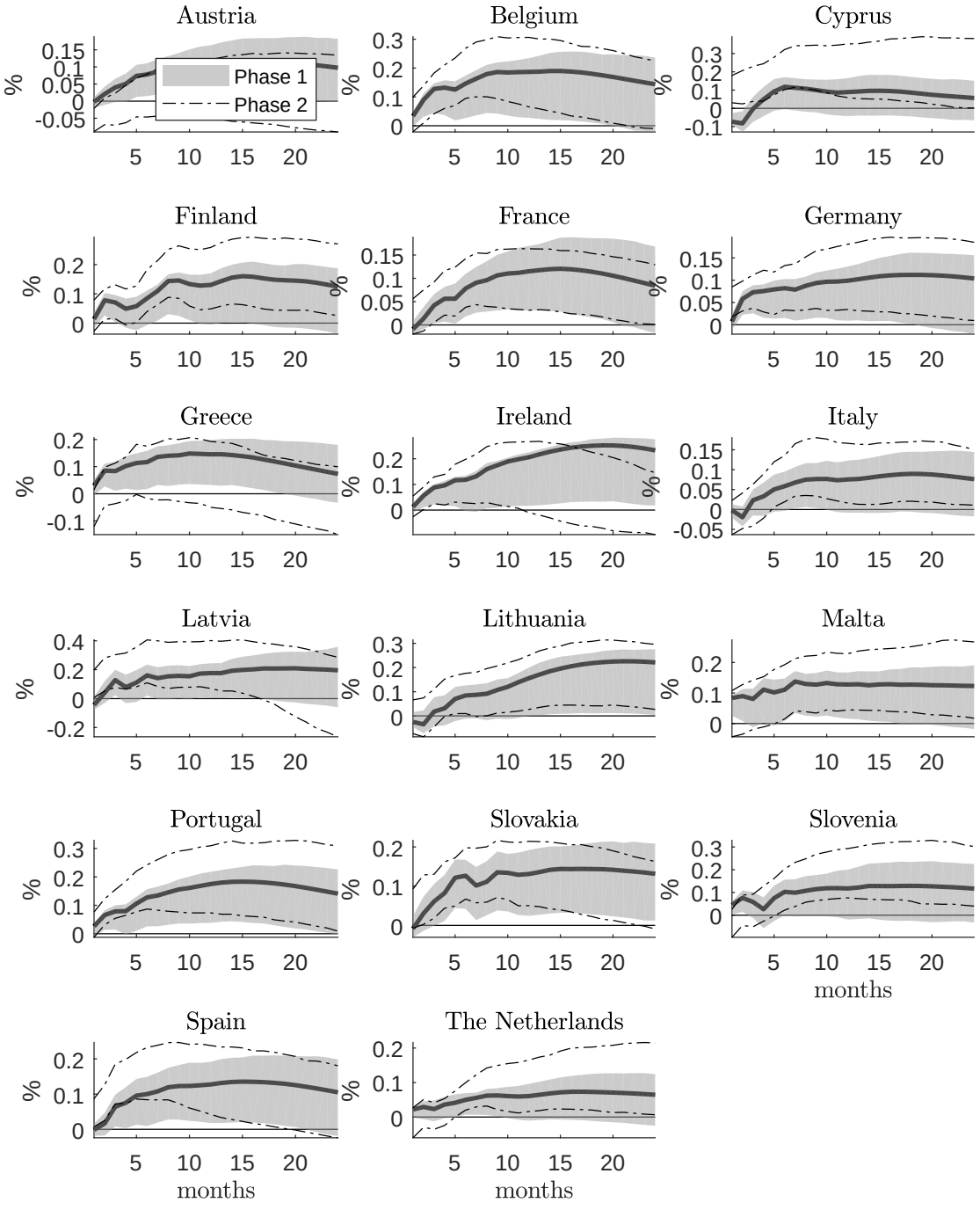
Notes: The figure shows the impulse responses of country-specific government consumption after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure D.4: Industrial production - impulse responses behind Figure 6



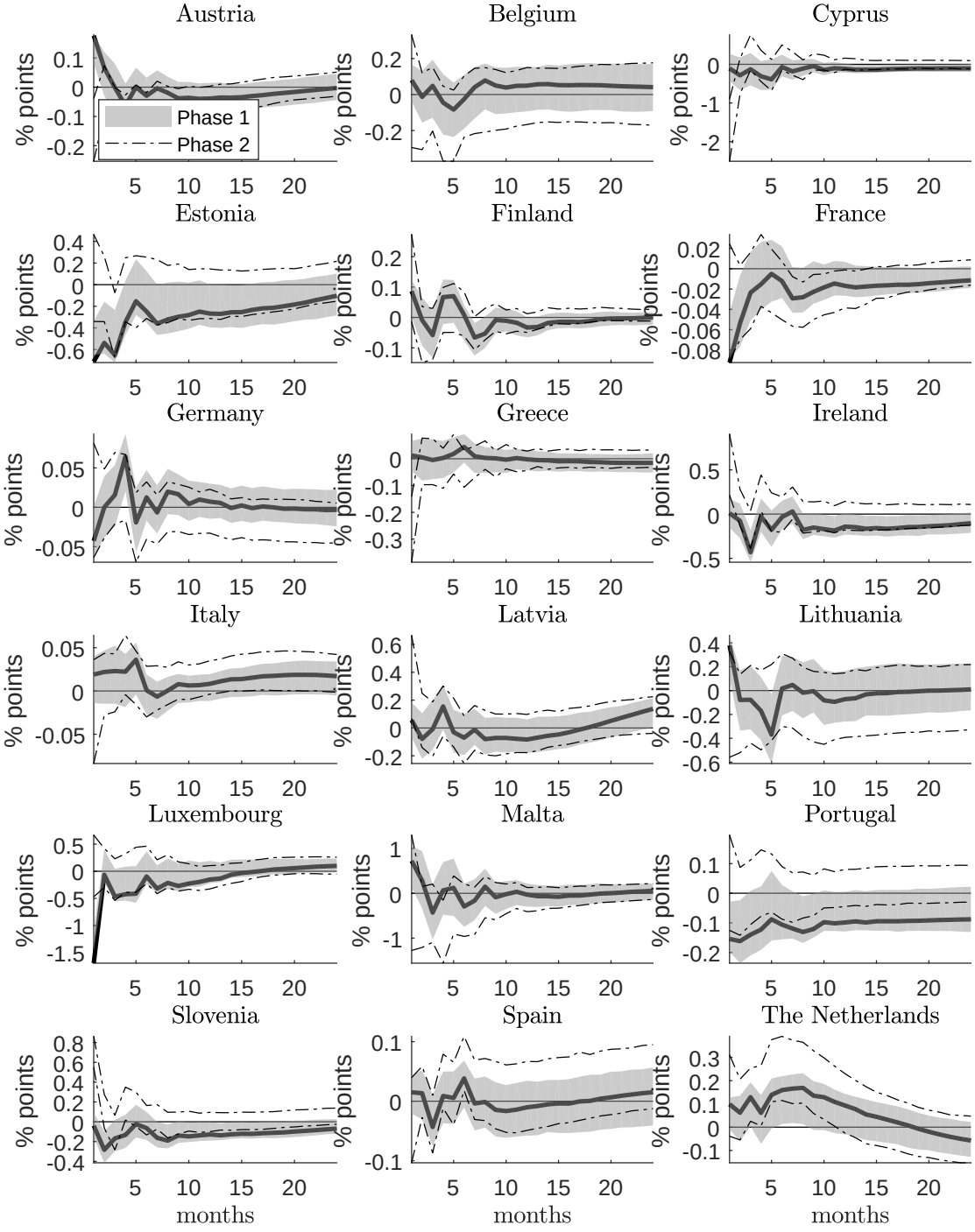
Notes: The figure shows the impulse responses of country-specific industrial production after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure D.5: Consumer price index - impulse responses behind Figure 6



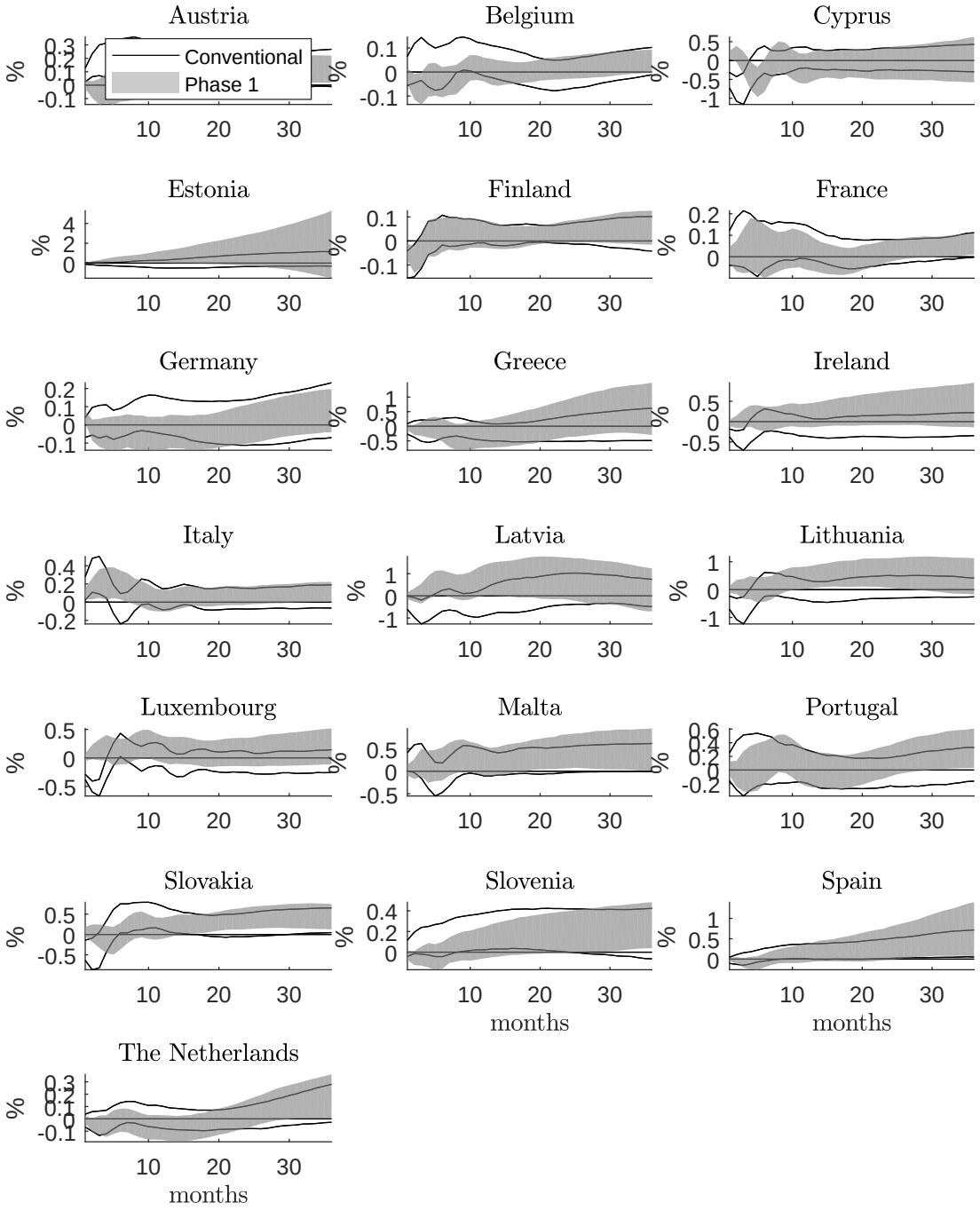
Notes: The figure shows the impulse responses of country-specific consumer price index after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure D.6: Net export - impulse responses behind Figure 8



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure D.7: Government consumption - impulse responses behind Figure 11

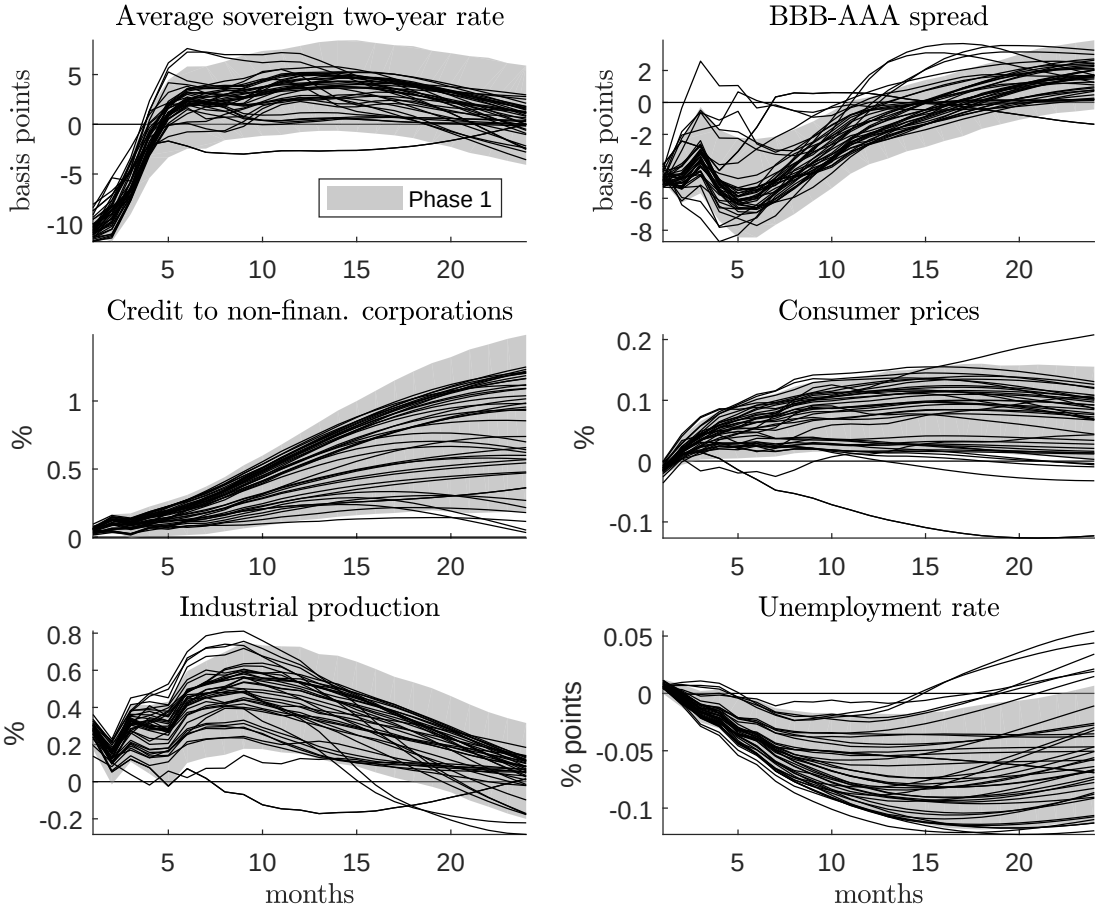


Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Appendix E : Sensitivity analysis

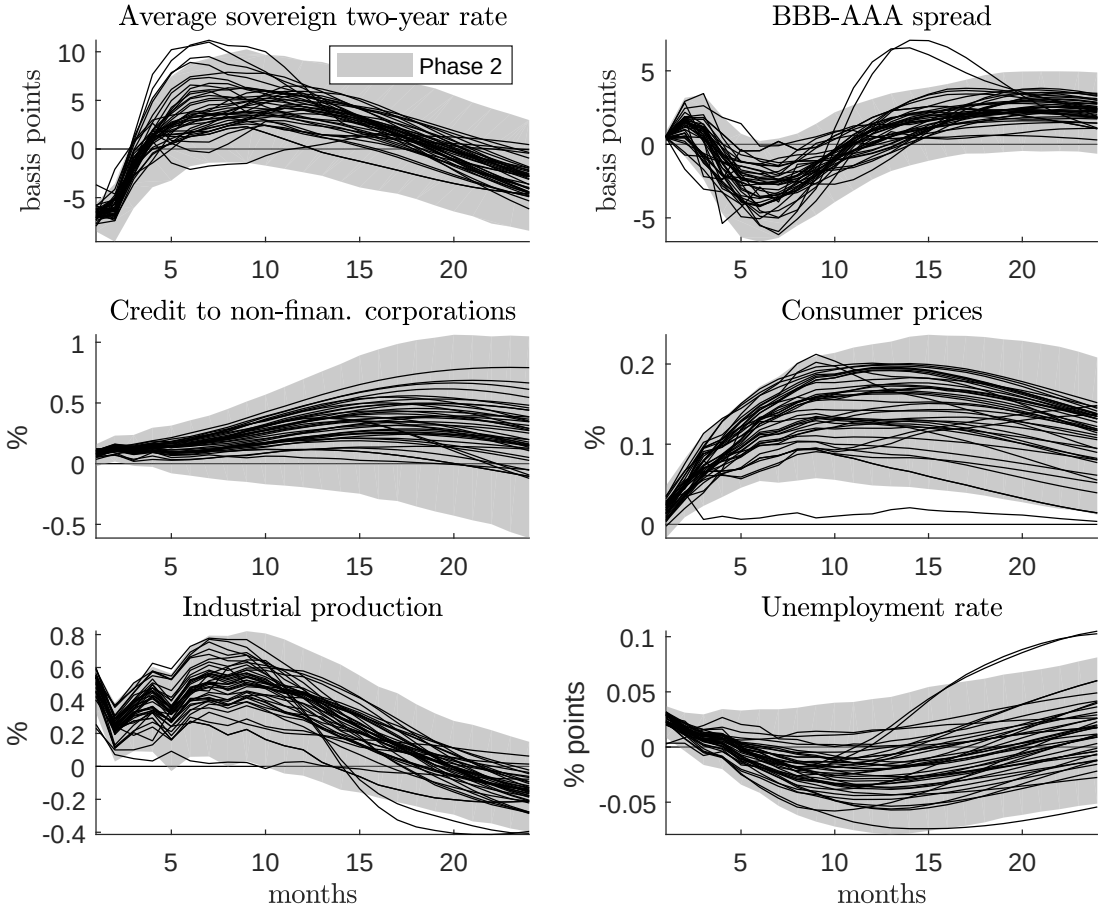
First, we look at the responses of the six baseline variables when adding the different marginal variables considered so far. Second, we increase the number of lags in the autoregressive component of the model from 5 to 8. Third, we replicate the analysis with eight lags using Bayesian estimation. Fourth, we estimate the reduced form model only on the period of unconventional monetary policy (2007M8-2016M11). Fifth, we compute impulse responses after winsorizing the instruments at 80% before identification. Sixth, we use the daily betas to construct the impulse vector as explained in footnote 11 in the paper. Seventh, we use a two-day event window for the construction of the proxy. Eighth, we use quarterly instead of monthly data. Ninth, we use only monthly VAR residuals in the estimation of the relative impulse vector. We replicate Figures 1 to 3 under the alternative model and data specifications. Finally, we construct three alternative proxies capturing specific aspects of ECB unconventional policy (credit easing, forward guidance, and quantitative easing), and a proxy merging phases 1 and 2, using either all yields or periphery yields. In the vast majority of cases, the responses are qualitatively the same as in the baseline model, and mostly also quantitatively similar.

Figure E.1: Robustness: baseline variables from Figure 1 when adding marginal variables (Phase I)



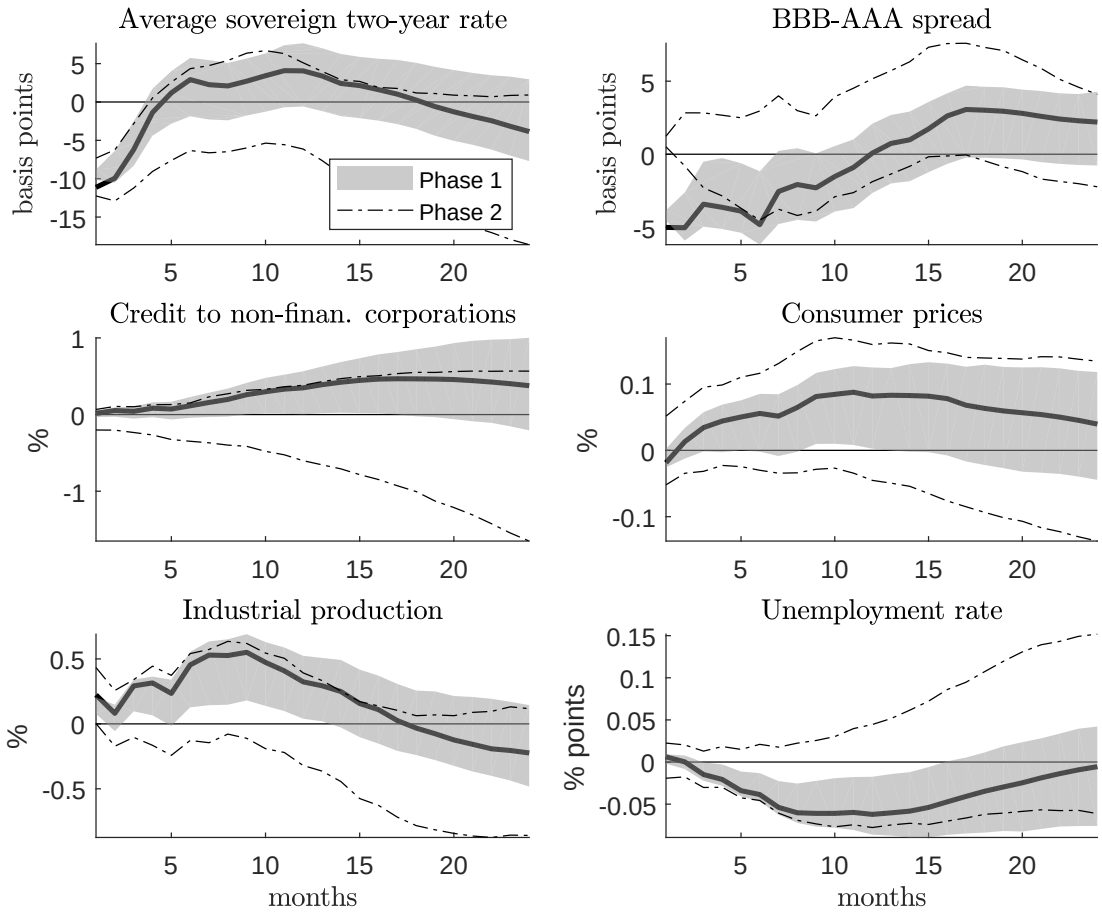
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock. The shaded area shows the confidence band for a shock from the first phase of ECB unconventional monetary policy. The continuous lines show the point estimates of the impulse responses from the extended VARs from Figure 2 and Figure 3.

Figure E.2: Robustness: baseline variables from Figure 1 when adding marginal variables (Phase II)



Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock. The shaded area shows the confidence band for a shock from the second phase of ECB unconventional monetary policy. The continuous lines show the point estimates of the impulse responses from the extended VARs from Figure 2 and Figure 3.

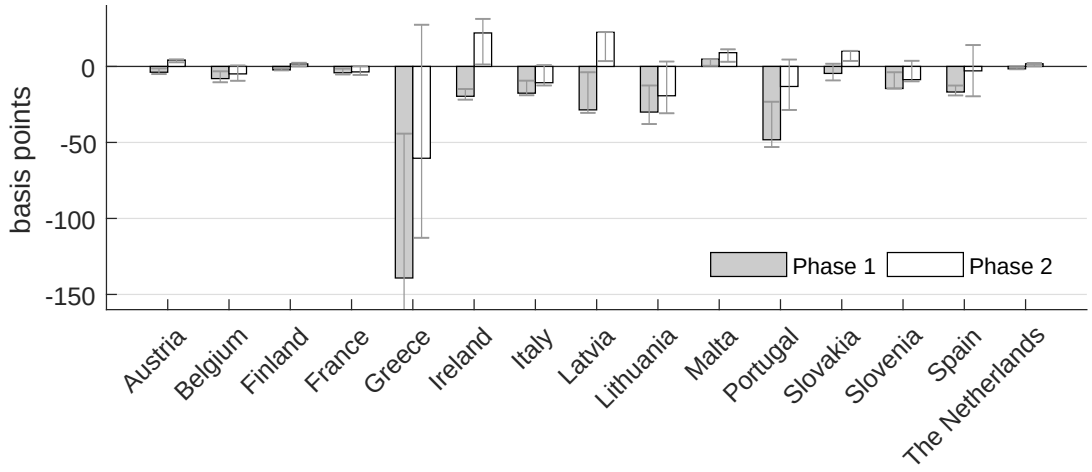
Figure E.3: Robustness: baseline variables from Figure 1 with eight lags rather than five



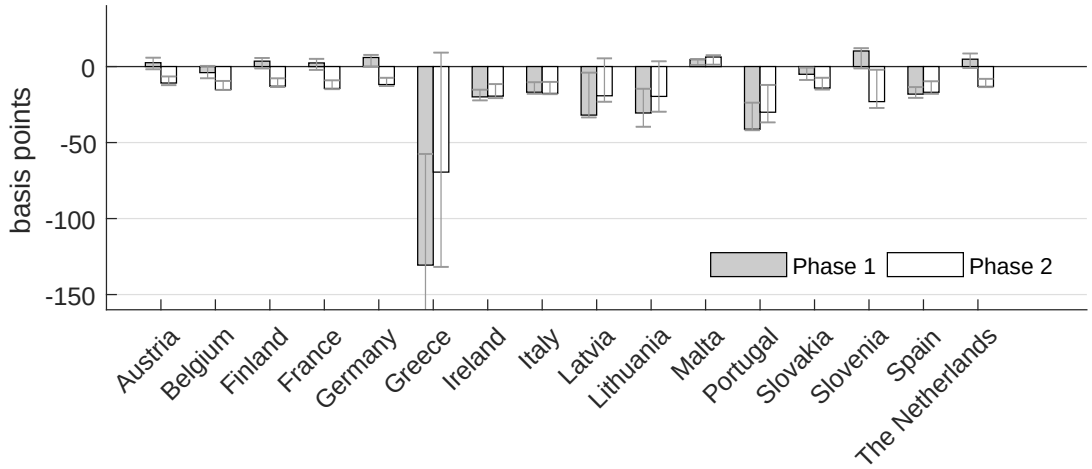
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.4: Robustness: spreads and yields from Figure 2 with eight lags rather than five

(a) Spreads versus Germany

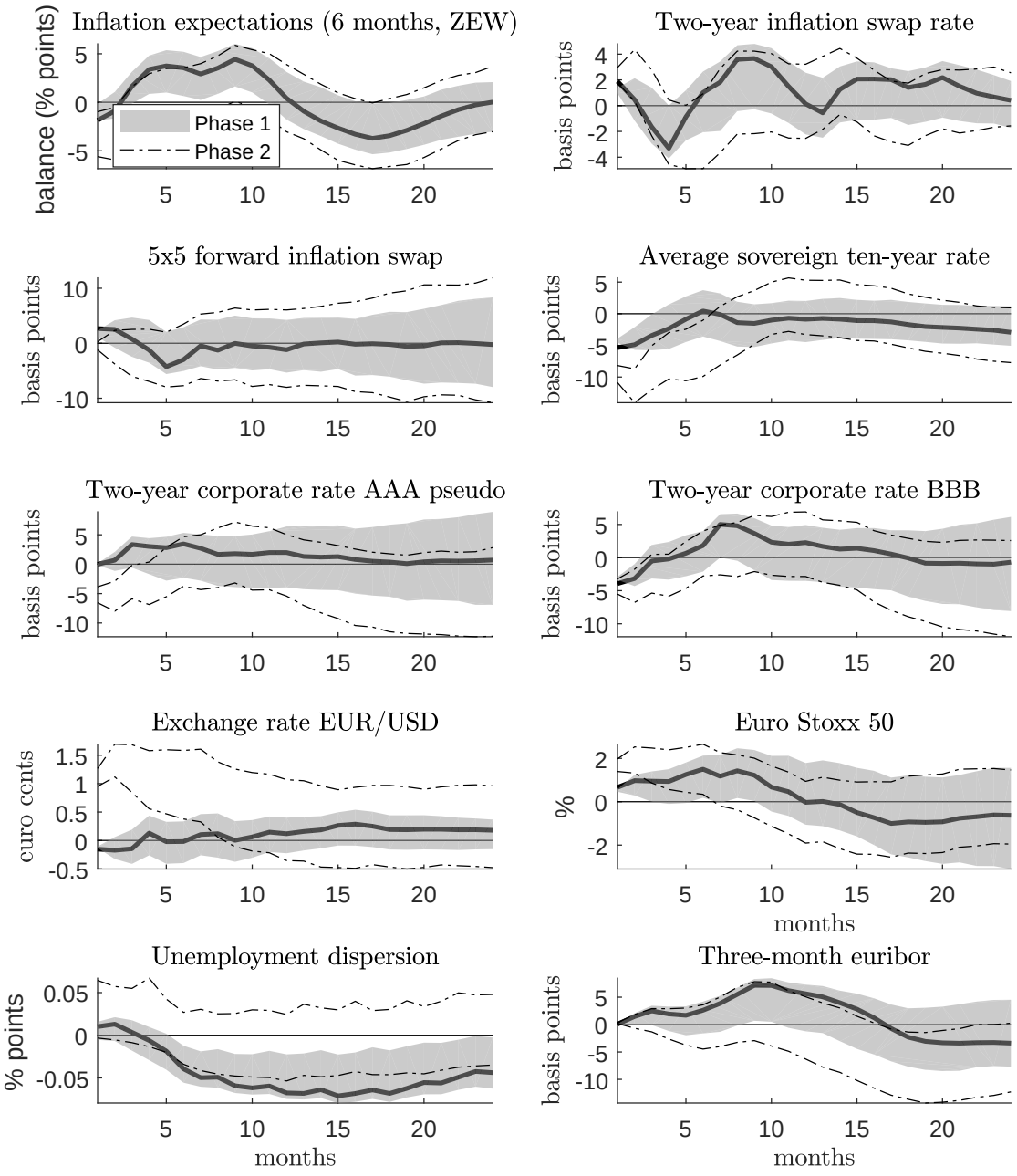


(b) Yields



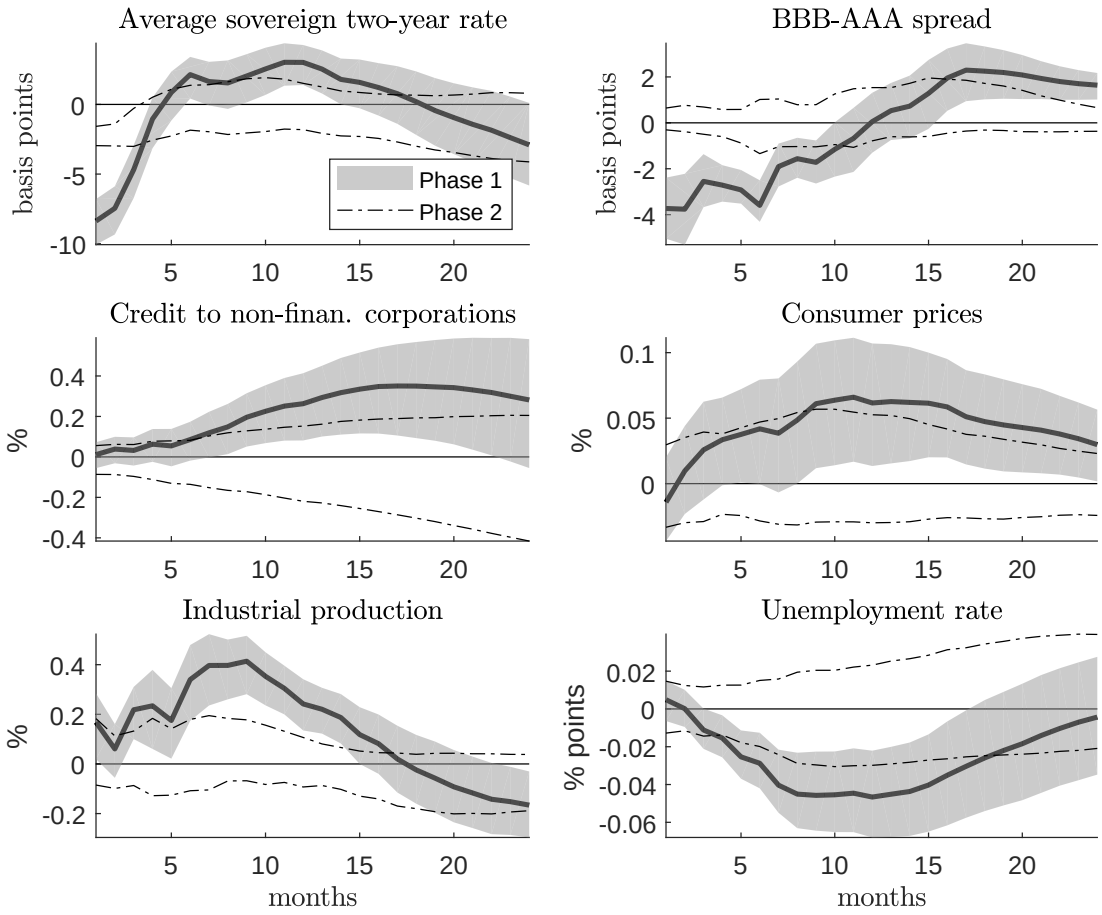
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase. In panel *a*, the peaks are reached after the following months from the shock (phase 1-2): Aut 6-0; Bel 7-7; Fin 5-16; Fra 7-7; Gre 8-8; Ire 0-11; Ita 2-7; Lat 14-1; Lit 8-8; Mal 23-1; Por 6-6; Svk 7-1; Svn 2-3; Spa 0-23; Nld 5-16. In panel *b*, the peaks are reached after the following months from the shock (phase 1-2): Aut 5-1; Bel 7-1; Fin 4-1; Fra 5-1; Ger 5-1; Gre 8-8; Ire 0-0; Ita 1-1; Lat 15-18; Lit 8-7; Mal 1-1; Por 3-3; Svk 7-1; Svn 13-3; Spa 0-1; Nld 5-1.

Figure E.5: Robustness: other variables from Figure 3 with eight lags rather than five



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

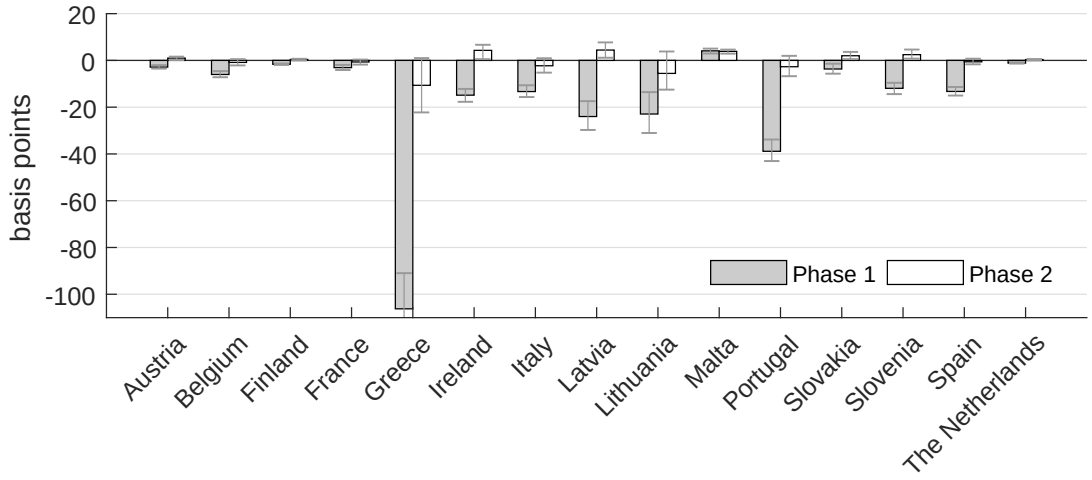
Figure E.6: Robustness: baseline variables from Figure 1 using Bayesian estimation with eight lags rather than five



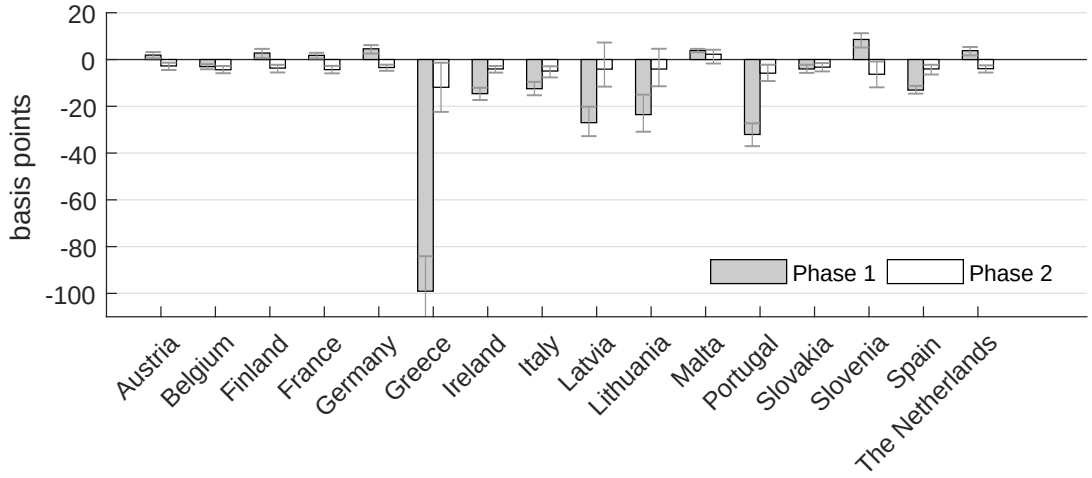
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% credible sets obtained using 2000 posterior draws. The shaded area and the continuous line show the confidence band and the pointwise median response for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.7: Robustness: spreads and yields from Figure 2 using Bayesian estimation with eight lags rather than five

(a) Spreads versus Germany

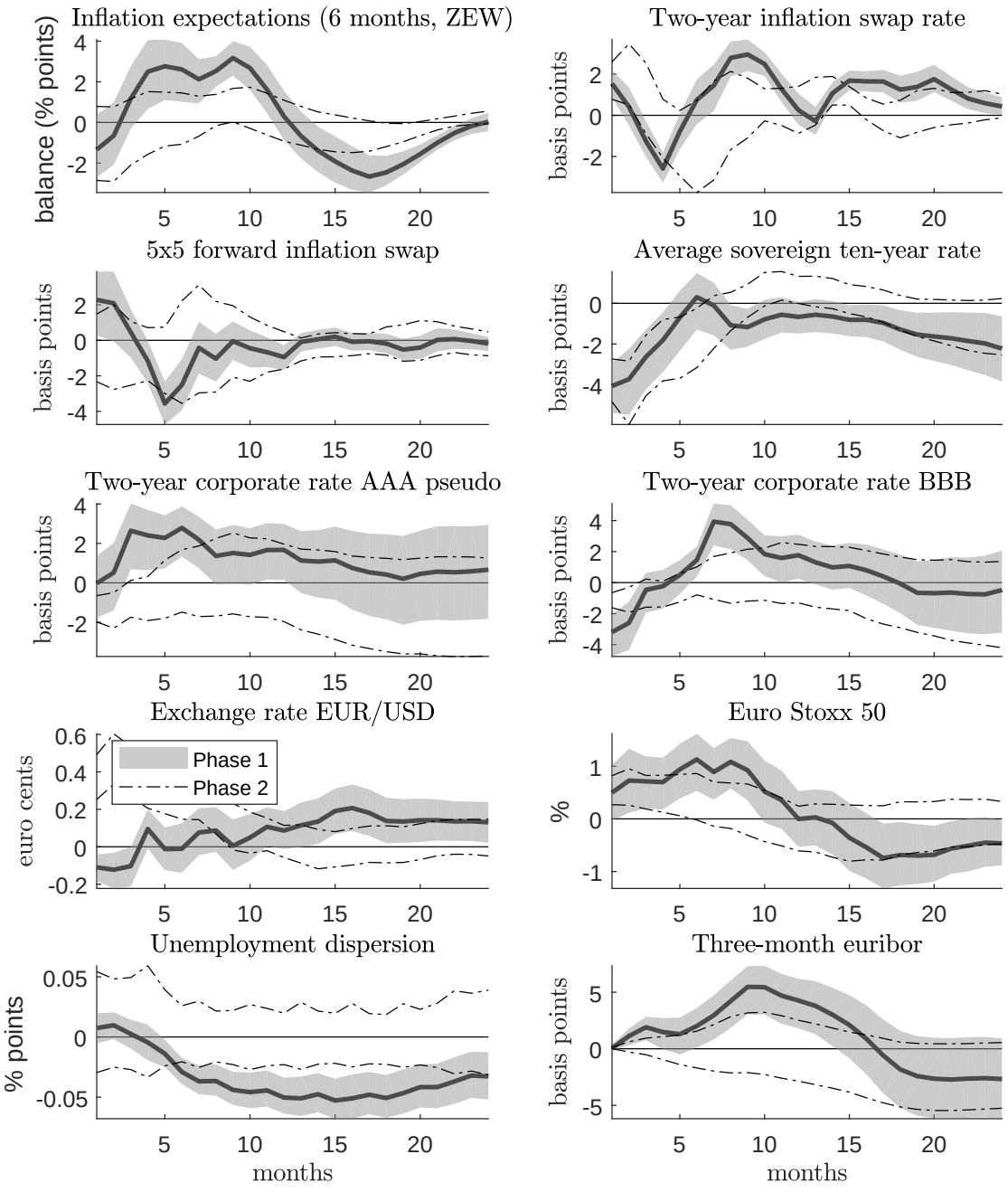


(b) Yields



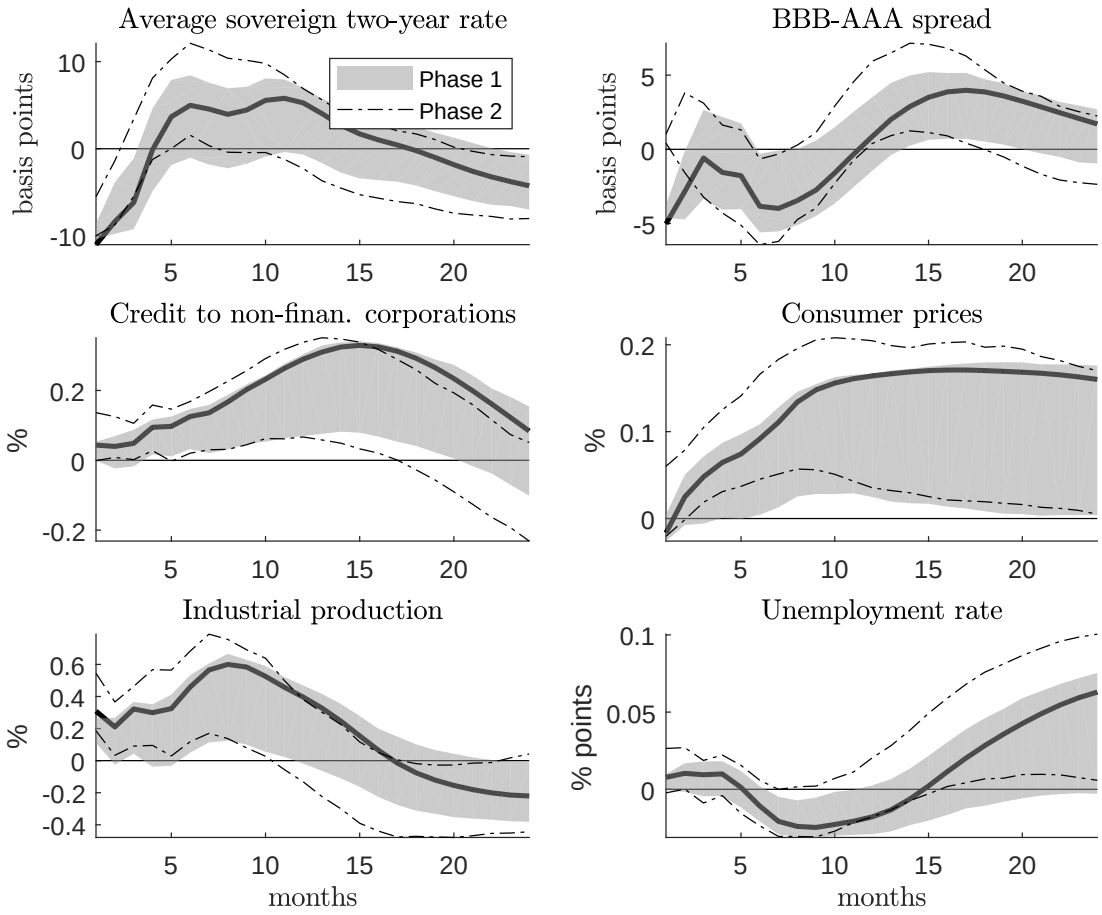
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% credible sets obtained using 2000 posterior draws. The shaded area shows the pointwise median response for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the pointwise median response for a shock from the second phase. In panel *a*, the peaks are reached after the following months from the shock (phase 1-2): Aut 7-0; Bel 7-7; Fin 5-16; Fra 7-7; Gre 8-8; Ire 0-11; Ita 2-7; Lat 14-1; Lit 8-8; Mal 23-1; Por 6-6; Svk 7-1; Svn 2-0; Spa 0-23; Nld 5-16. In panel *b*, the peaks are reached after the following months from the shock (phase 1-2): Aut 5-1; Bel 7-1; Fin 5-1; Fra 5-1; Ger 5-1; Gre 8-8; Ire 0-0; Ita 1-1; Lat 15-15; Lit 8-8; Mal 1-1; Por 3-3; Svk 7-1; Svn 13-3; Spa 0-1; Nld 5-1.

Figure E.8: Robustness: variables from Figure 3 using Bayesian estimation with eight lags rather than five



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% credible sets obtained using 2000 posterior draws. The shaded area and the continuous line show the confidence band and the pointwise median response for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

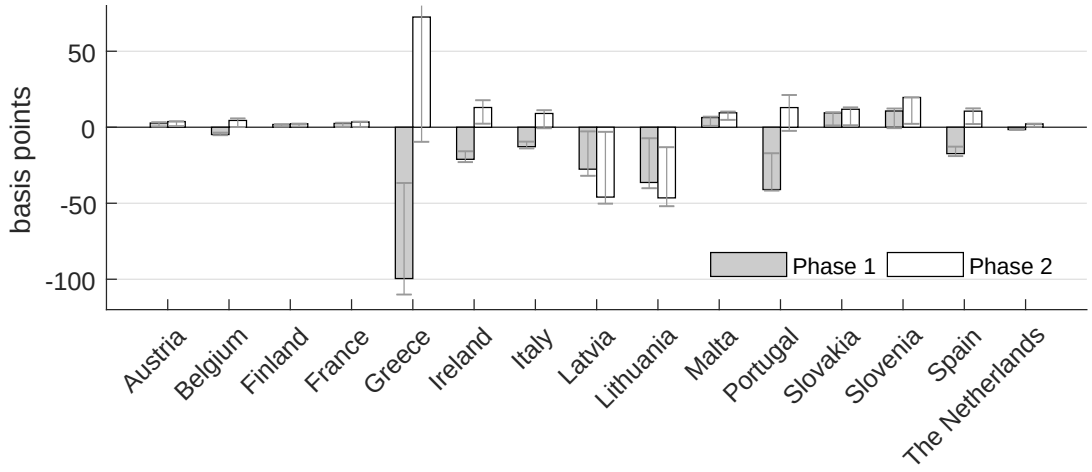
Figure E.9: Robustness: baseline variables from Figure 1 after estimating the VAR from August 2007



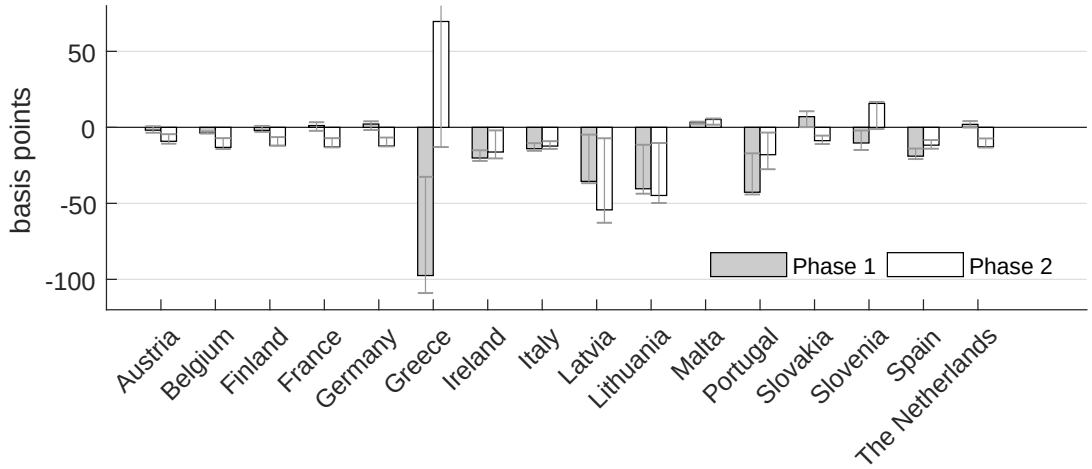
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.10: Robustness: spreads and yields from Figure 2 after after estimating the VAR from August 2007

(a) Spreads versus Germany

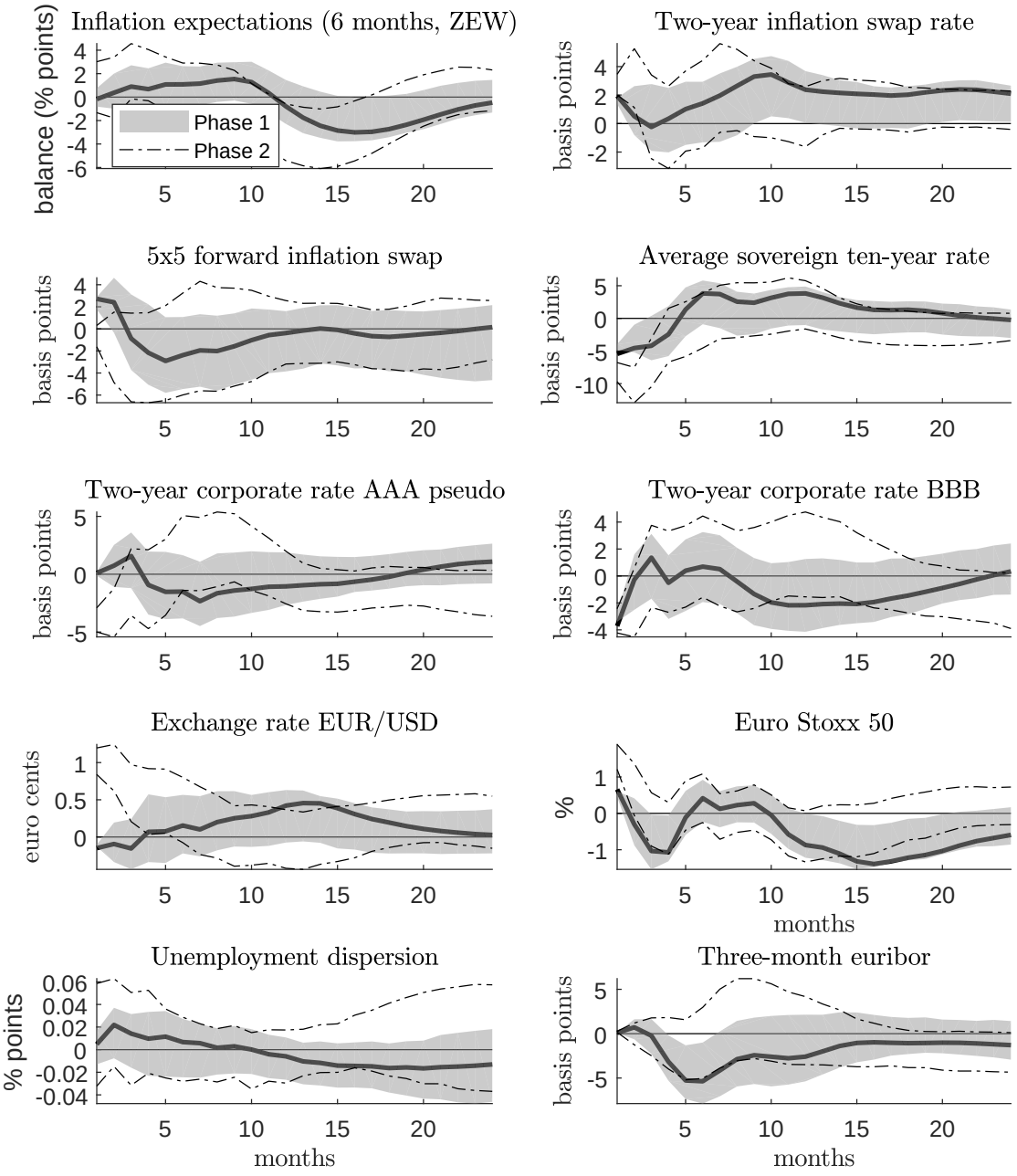


(b) Yields



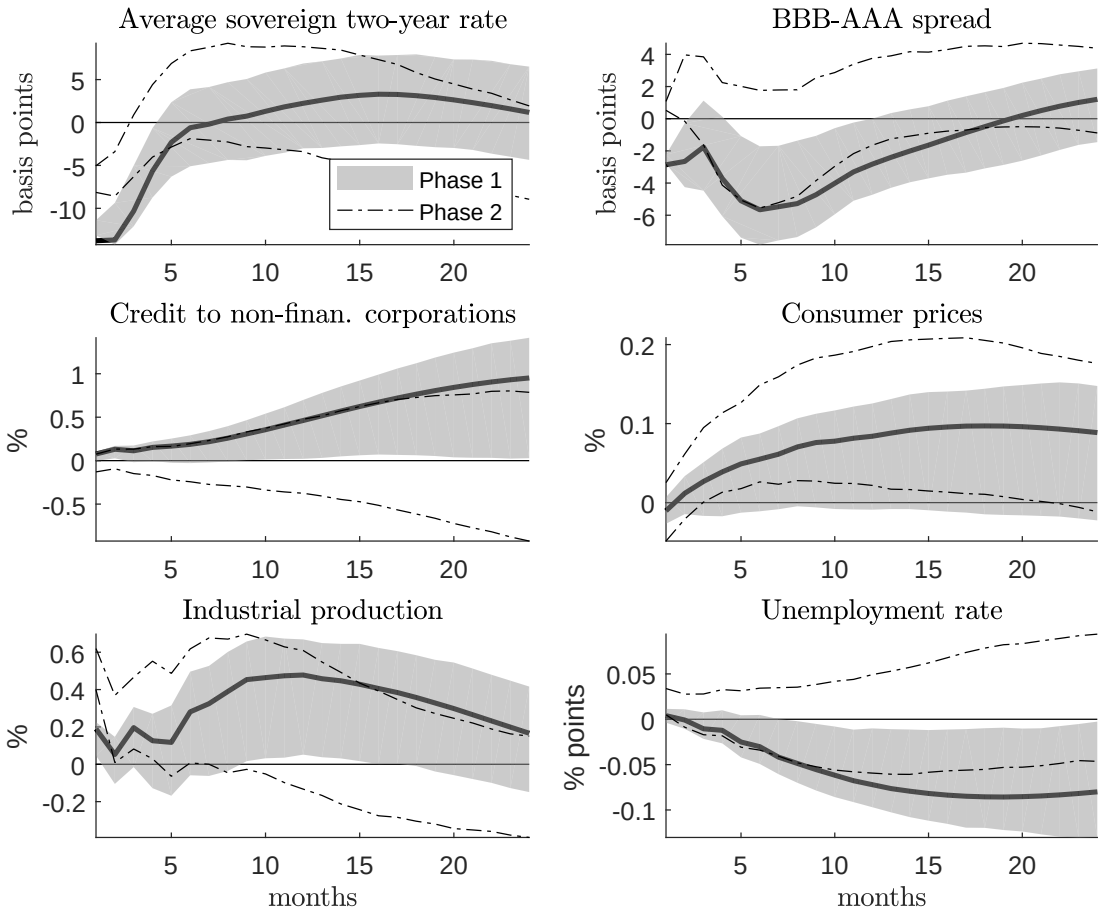
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase. In panel *a*, the peaks are reached after the following months from the shock (phase 1-2): Aut 16-16; Bel 0-13; Fin 15-15; Fra 16-14; Gre 2-4; Ire 0-11; Ita 0-3; Lat 14-15; Lit 7-7; Mal 23-1; Por 3-13; Svk 18-16; Svn 18-4; Spa 0-3; Nld 0-14. In panel *b*, the peaks are reached after the following months from the shock (phase 1-2): Aut 23-1; Bel 0-1; Fin 15-1; Fra 5-1; Ger 6-1; Gre 2-4; Ire 0-2; Ita 0-0; Lat 15-15; Lit 7-7; Mal 0-1; Por 3-2; Svk 18-1; Svn 2-6; Spa 0-0; Nld 1-1.

Figure E.11: Robustness: other variables from Figure 3 after estimating the VAR from August 2007



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

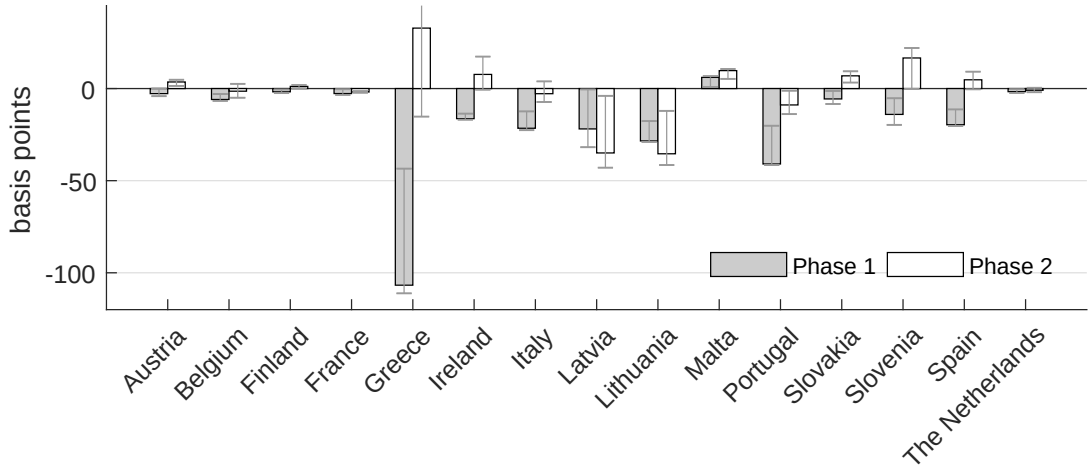
Figure E.12: Robustness: baseline variables from Figure 1 after a 80% winsorization of the external instruments



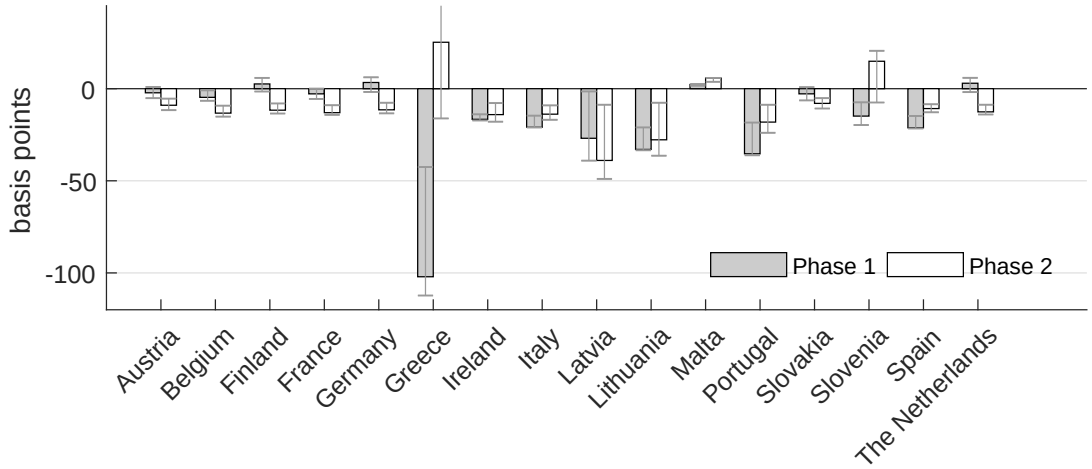
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase. The 80% winsorization of the proxies is applied to the daily proxy before aggregation to the monthly frequency.

Figure E.13: Robustness: spreads and yields from Figure 2 after a 80% winsorization of the external instruments

(a) Spreads versus Germany

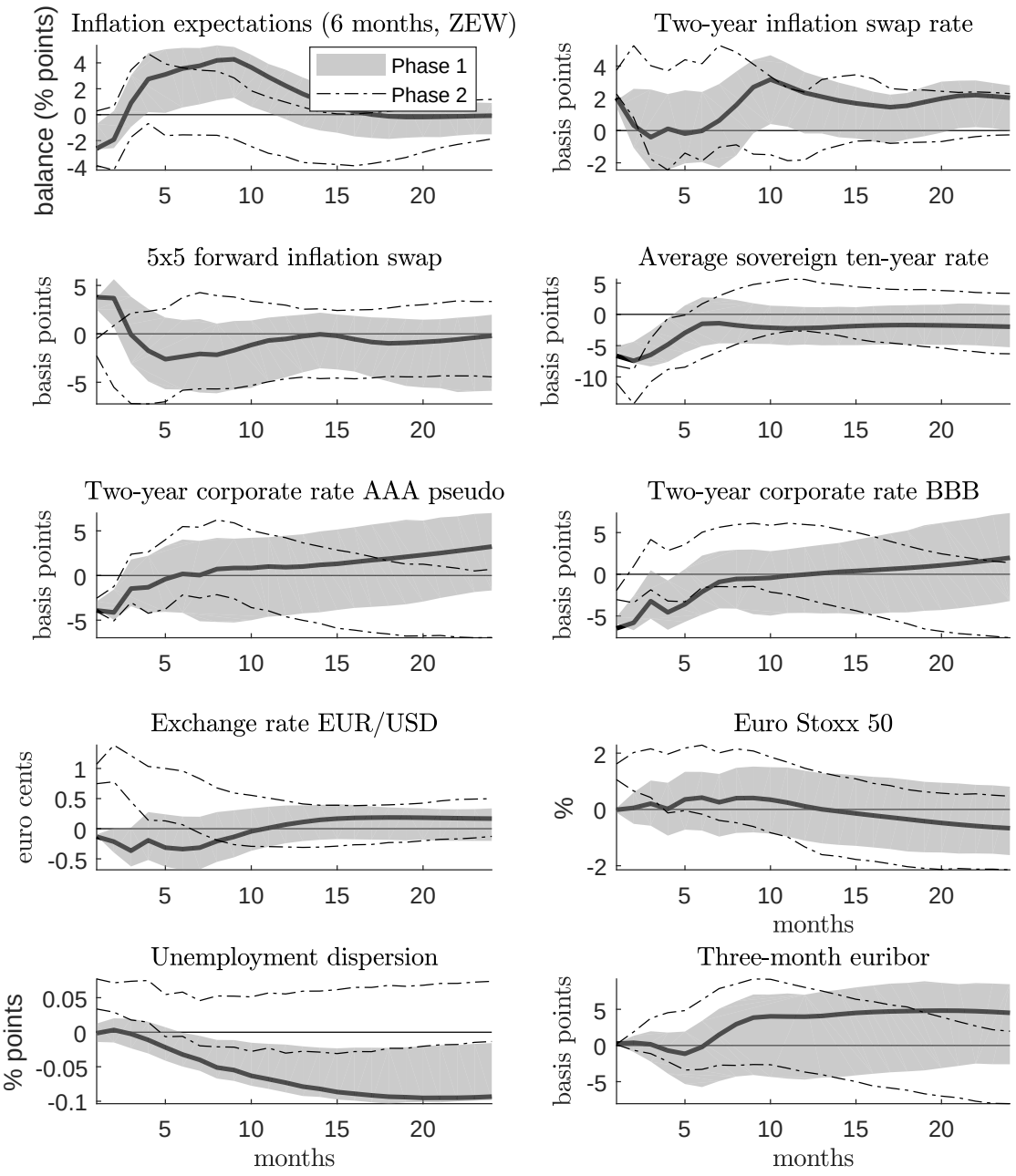


(b) Yields



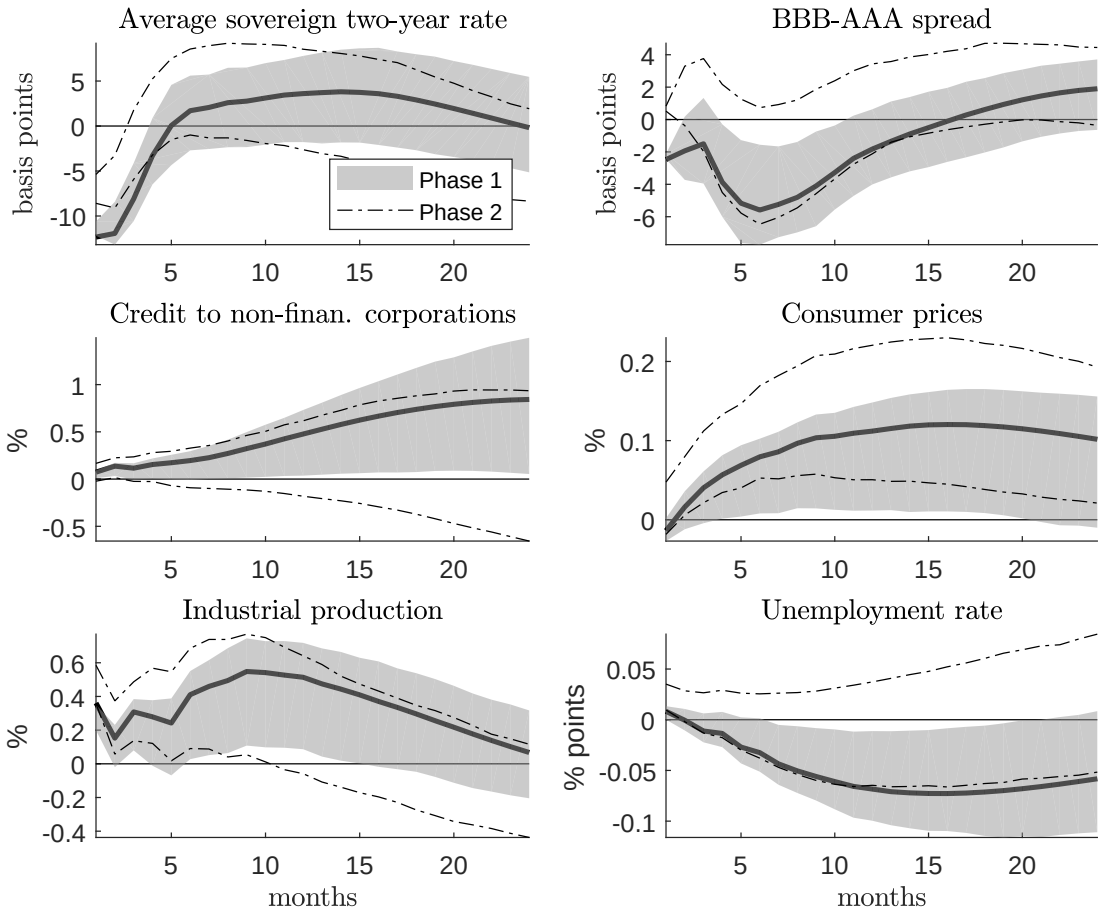
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase. In panel *a*, the peaks are reached after the following months from the shock (phase 1-2): Aut 7-3; Bel 2-7; Fin 7-3; Fra 7-0; Gre 3-4; Ire 0-6; Ita 2-7; Lat 15-14; Lit 2-7; Mal 23-1; Por 4-2; Svk 2-1; Svn 2-4; Spa 2-3; Nld 6-5. In panel *b*, the peaks are reached after the following months from the shock (phase 1-2): Aut 10-1; Bel 2-1; Fin 5-1; Fra 10-1; Ger 5-1; Gre 3-4; Ire 0-1; Ita 1-1; Lat 15-15; Lit 2-7; Mal 0-0; Por 3-2; Svk 2-1; Svn 2-5; Spa 1-0; Nld 5-1.

Figure E.14: Robustness: other variables from Figure 3 after a 80% winsorization of the external instruments



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

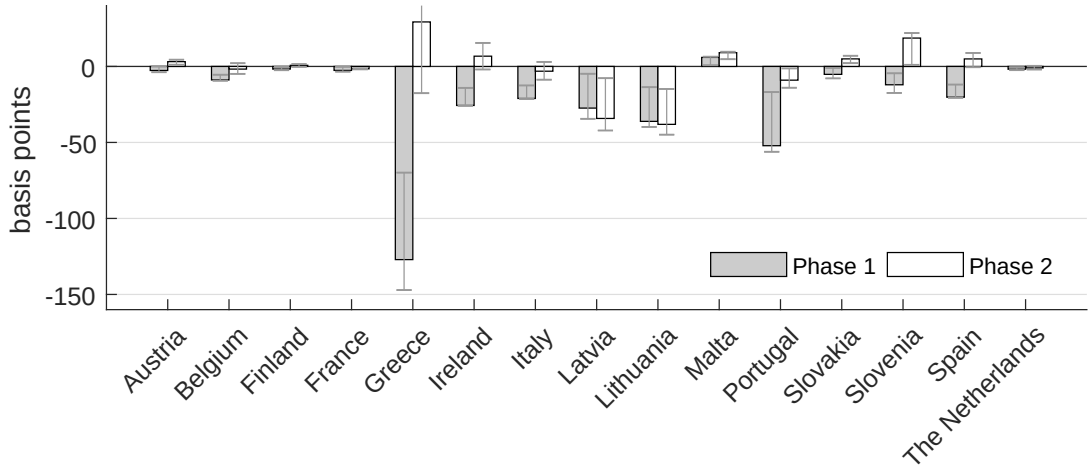
Figure E.15: Robustness: baseline variables from Figure 1, using the daily betas from footnote 11 in the paper



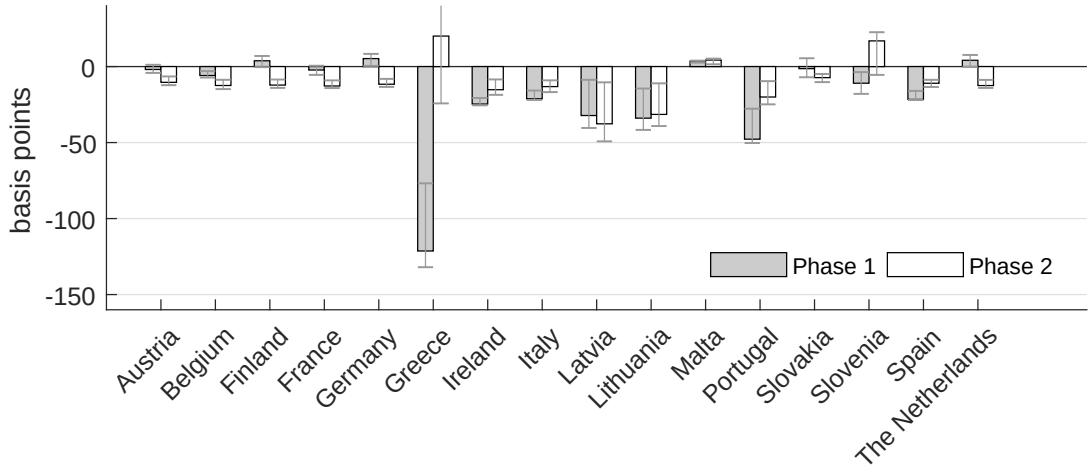
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.16: Robustness: spreads and yields from Figure 2, using the daily betas from footnote 11 in the paper

(a) Spreads versus Germany

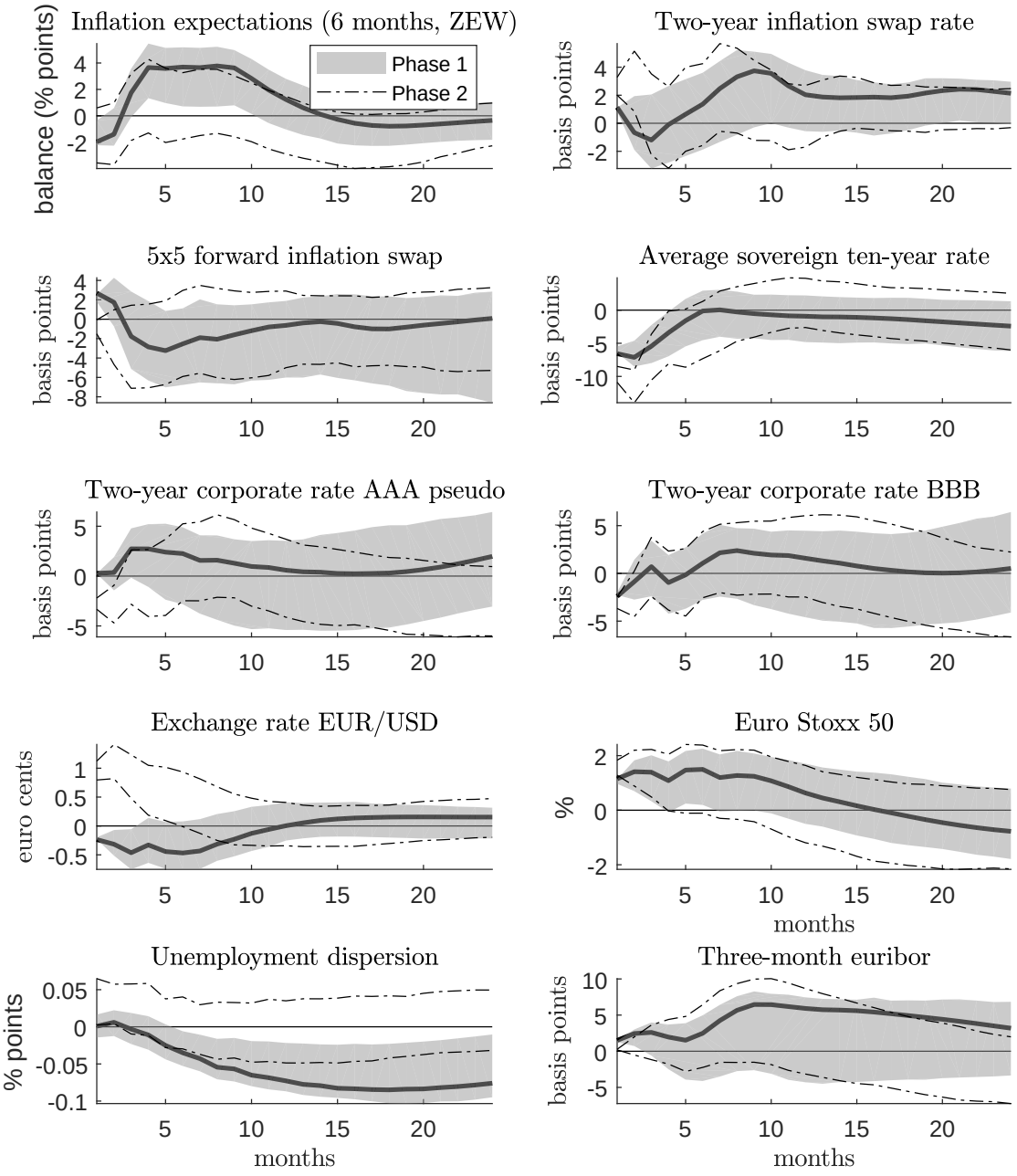


(b) Yields



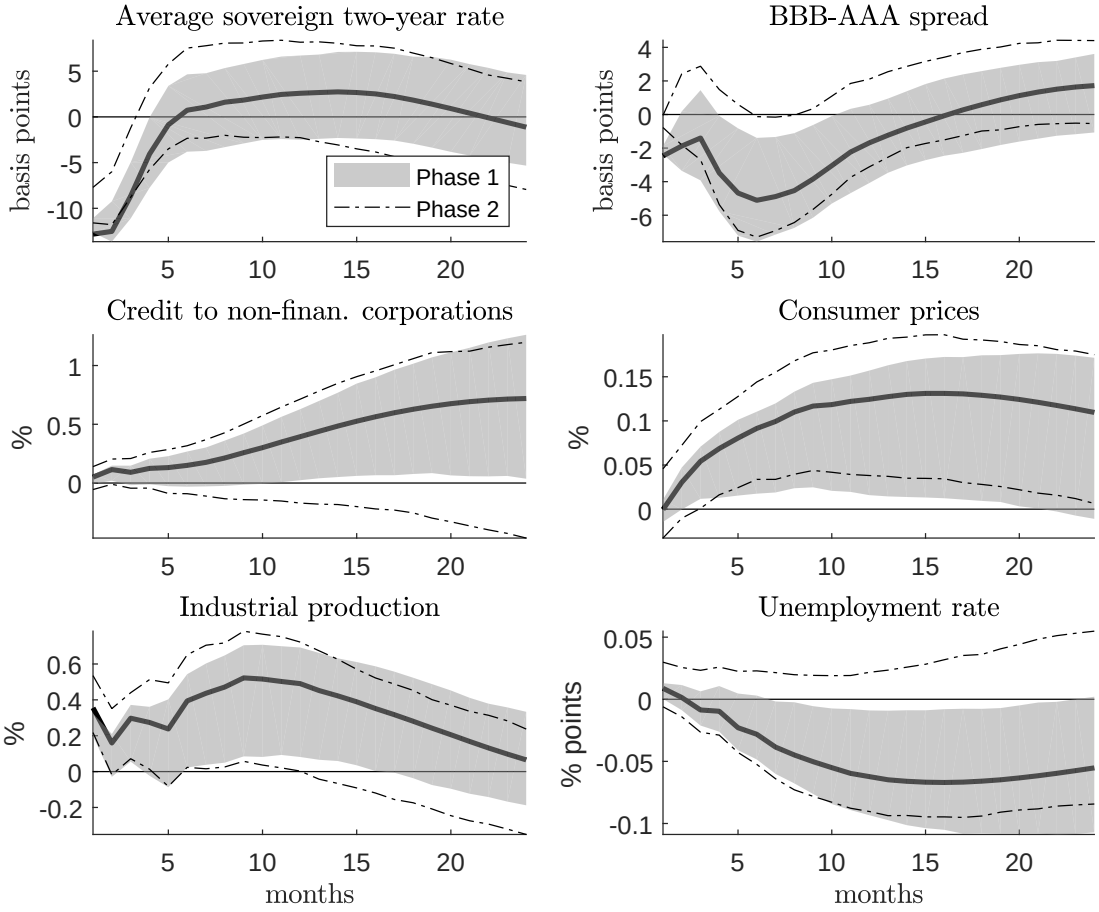
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase. In panel *a*, the peaks are reached after the following months from the shock (phase 1-2): Aut 7-3; Bel 2-7; Fin 5-3; Fra 7-0; Gre 3-4; Ire 2-6; Ita 2-7; Lat 15-14; Lit 7-7; Mal 23-1; Por 7-2; Svk 2-1; Svn 2-4; Spa 2-3; Nld 5-5. In panel *b*, the peaks are reached after the following months from the shock (phase 1-2): Aut 10-1; Bel 1-1; Fin 5-1; Fra 11-1; Ger 5-1; Gre 2-4; Ire 0-1; Ita 1-1; Lat 15-15; Lit 8-7; Mal 0-1; Por 3-2; Svk 2-5; Svn 2-5; Spa 1-0; Nld 5-1.

Figure E.17: Robustness: other variables from Figure 3, using the daily betas from footnote 11 in the paper



Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

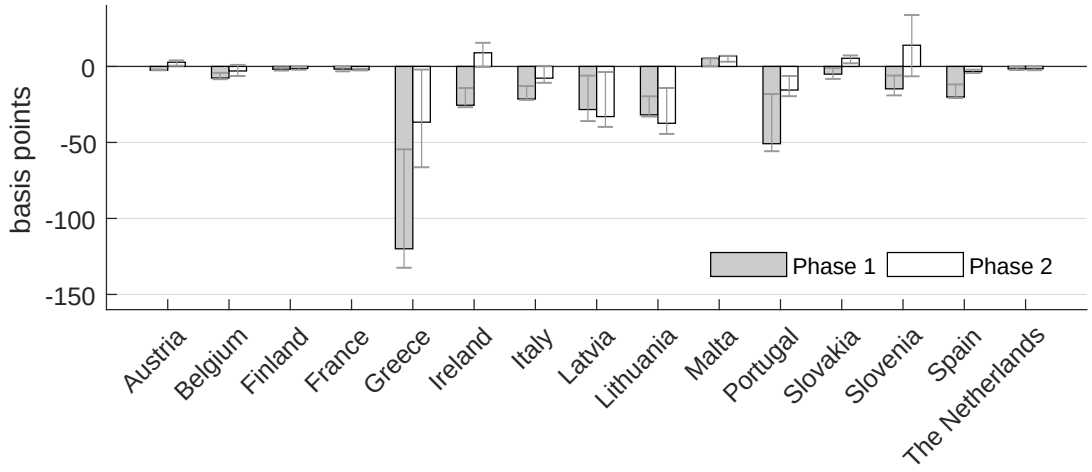
Figure E.18: Robustness: baseline variables from Figure 1, using a two day window around the events



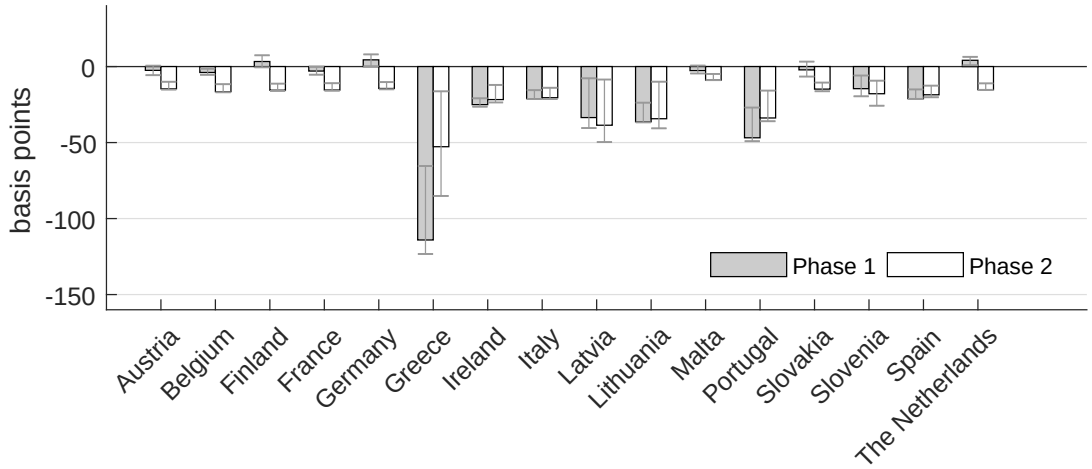
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.19: Robustness: spreads and yields from Figure 2, using a two day window around the events

(a) Spreads versus Germany

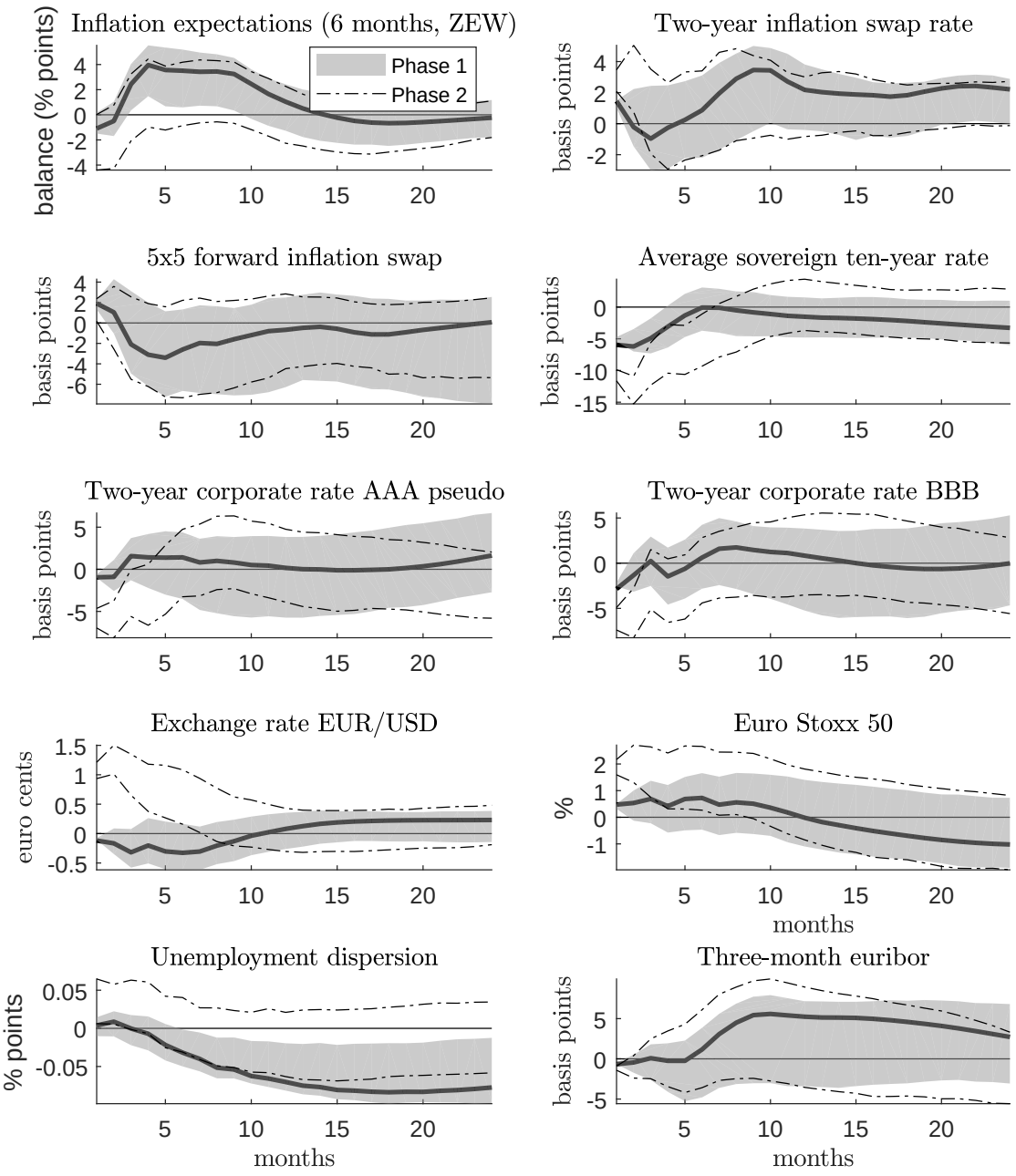


(b) Yields



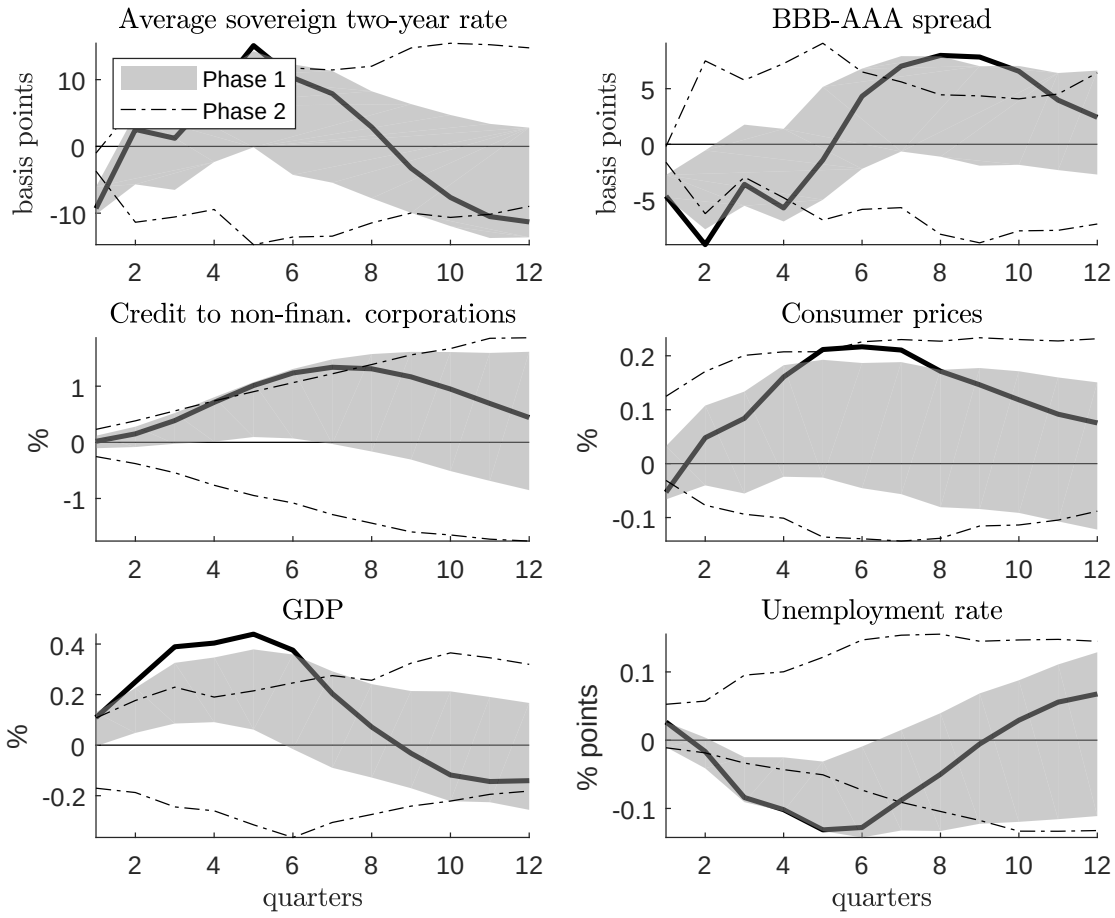
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase. In panel *a*, the peaks are reached after the following months from the shock (phase 1-2): Aut 0-3; Bel 2-7; Fin 5-5; Fra 7-0; Gre 3-2; Ire 2-7; Ita 2-7; Lat 15-14; Lit 7-2; Mal 23-1; Por 7-2; Svk 2-1; Svn 2-13; Spa 2-0; Nld 5-5. In panel *b*, the peaks are reached after the following months from the shock (phase 1-2): Aut 11-1; Bel 1-1; Fin 5-1; Fra 11-1; Ger 5-1; Gre 2-2; Ire 0-1; Ita 1-1; Lat 15-15; Lit 2-7; Mal 3-1; Por 3-3; Svk 23-1; Svn 2-2; Spa 1-1; Nld 2-1.

Figure E.20: Robustness: other variables from Figure 3, using a two day window around the events



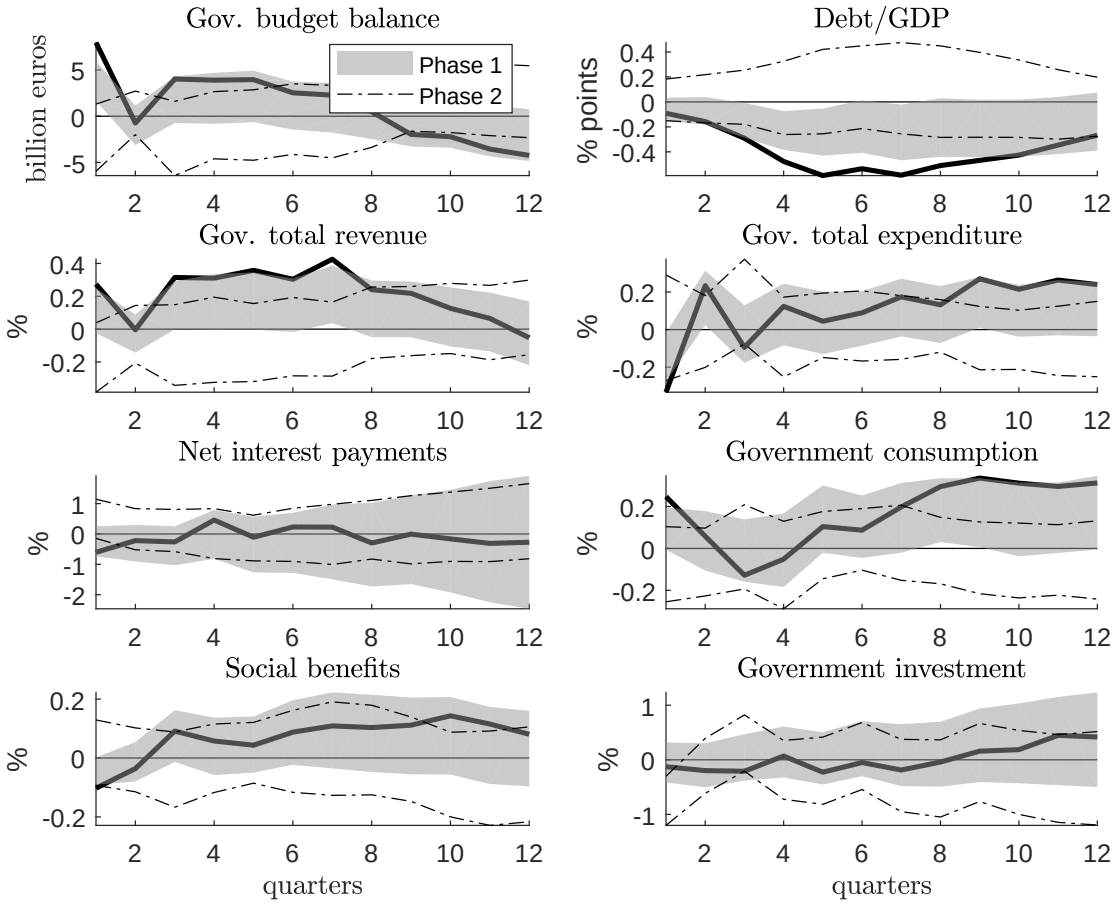
Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.21: Robustness: baseline model for the euro area, using quarterly data and four lags



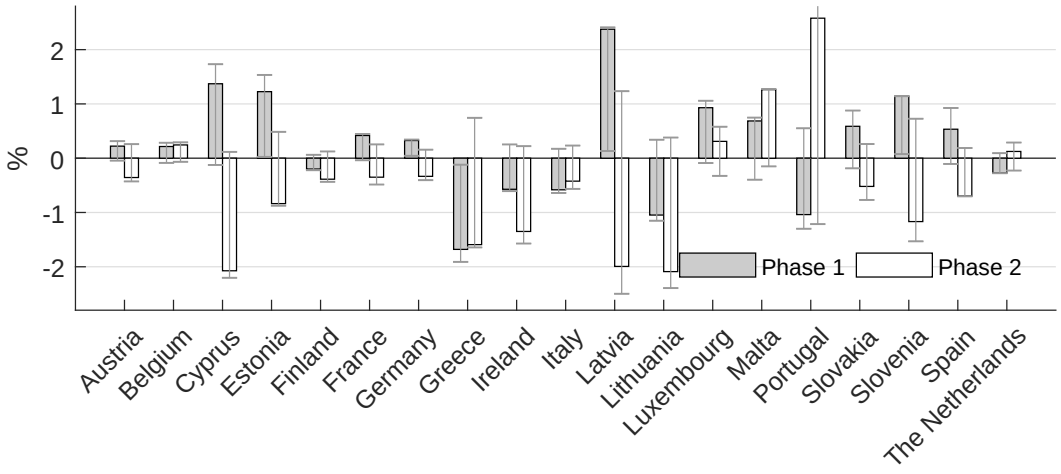
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase. Relative to Figure 1 we replace industrial production with real GDP and and aggregate to quarterly frequency the remaining variables.

Figure E.22: Robustness: fiscal responses at the euro area level, using quarterly data and four lags



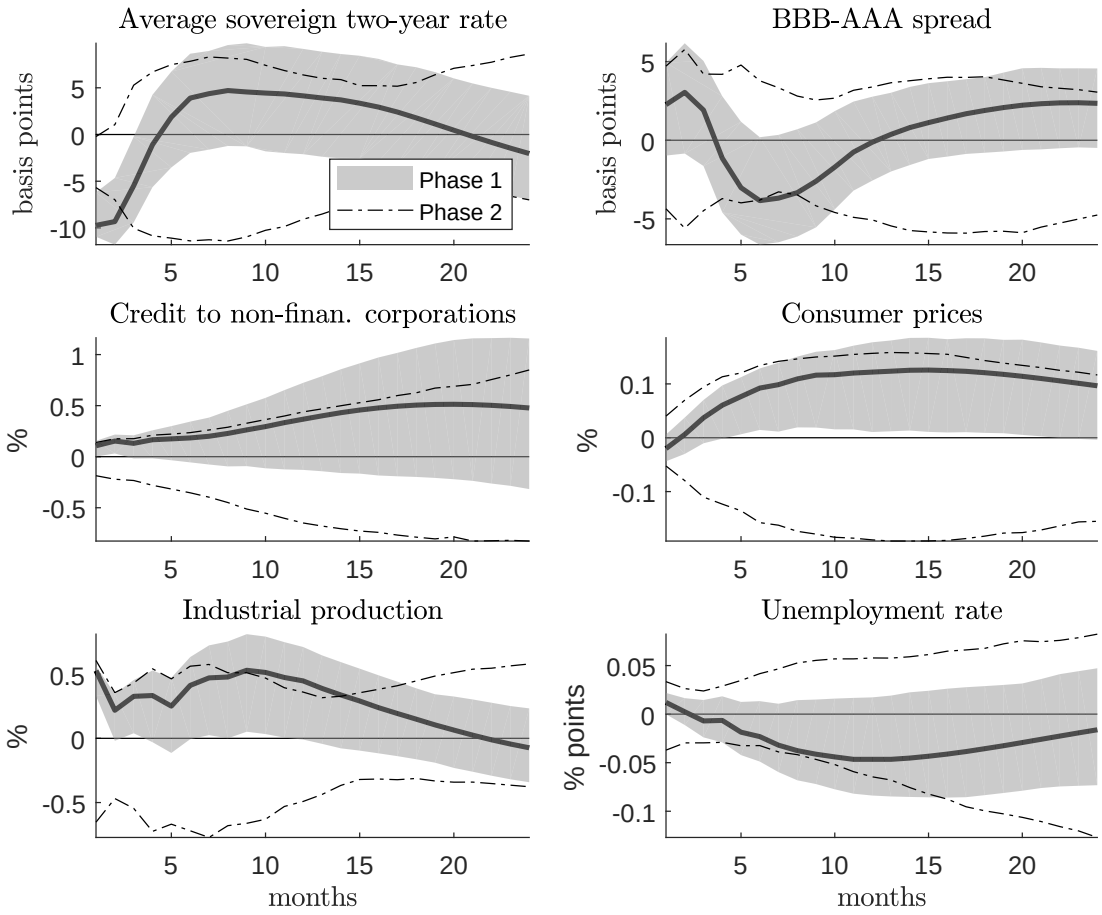
Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.23: Robustness: peak responses of government consumption, using quarterly data and four lags



Notes: The figure shows the peak responses of country-specific government consumption after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase. The peaks are reached after the following quarters from the shock (phase 1-2): Aut 6-0; Bel 0-4; Cyp 0-0; Est 6-6; Fin 0-0; Fra 1-0; Ger 2-11; Gre 4-0; Ire 0-0; Ita 2-8; Lat 3-7; Lit 1-0; Lux 0-2; Mal 5-2; Por 3-0; Svk 11-9; Svn 11-0; Spa 9-3; Nld 3-7. Figure D.3 in the online appendix reports the full underlying impulse responses.

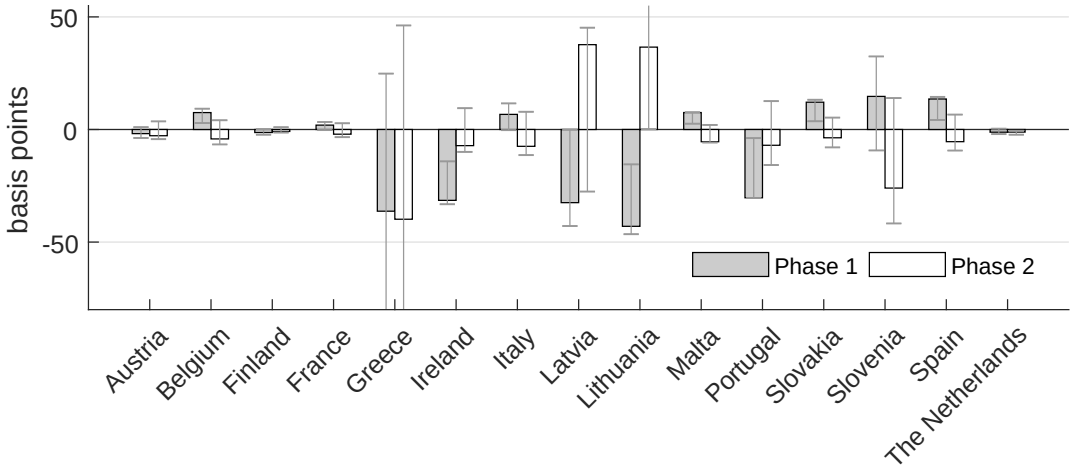
Figure E.24: Robustness: baseline variables from Figure 1, identifying the shocks only on monthly data



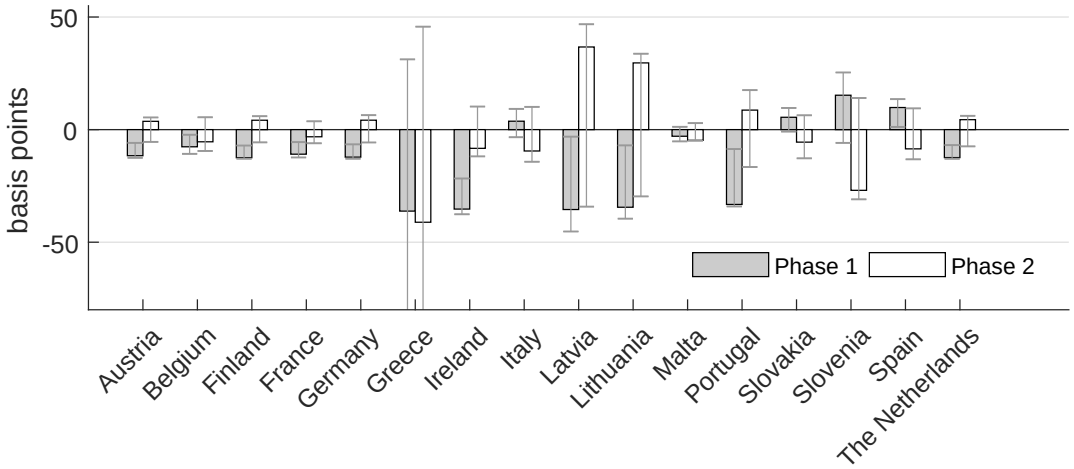
Notes: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.25: Robustness: spreads and yields from Figure 2, identifying the shocks only on monthly data

(a) Spreads versus Germany

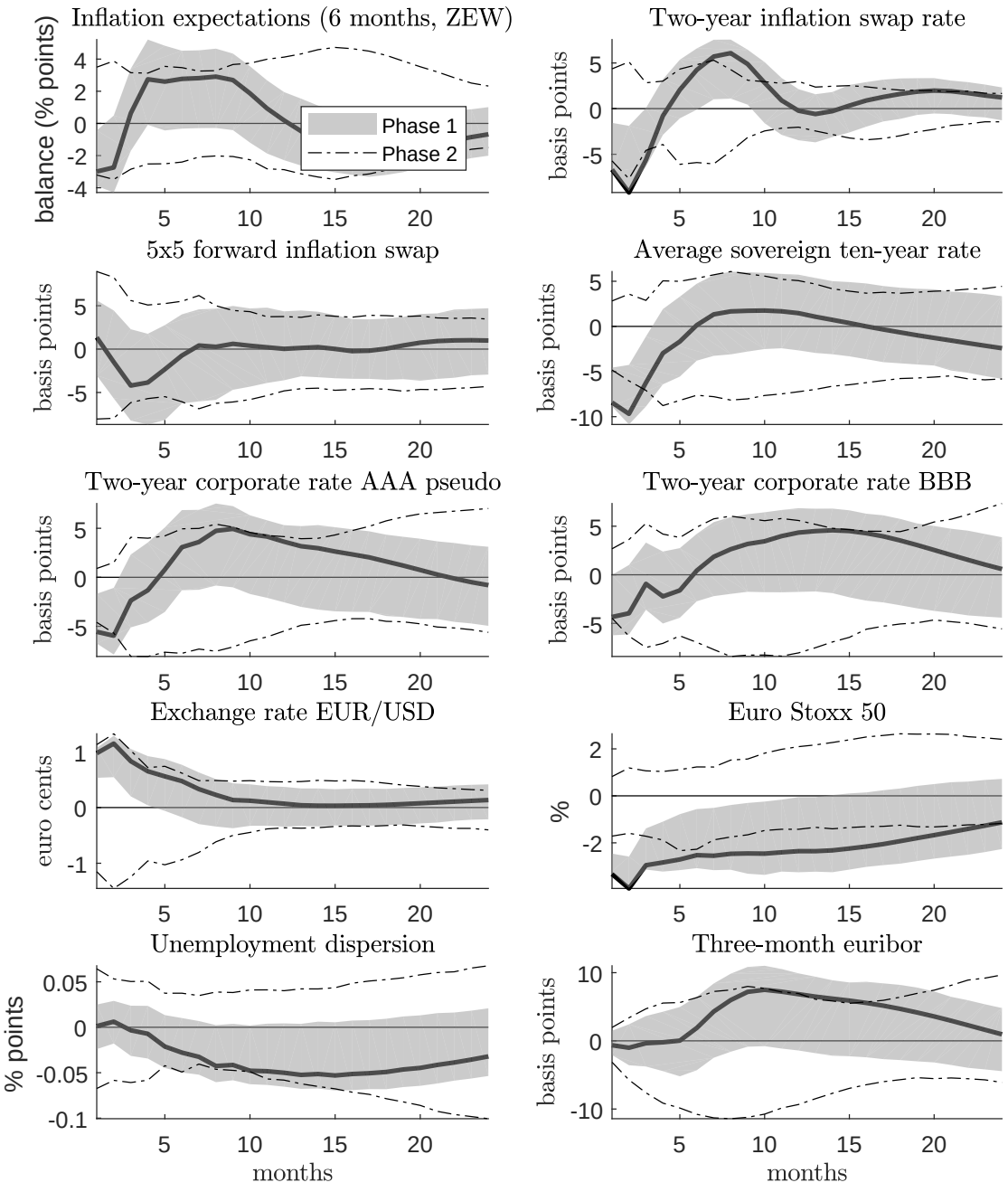


(b) Yields



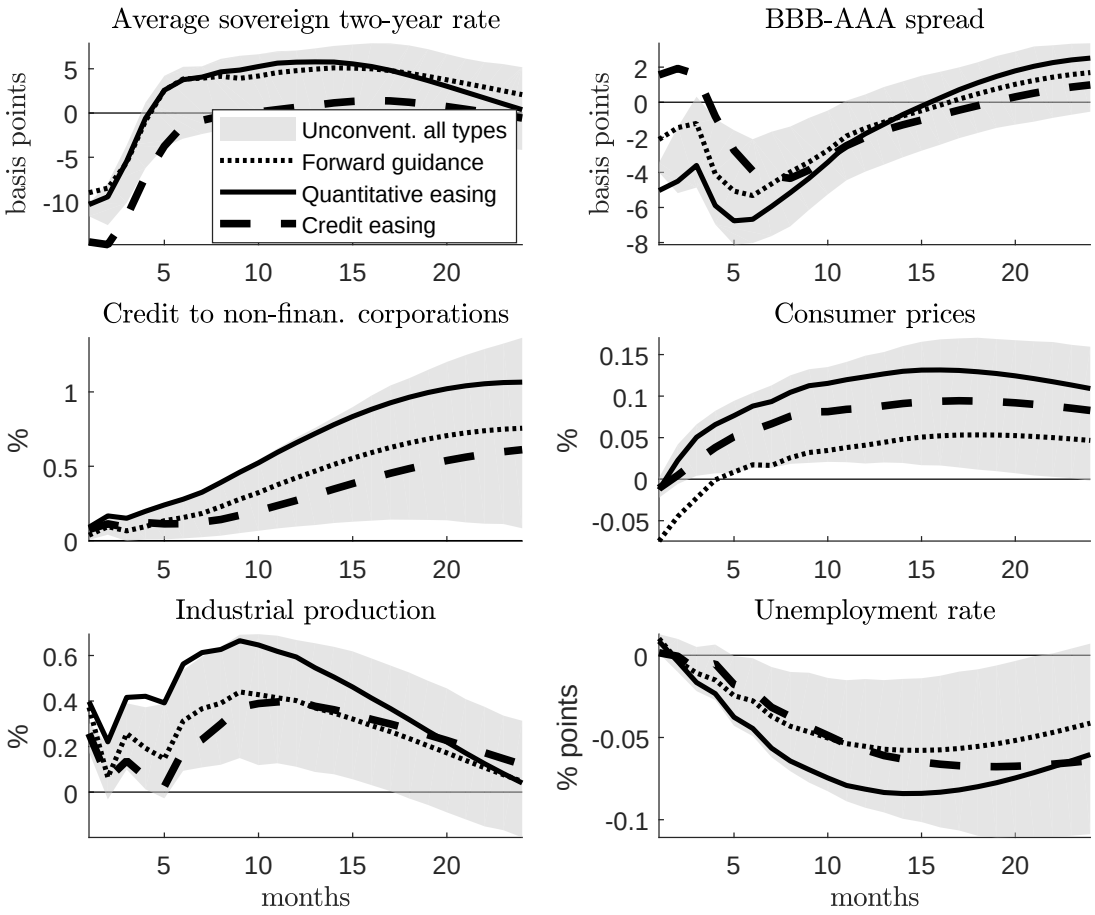
Notes: The figure shows the peak responses of ten-year country-specific sovereign spreads versus Germany (panel a) and ten-year government bond rates (panel b) after a one standard deviation expansionary monetary policy shock, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area shows the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the non-shaded area shows the point estimate for a shock from the second phase.

Figure E.26: Robustness: other variables from Figure 3, identifying the shocks only on monthly data



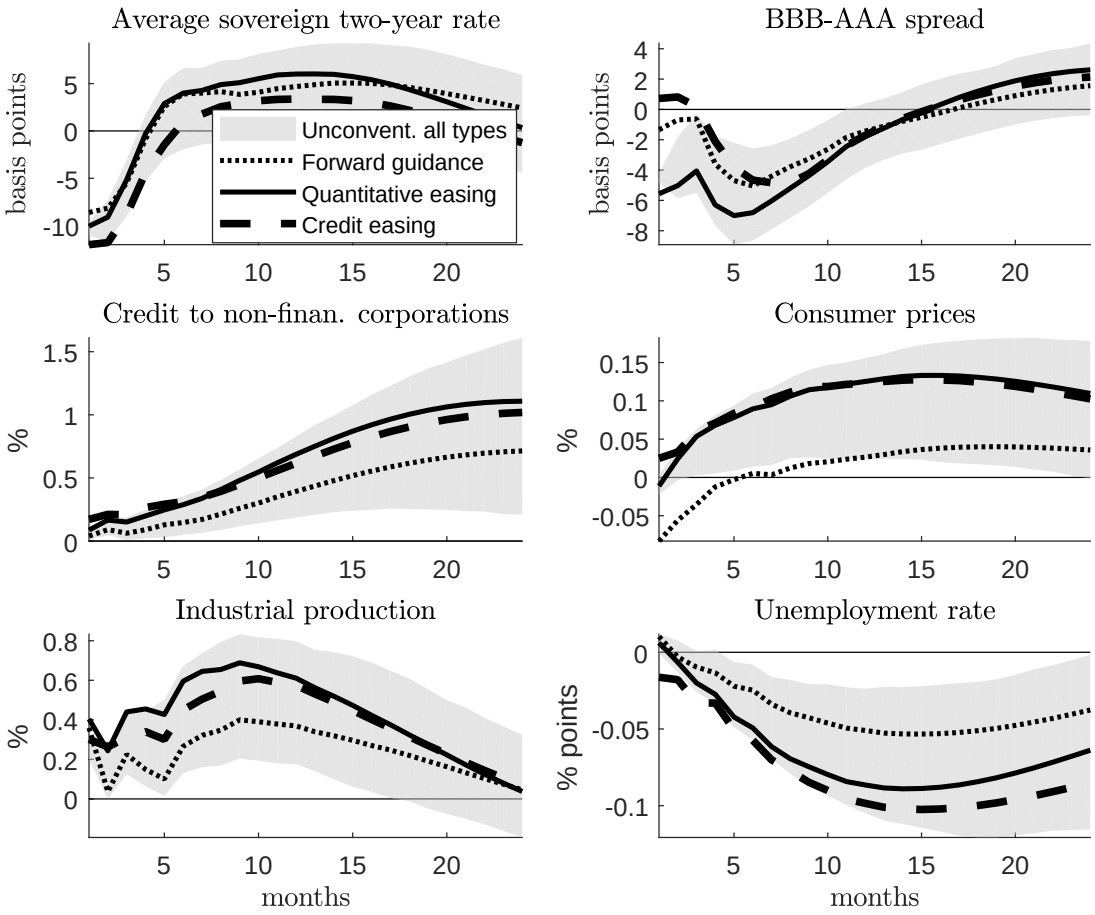
Notes: The figure shows the response to a one standard deviation expansionary monetary policy shock of variables individually added to the baseline VAR, along with 90% confidence bands obtained using 500 bootstrap replications. The shaded area and the continuous line show the confidence band and the point estimate for a shock from the first phase of ECB unconventional monetary policy, while the dashed lines show the confidence band for a shock from the second phase.

Figure E.27: Robustness: baseline variables from Figure 1. Instruments constructed on yields of all countries



Note: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock. The shaded area shows the 90% confidence bands obtained using 500 bootstrap replications when all unconventional monetary policy events are used to construct the instruments. The lines show the point estimates when using only the following events: forward guidance 03.03.2011, 09.06.2011, 04.08.2011, 06.10.2011, 06.06.2012, 06.12.2012, 02.05.2013, 04.07.2013, 08.11.2013, 21.07.2016, 08.09.2016, 20.10.2016, 08.12.2016; credit easing 22.08.2007, 28.03.2008, 29.09.2008, 08.10.2008, 15.10.2008, 07.05.2009, 03.12.2009, 04.03.2010, 28.07.2010, 03.03.2011, 04.08.2011, 06.10.2011, 08.12.2011, 21.12.2011, 09.02.2012, 28.02.2012, 22.03.2013, 05.06.2014, 03.07.2014, 31.08.2015, 10.03.2016, 03.05.2016 05.10.2016, 08.12.2016; quantitative easing 07.05.2009, 04.06.2009, 10.05.2010, 08.08.2011, 06.10.2011, 08.12.2011, 26.07.2012, 02.08.2012, 06.09.2012, 22.01.2015, 16.07.2015, 03.09.2015, 23.09.2015, 22.10.2015, 09.11.2015, 03.12.2015, 21.01.2016, 10.03.2016, 21.04.2016, 02.06.2016, 21.07.2016, 08.09.2016, 20.10.2016, 08.12.2016.

Figure E.28: Robustness: baseline variables from Figure 1. Instruments constructed on yields of periphery countries



Note: The figure shows the impulse responses of the variables in the baseline VAR after a one standard deviation expansionary monetary policy shock. The shaded area shows the 90% confidence bands obtained using 500 bootstrap replications when all unconventional monetary policy events are used to construct the instruments. The lines show the point estimates when using only the following events: forward guidance 03.03.2011, 09.06.2011, 04.08.2011, 06.10.2011, 06.06.2012, 06.12.2012, 02.05.2013, 04.07.2013, 08.11.2013, 21.07.2016, 08.09.2016, 20.10.2016, 08.12.2016; credit easing 22.08.2007, 28.03.2008, 29.09.2008, 08.10.2008, 15.10.2008, 07.05.2009, 03.12.2009, 04.03.2010, 28.07.2010, 03.03.2011, 04.08.2011, 06.10.2011, 08.12.2011, 21.12.2011, 09.02.2012, 28.02.2012, 22.03.2013, 05.06.2014, 03.07.2014, 31.08.2015, 10.03.2016, 03.05.2016 05.10.2016, 08.12.2016; quantitative easing 07.05.2009, 04.06.2009, 10.05.2010, 08.08.2011, 06.10.2011, 08.12.2011, 26.07.2012, 02.08.2012, 06.09.2012, 22.01.2015, 16.07.2015, 03.09.2015, 23.09.2015, 22.10.2015, 09.11.2015, 03.12.2015, 21.01.2016, 10.03.2016, 21.04.2016, 02.06.2016, 21.07.2016, 08.09.2016, 20.10.2016, 08.12.2016.

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