Industry Impacts of Unconventional Monetary Policy
Online Appendix

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Job Market Paper

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1 Literature Review

This paper studies the industry effects of unconventional monetary policy (henceforth unconventional policy). There is a large volume of literature empirically investigating the heterogeneous impacts of conventional monetary policy (henceforth conventional policy). The heterogeneity typically studied in the literature are industries (or sometimes referred as sectors) and regions. They generally employ response functions from a structural vector autoregressive (VAR) model with Cholesky decomposition to identify the effect of monetary policy in the spirit of Christiano et al. (1999).

Dale and Haldane (1995) initiate the literature of industry effects of monetary policy and shows that the industry sector has larger and quicker responses than the retail trade industries in the UK. Ganley and Salmon (1997) also adopt UK data of 24 different industries to investigate the effects of monetary policy and find that the durable goods manufacturing, construction, and trade industries display strong responses while the agriculture industry reveals a poor reaction to the shock.

The literature of industry effects of monetary policy shock studies not only the UK economy but also other countries (Dedola and Lippi, 2005; Ibrahim, 2005; Alam and Waheed, 2006; Ghosh, 2009; Hayo and Uhlenbrock, 2000, and many others). Among these analyses, the durable goods manufacturing industry is very sensitive to monetary policy. Some of those studies find that the construction, finance and insurance, and wholesale and retail trade industries are also responsive. On the other hand, the agricultural industry is not a responsive industry.

Conventional policy manipulates the short-term interest rates, and thus interest rate sensitive industries tend to react to the shock more (interest rates channel). Those industries include the durable goods manufacturing, construction, and finance. The findings above overall favor this channel of monetary policy despite that there exist some industries which are responsive but not generally interest rate sensitive, such as trade. This implies other channels play an important role in the transmission mechanism[1].

With regard to regional effects of conventional policy, Carlino and DeFina (1998) examine the effects of monetary policy in 8 regions in the US. They find that there are some areas that are more responsive (such as the Great Lakes region) and some that are less responsive (such as the South West and Rocky Mountain regions) than the US average. They also show that the regional responsiveness is positively correlated to the share of the manufacturing industry in the district. Similarly, Arnold and Vrugt (2002) measure regional impact for 11 areas in the Netherlands and find that regions with a higher share of the construction industry respond to the shock to a greater extent. Arnold and Vrugt (2002) argue that industry heterogeneity is more substantial in mag-

[1]Such as credit, exchange rate, and assets price channels.

nitude than regional heterogeneity. Their results indicate that the share in the manufacturing or construction, which is an interest rate responsive industry, determines the monetary policy sensitivity. This then implies that the main regional heterogeneity comes from the industry composition. Regional effects can be inferred from the industry composition in the area, while the reverse is not true. Therefore, investigating the industry effect rather than the regional effect of monetary policy provides a better picture of how unconventional policy works in an economy.

Industry study is not only a common practice in monetary policy literature but also in other macroeconomic fields. For example, in the fiscal policy literature, it is documented that service industry is more responsive to the policy than manufacturing industry (for example Bénétrix and Lane, 2010; Monacelli and Perotti, 2008). Even though disaggregation is coarse[2], the results mildly disagree with the monetary policy literature. On the contrary, the news shock literature shows similar industry characteristics as the monetary policy literature. Vukotić (2019) finds that a shock to the future total factor productivity (TFP) increases the current TFP of durable goods manufacturing industries more than non-durable goods manufacturing industries. It is of interest to compare these studies to how unconventional policy affects individual industries.

When an economy gets close to the ZLB, there is no margin for further decline in the policy rates[3] and the central banks need to influence the economy through a different way, an advent of unconventional policy. Unconventional policy envelops a wide range of instruments, including quantitative easing (QE), credit easing, yield curve control, forward guidance, negative interest rate policy, etc. While each major central bank operates the policies somewhat differently[4], their purpose is consistently to alleviate the financial market stress and promote economic growth (Fawley et al., 2013).

There are two strands of empirical literature of unconventional policy that relate to this paper: financial market effect of unconventional policy and real economy effect of unconventional policy. The first strand of literature investigates announcement effects of QE on the financial market using high frequency data (such as Gagnon et al., 2011; Hancock and Passmore, 2011; Krishnamurthy and Vissing-Jorgensen, 2011; Chodorow-Reich, 2014; Lucas and Vissing-Jorgensen, 2014; and Neely, 2015). These event studies show that the Federal Reserve's large-scale asset purchases mitigate the medium and long-term yields of various assets. The mechanism is that asset purchases reduce the long-term bond supply and mitigate the yields of other assets that possess similar characteristics,

[2]If one disaggregates the industries finer, the results may be different.

[3]Negative interest rate is possible while the amounts that policy rate goes down it still very limited.

[4]The Federal Reserve and the Bank of England focuses on purchasing long term securities, while the Bank of Japan mainly operates the direct lending to banks (Fawley et al., 2013). Collateral for the Bank of Japan includes government bonds, treasury discount bills, government-guaranteed bonds, etc.

such as maturity, through the portfolio balance channel[5]. These lower yields of securities increase the value of assets held and improve the financial market condition (Chodorow-Reich, 2014). Also, due to higher asset values and lower yields, unconventional policy creates a better environment for firms to issue stocks or corporate bonds. These results suggest that in the VAR framework, I should expect a rise in activities of finance industry to the unconventional policy shock.

The second strand of literature uses a family of VAR models to investigate the effects of an unconventional policy shock on real economic activities (such as Gambacorta et al., 2014; Boeckx et al., 2017; Bhattarai et al., 2015; and Burriel and Galesi, 2018). They typically exploit central bank total assets as an instrument to identify an unconventional policy shock. The overall consensus from the literature is that an unconventional policy shock increases national GDP and price level[6].

Among those studies introduced in this section, there are two papers that are closely linked to this paper. First, this paper is close to Gambacorta et al. (2014), since I follow their identification and examine the cross-country heterogeneity. They use the implied stock market volatility and central bank assets to identify an unconventional policy shock. They then estimate a panel VAR to investigate the effects of unconventional policy for highly advanced economies. They discover that the identified shock increases output and prices of these countries. The main focus is to study the cross industry effects of unconventional policy within a country and to look at the cross-country differences from the industry perspective instead of from an aggregate point of view.

This paper is also closely linked to Dedola and Lippi (2005). They estimate the effects of conventional policy on industries within manufacturing for 5 OECD countries and explore what monetary transmission measures are related to the industry output responses of monetary policy. They found that the industry responses are heterogeneous but cross country heterogeneity is small. They also find the existence of the interest rate and credit channels of conventional policy. As in Dedola and Lippi (2005), this paper seeks to understand the differential effects of monetary policy from both cross-industry and cross-country dimensions. Also, I run similar regressions as they do to find how industry elasticities are related to industry characteristics. However, may paper deviates from theirs as this paper analyzes unconventional policy not conventional policy and investigates a broader coverage of industries rather than only those in manufacturing.

Even though the impacts to the overall economy and financial market are known in the literature, how everything else responds to the policy is not yet known. Also, cross country dimension of industry study is scarce in the literature. This paper fills those gaps and contributes to a deeper understanding of the industry impacts of unconventional policy and implications of industry heterogeneity in the international dimension. Additionally, through regressing analysis, this paper

[5]The central bank purchases reduce the supply of the security. Public investors shift their portfolio toward other assets whose characteristics (risk or maturities) are similar. This reduces the yields of these assets as well.

[6]However, there are some skepticism of the effectiveness, such as Greenlaw et al. (2018)

seeks to understand how the monetary policy responsiveness is related to the industry characteristics.

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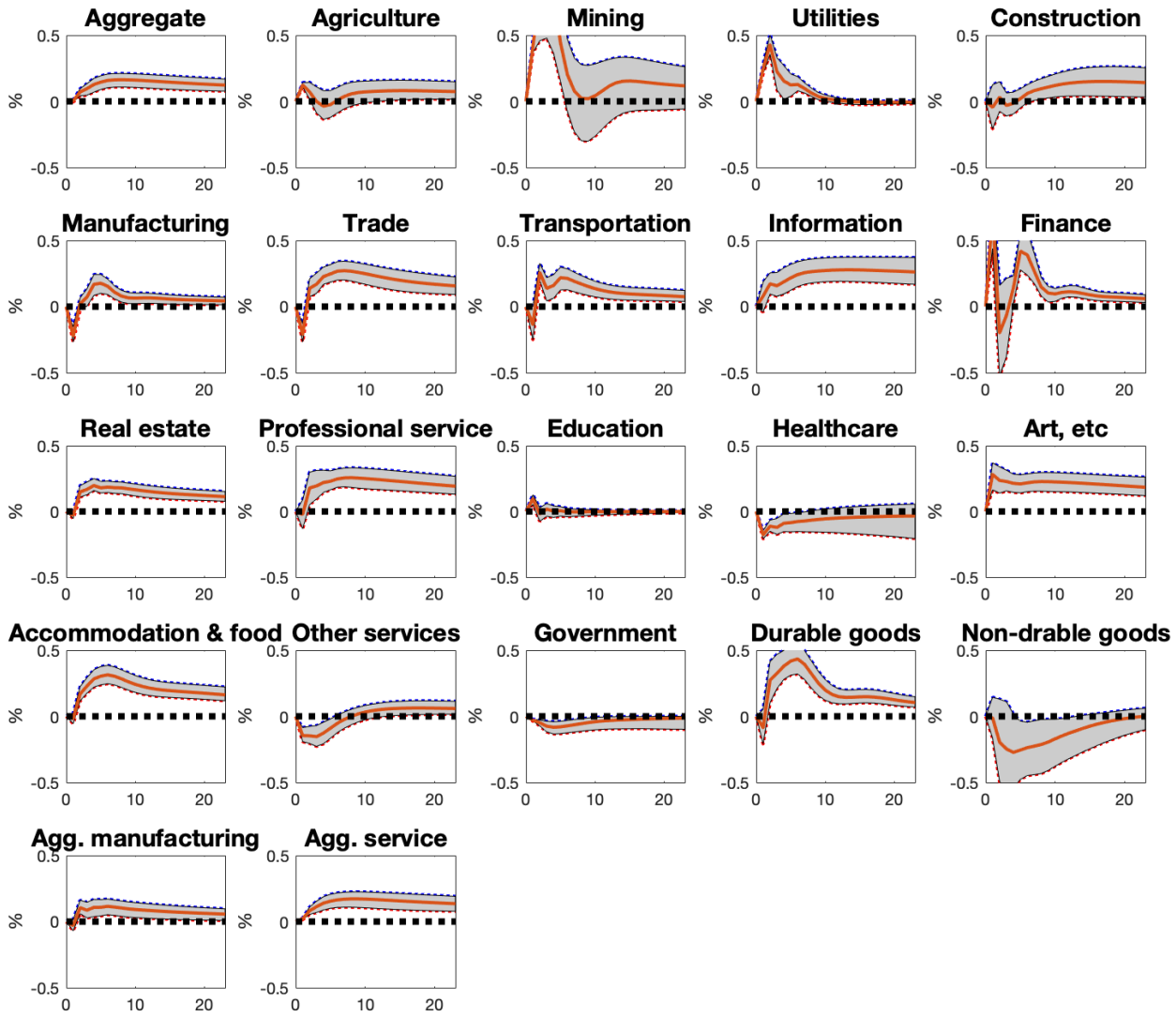
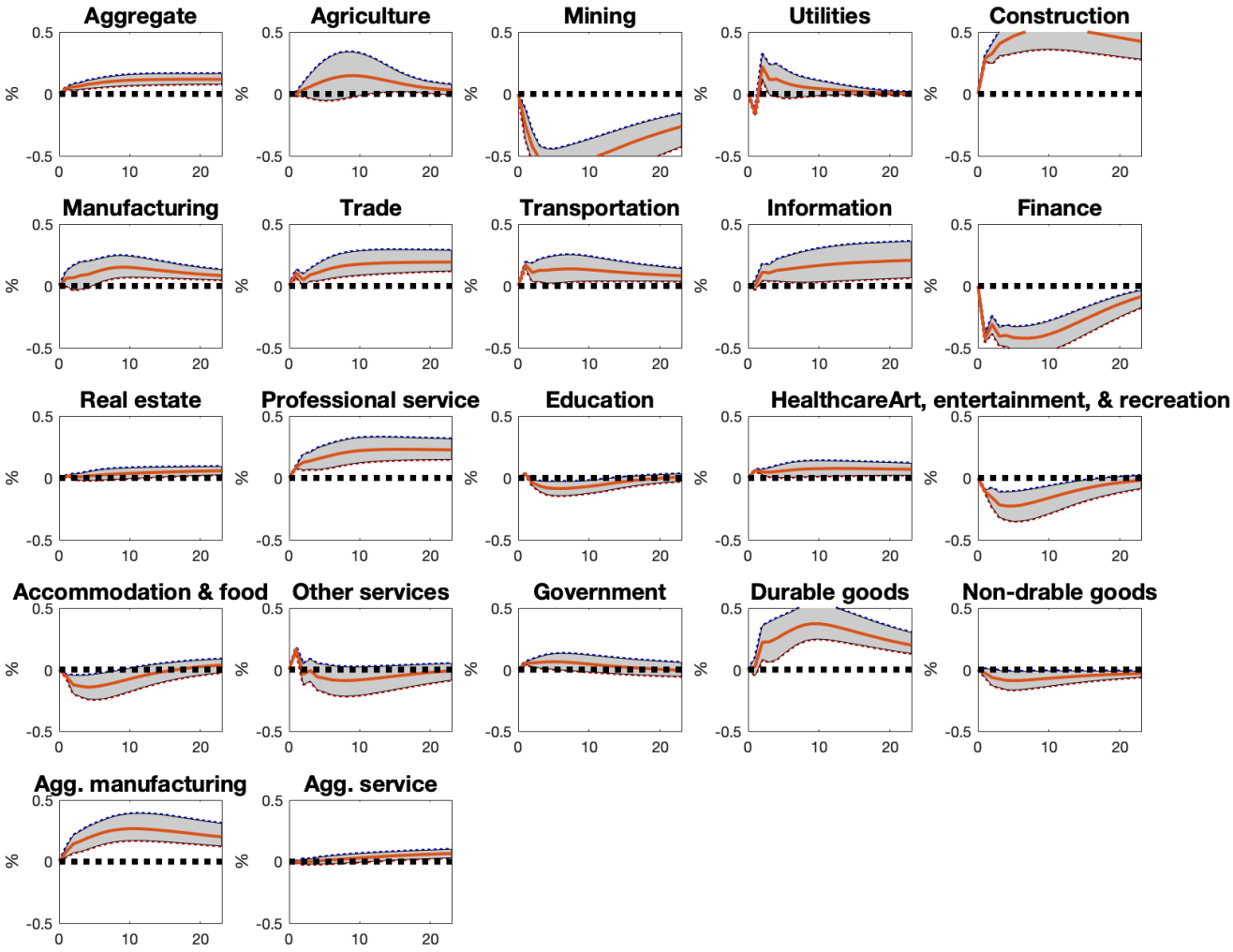
Figures

Figure 1: The United States - Industry Impulse Response Functions



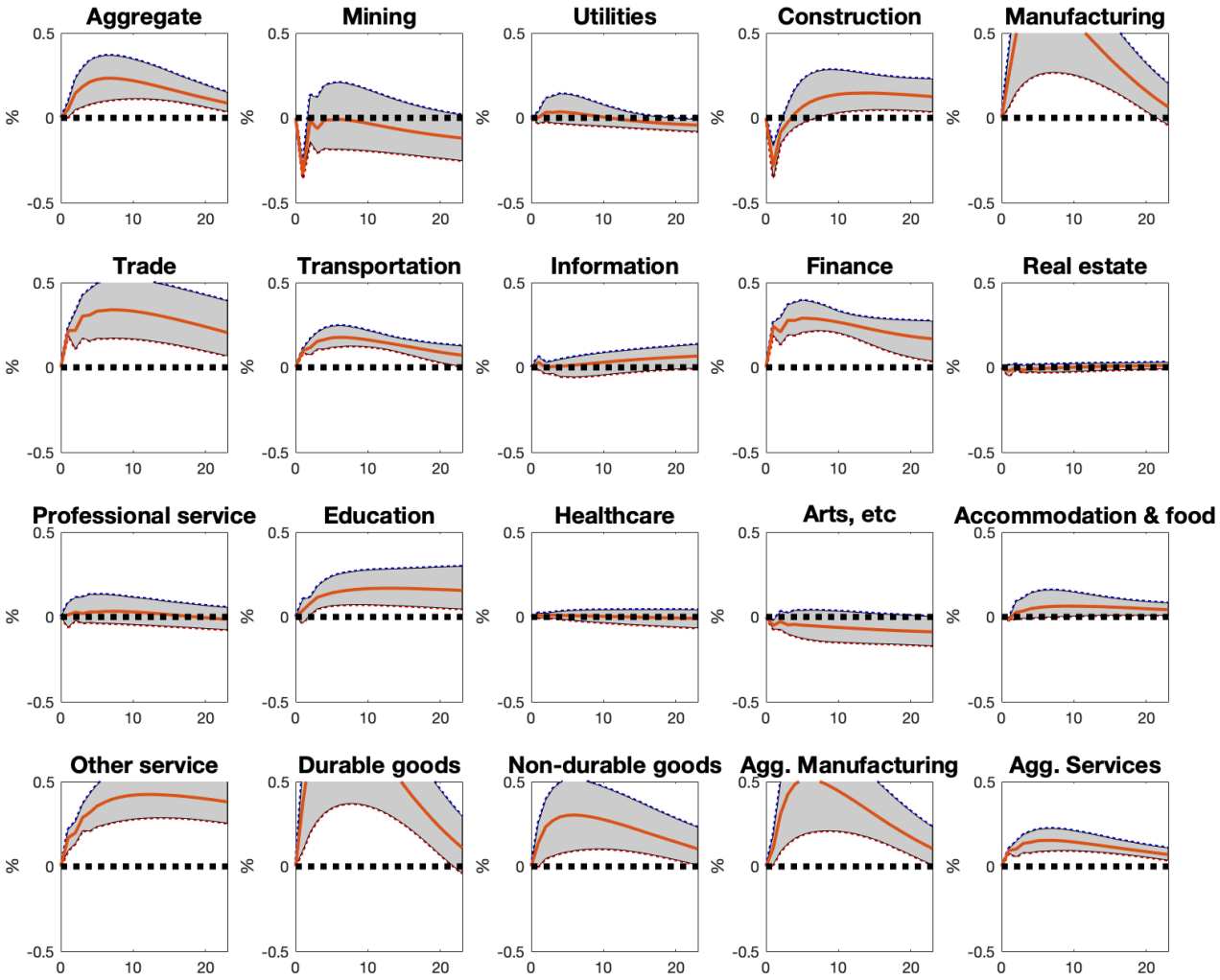
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

Figure 2: The United Kingdom - Industry Impulse Response Functions



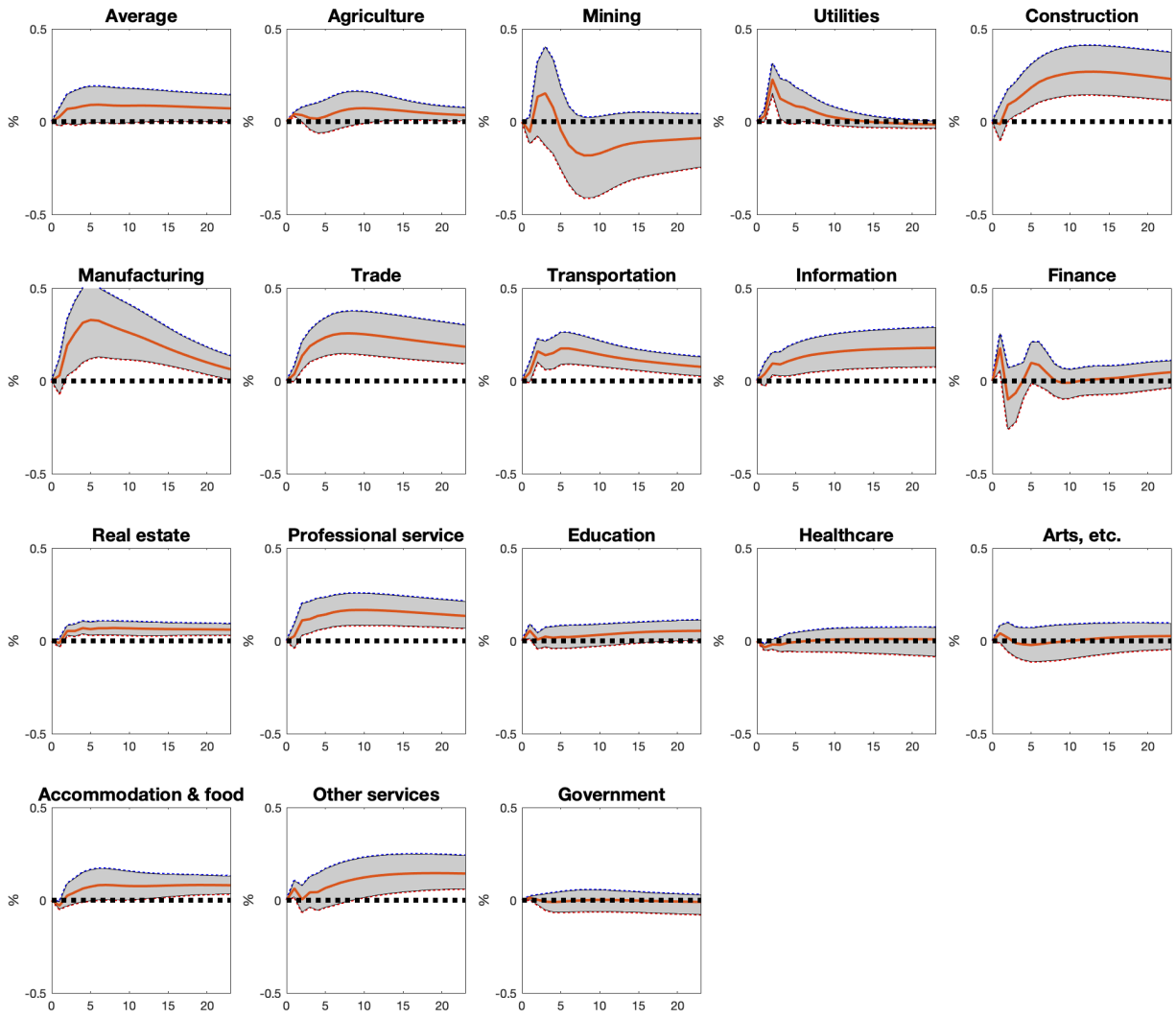
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 3: Japan - Industry Impulse Response Functions



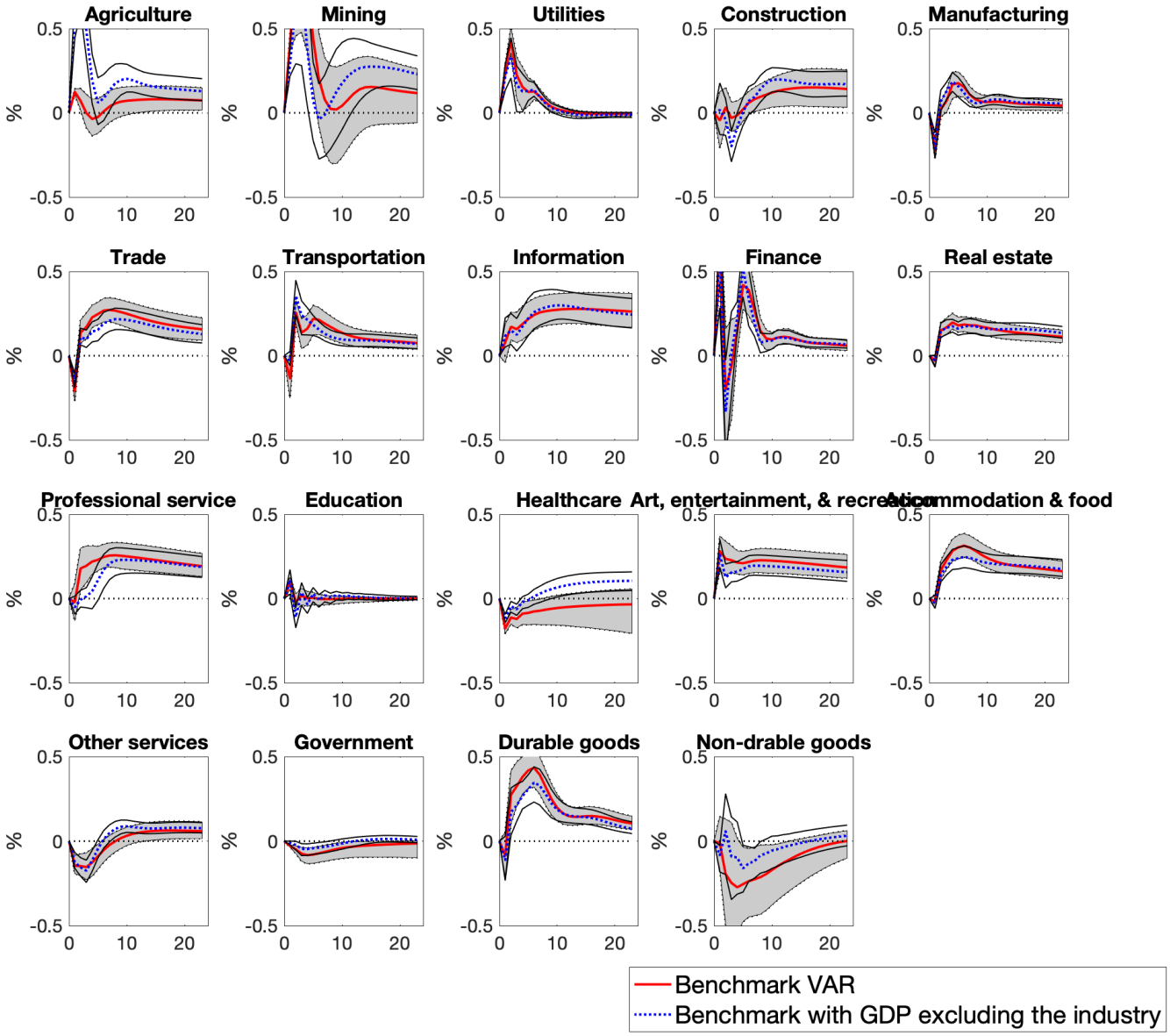
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 4: Average Industry Impulse Response Functions



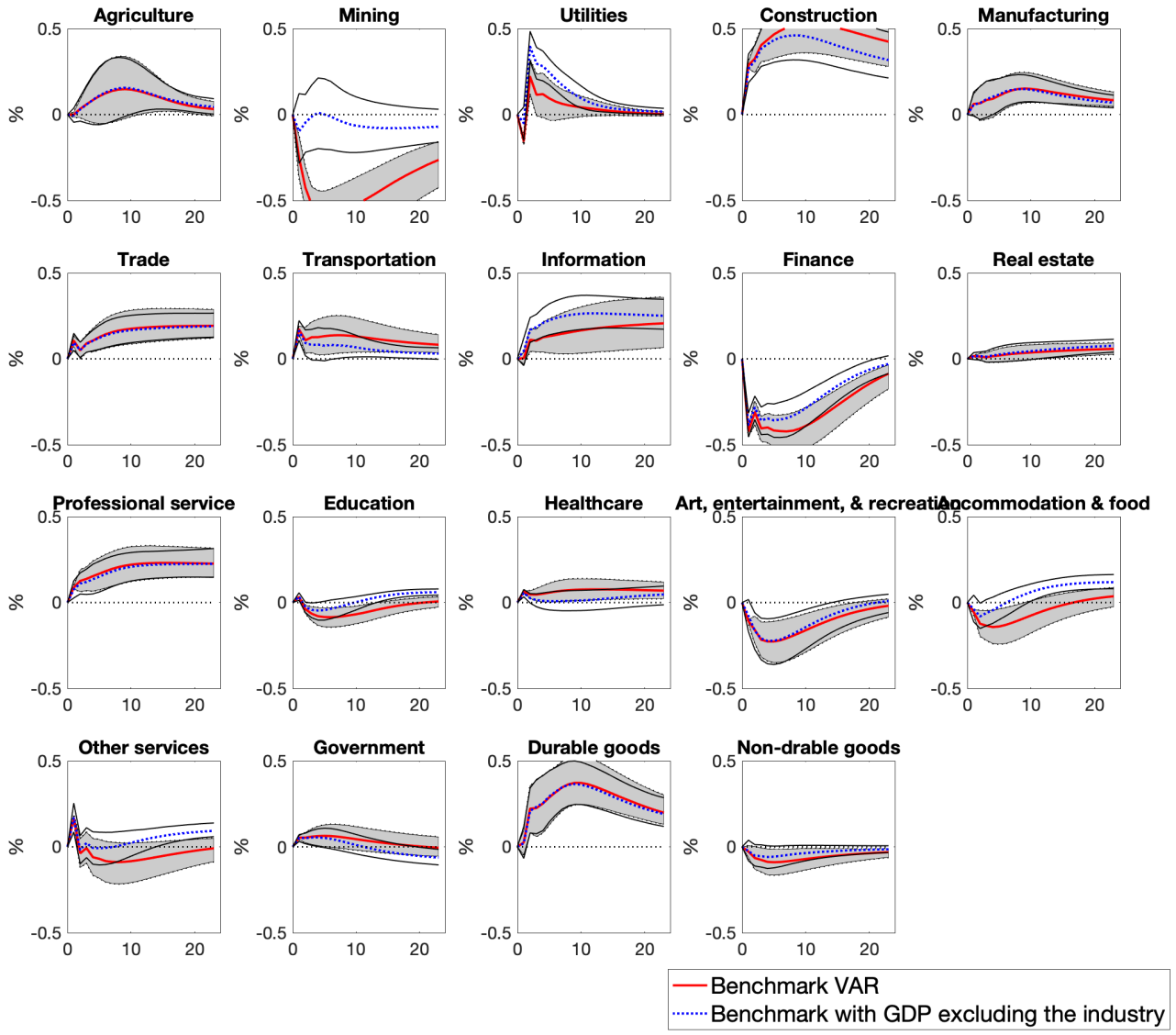
Note: The Median, 16th, and 84th Bayesian percentiles. Mixed horizons.

Figure 5: The United States - Industry Impulse Response Functions with Aggregate Output Excluding the Industry



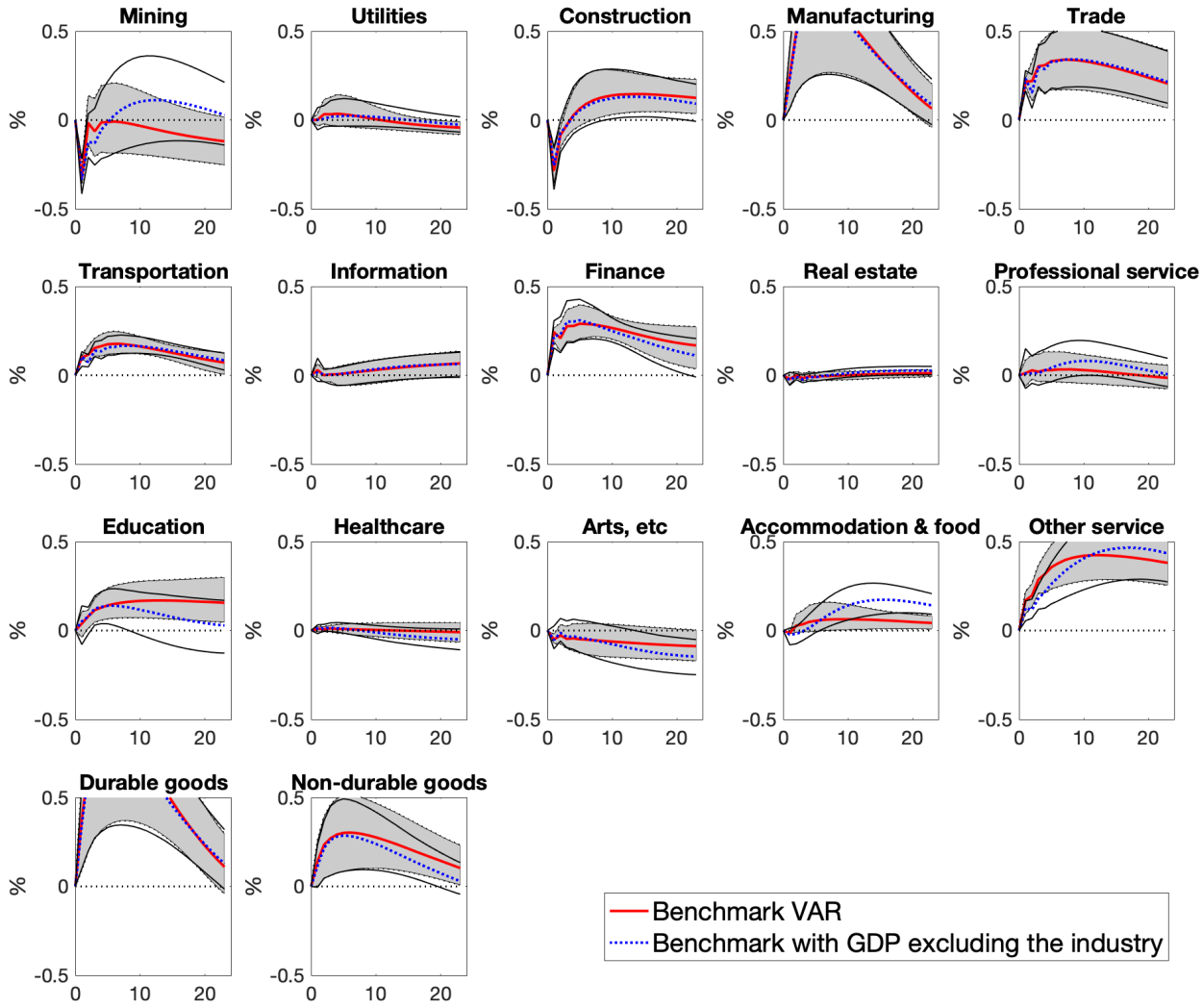
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

Figure 6: The United Kingdom - Industry Impulse Response Functions with Aggregate Output Excluding the Industry



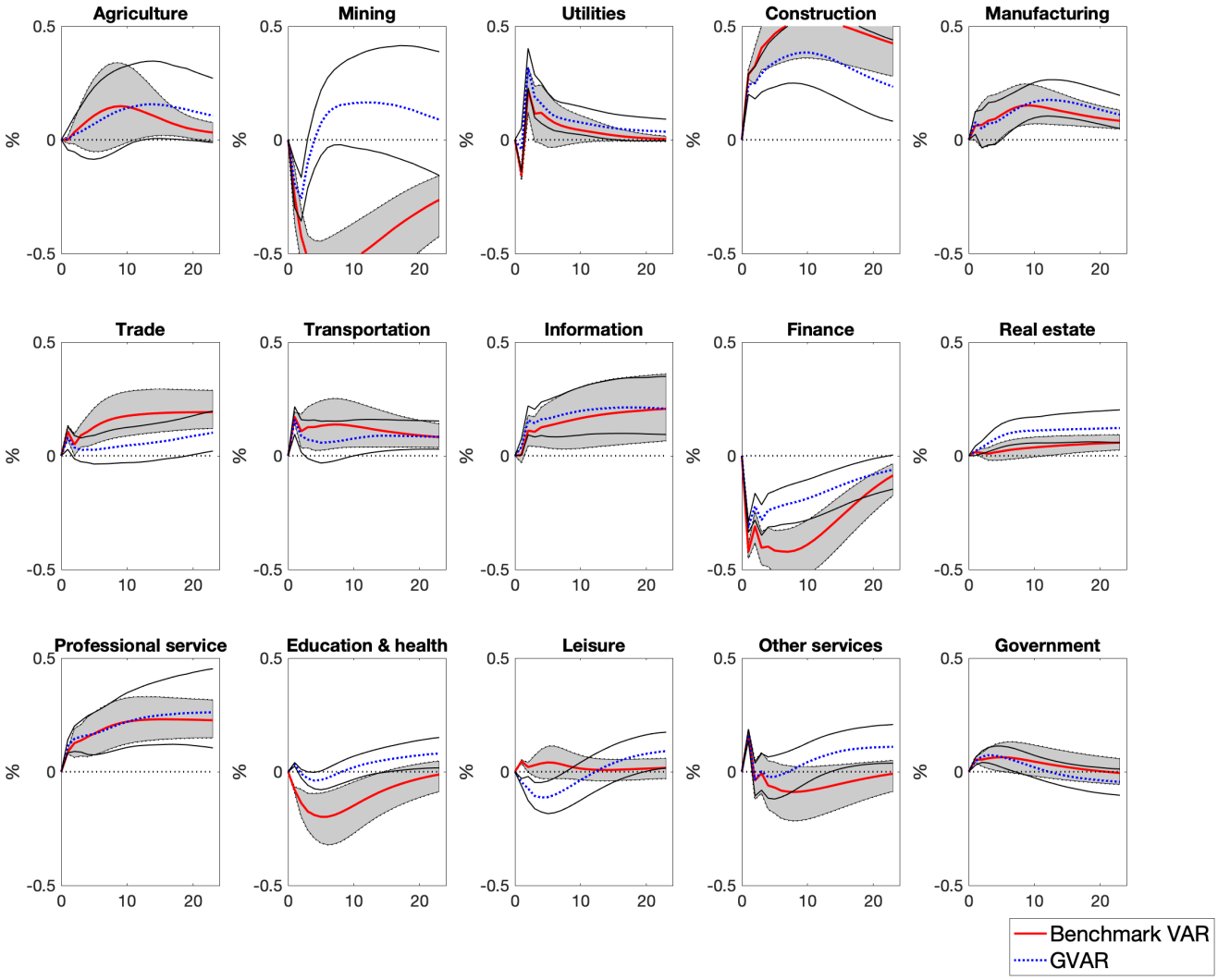
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 7: Japan - Industry Impulse Response Functions with Aggregate Output Excluding the Industry



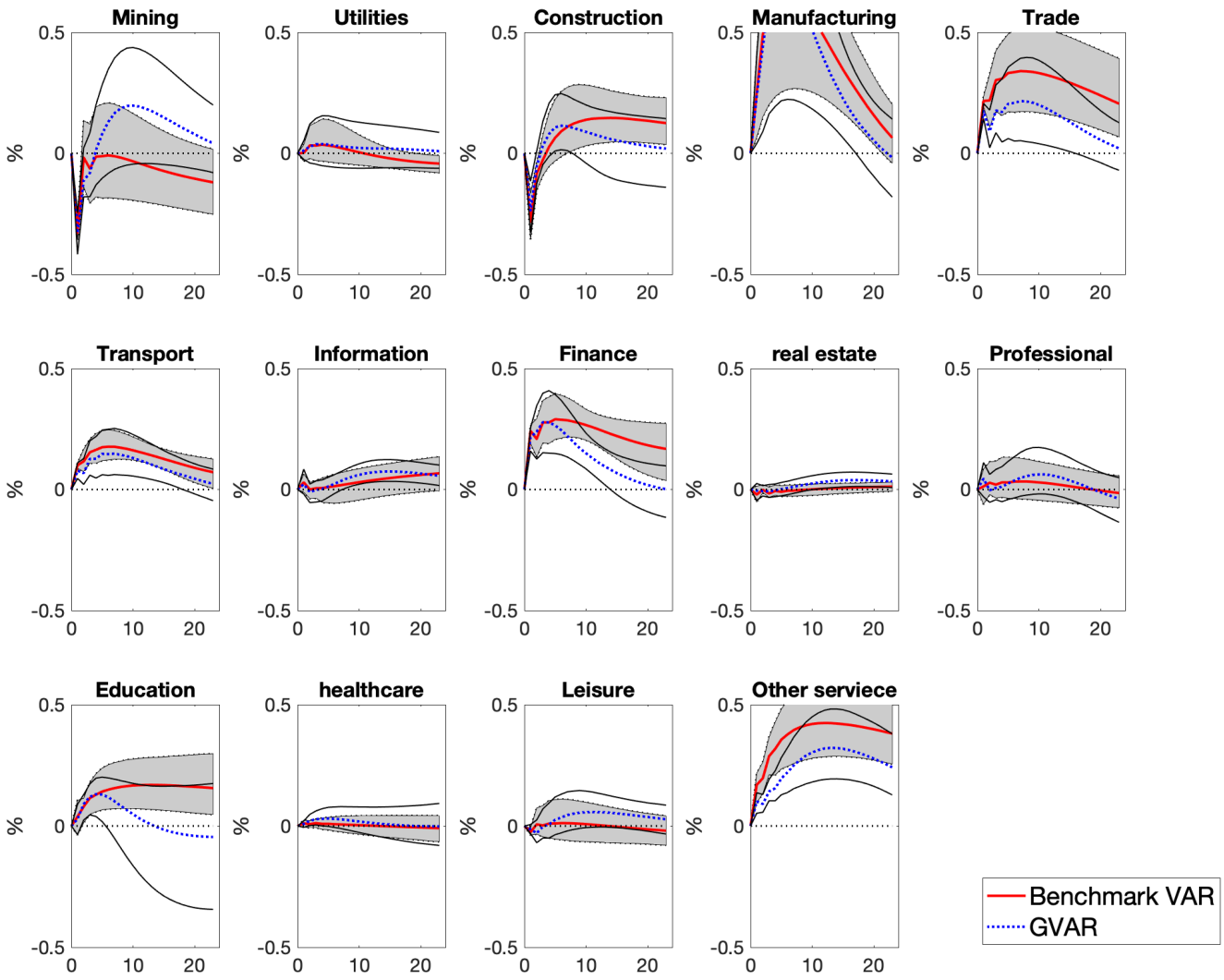
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 8: The United Kingdom - Industry Impulse Response Functions with GVAR



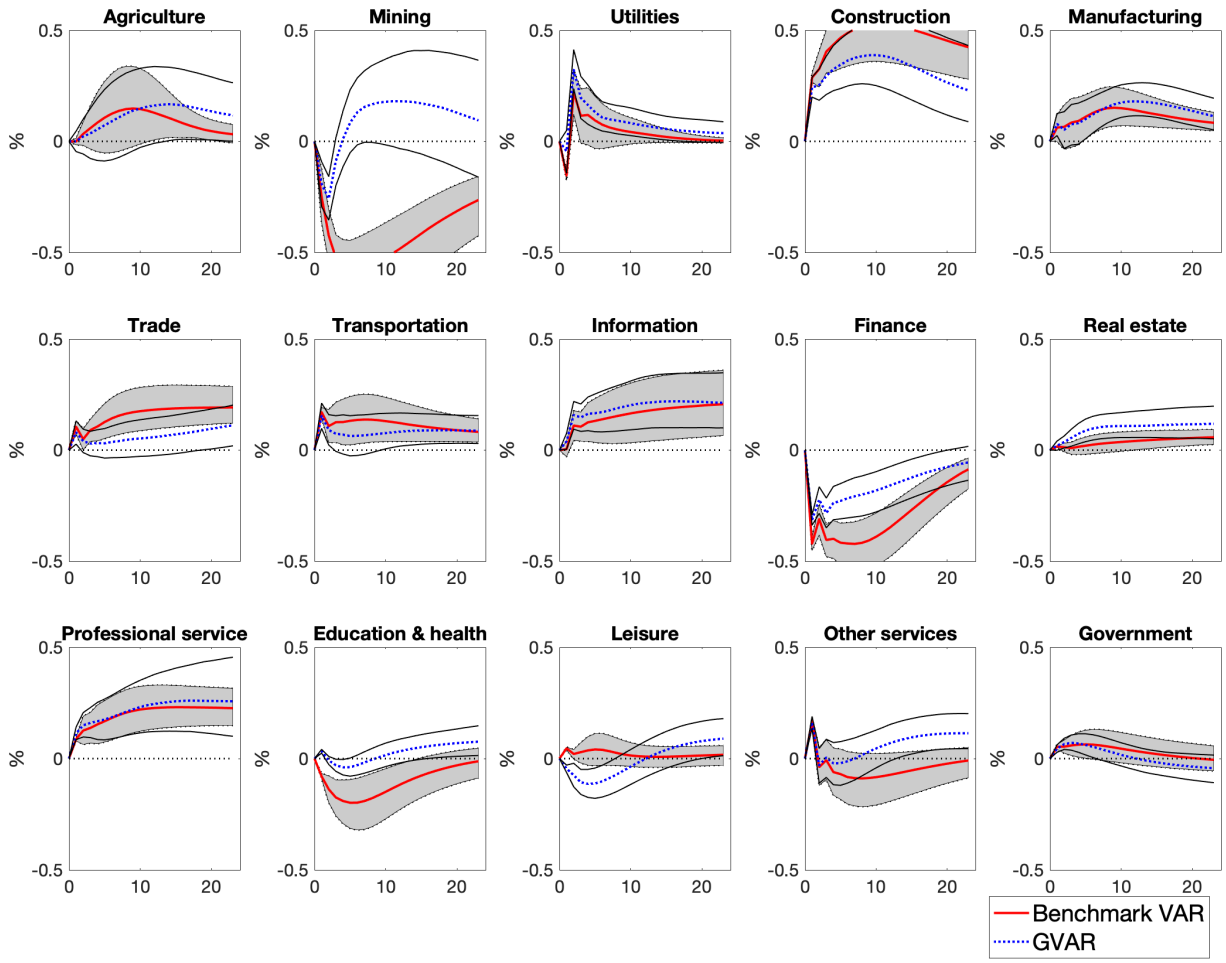
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 9: Japan - Industry Impulse Response Functions with GVAR



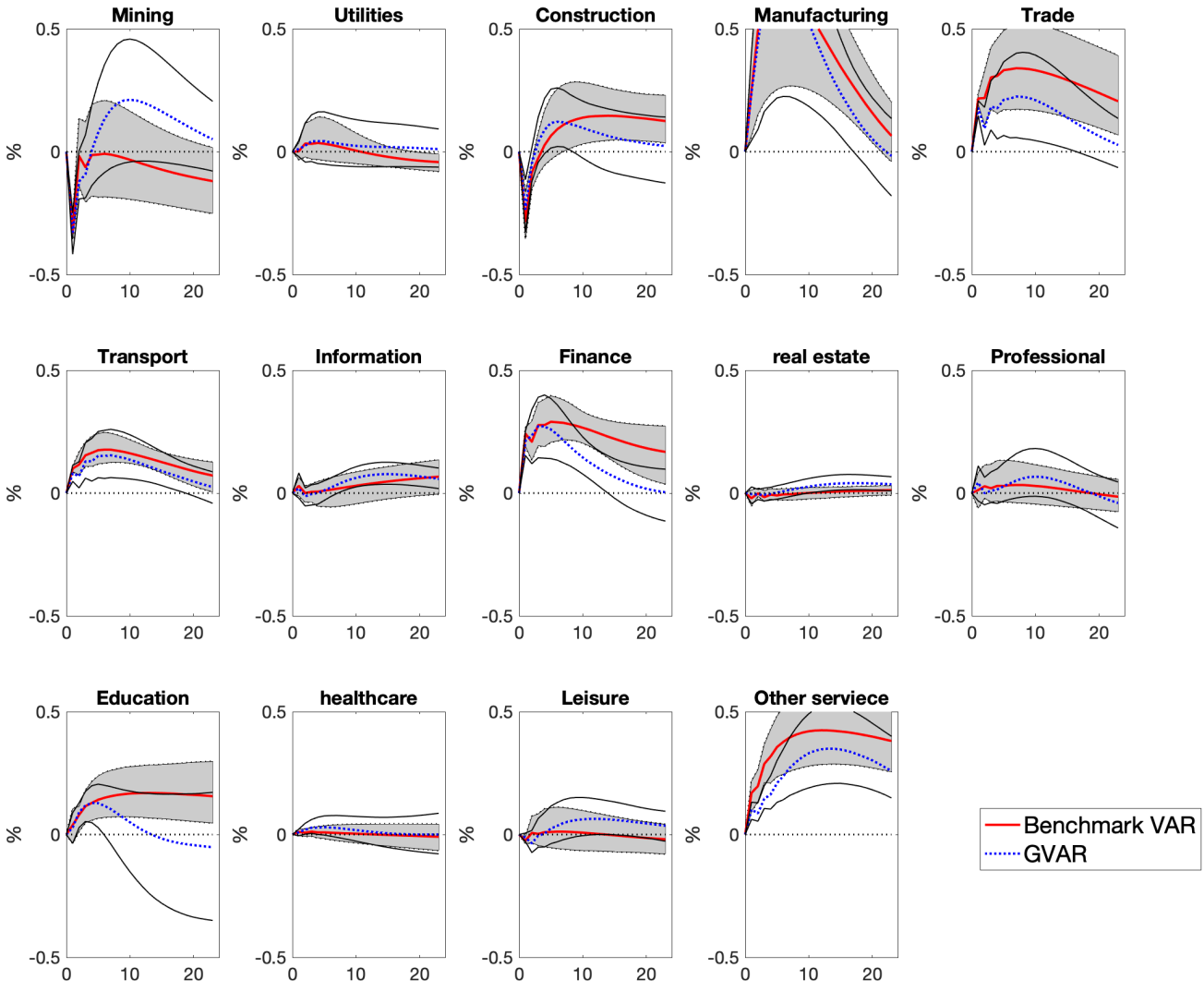
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 10: The United Kingdom - Industry Impulse Response Functions with GVAR (weight 2007)



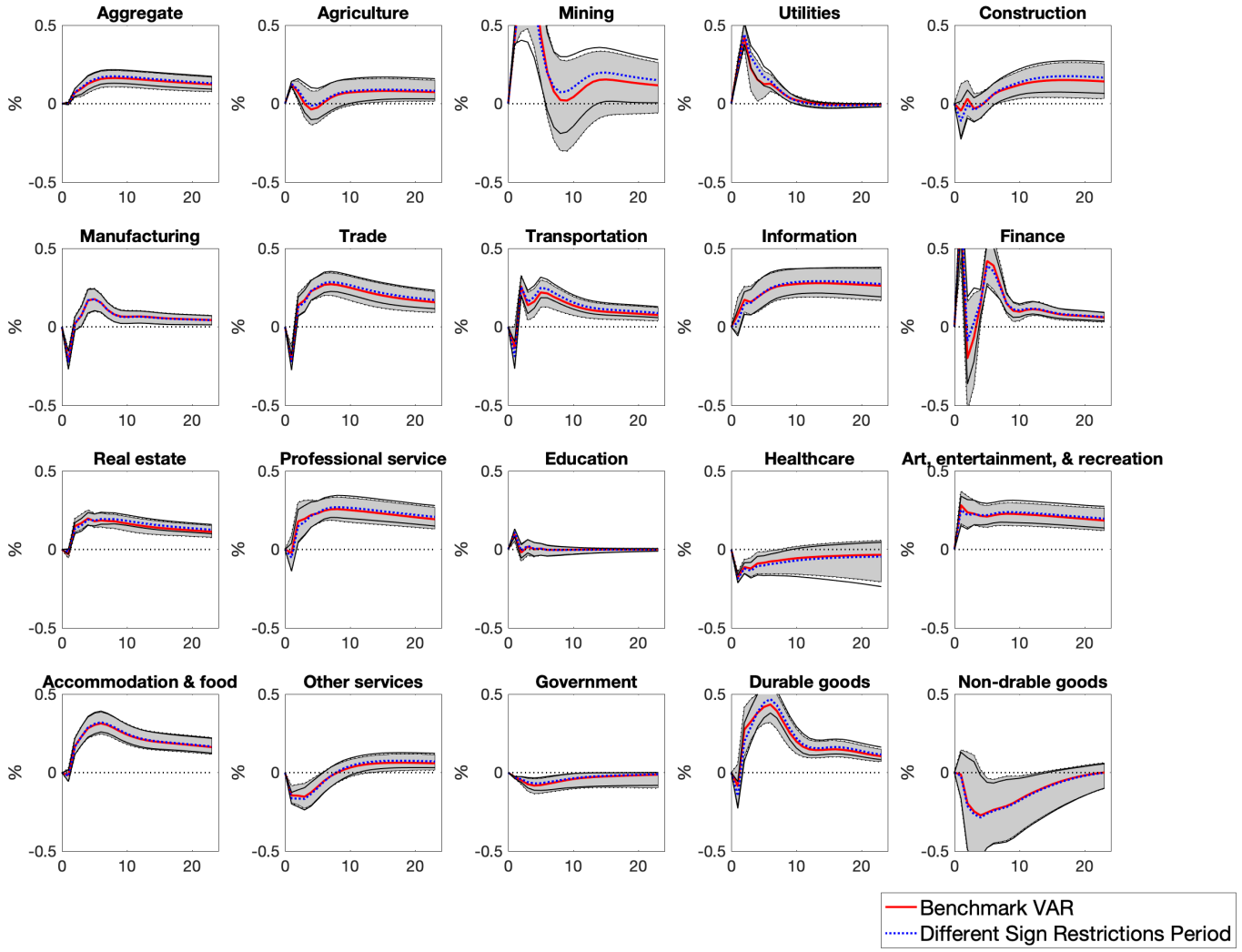
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 11: Japan - Industry Impulse Response Functions with GVAR (weight 2005)



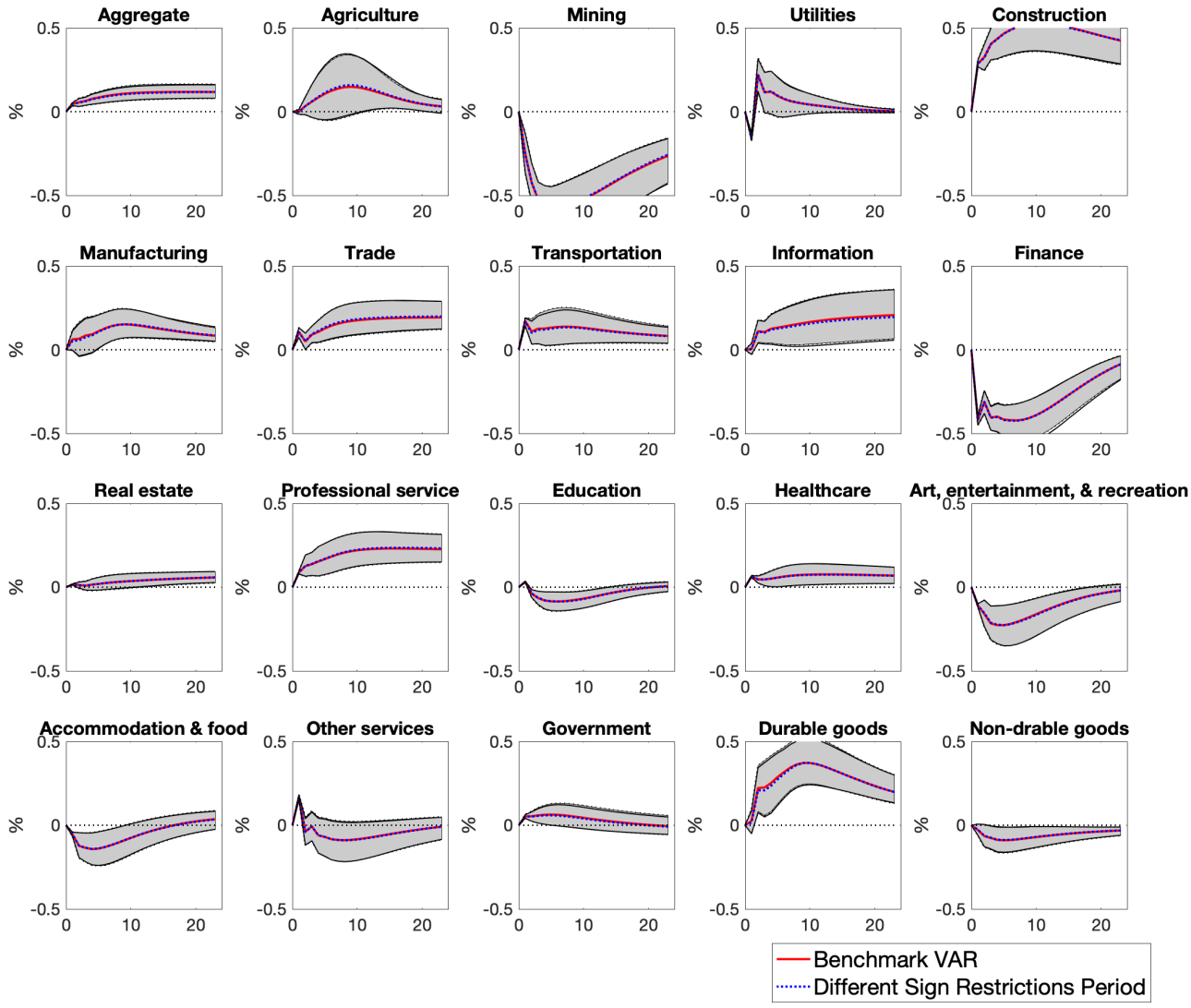
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 12: The United States - Industry Impulse Response Functions with Different Identification Periods



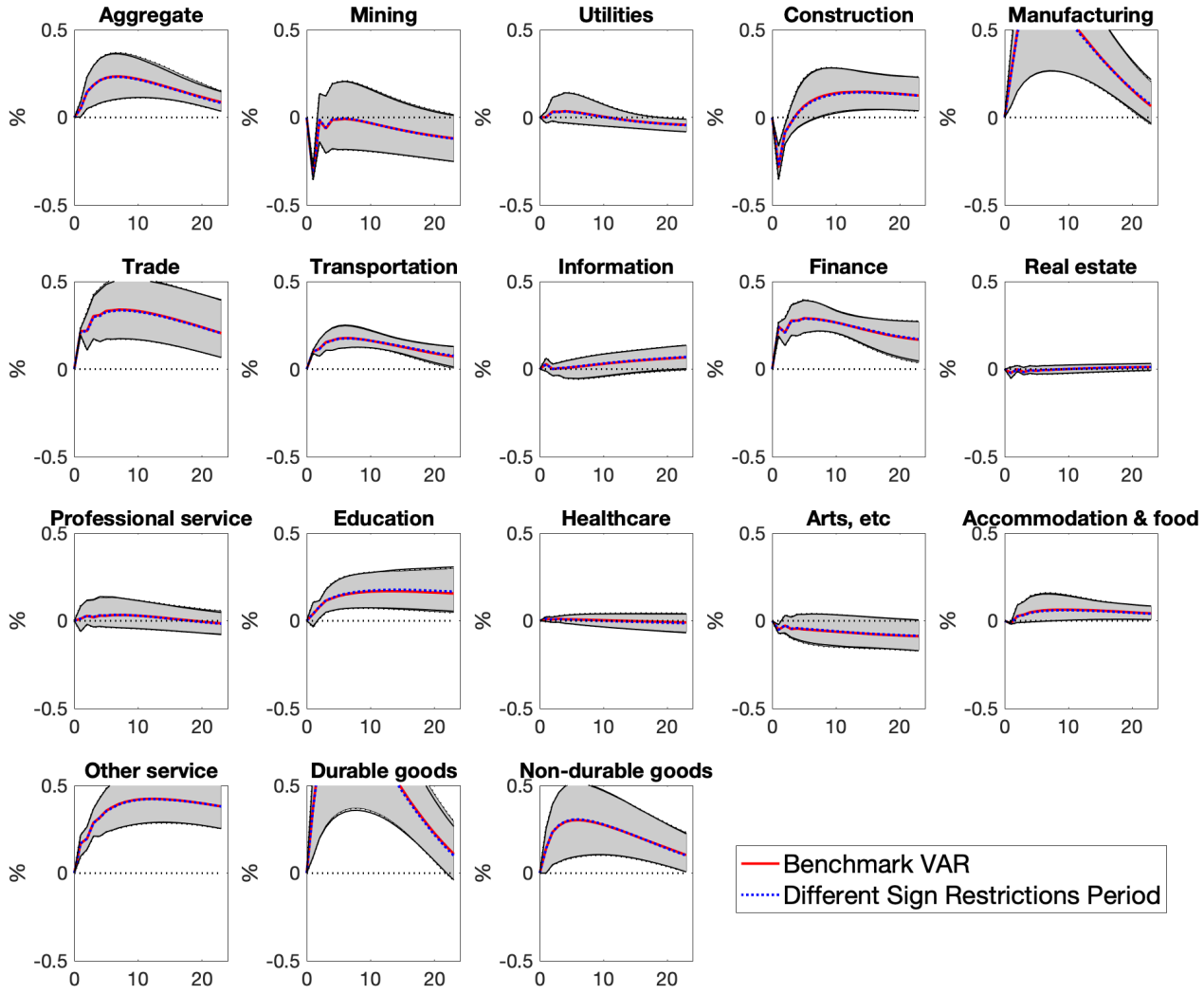
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

Figure 13: The United Kigdom - Industry Impulse Response Functions with Different Identification Periods



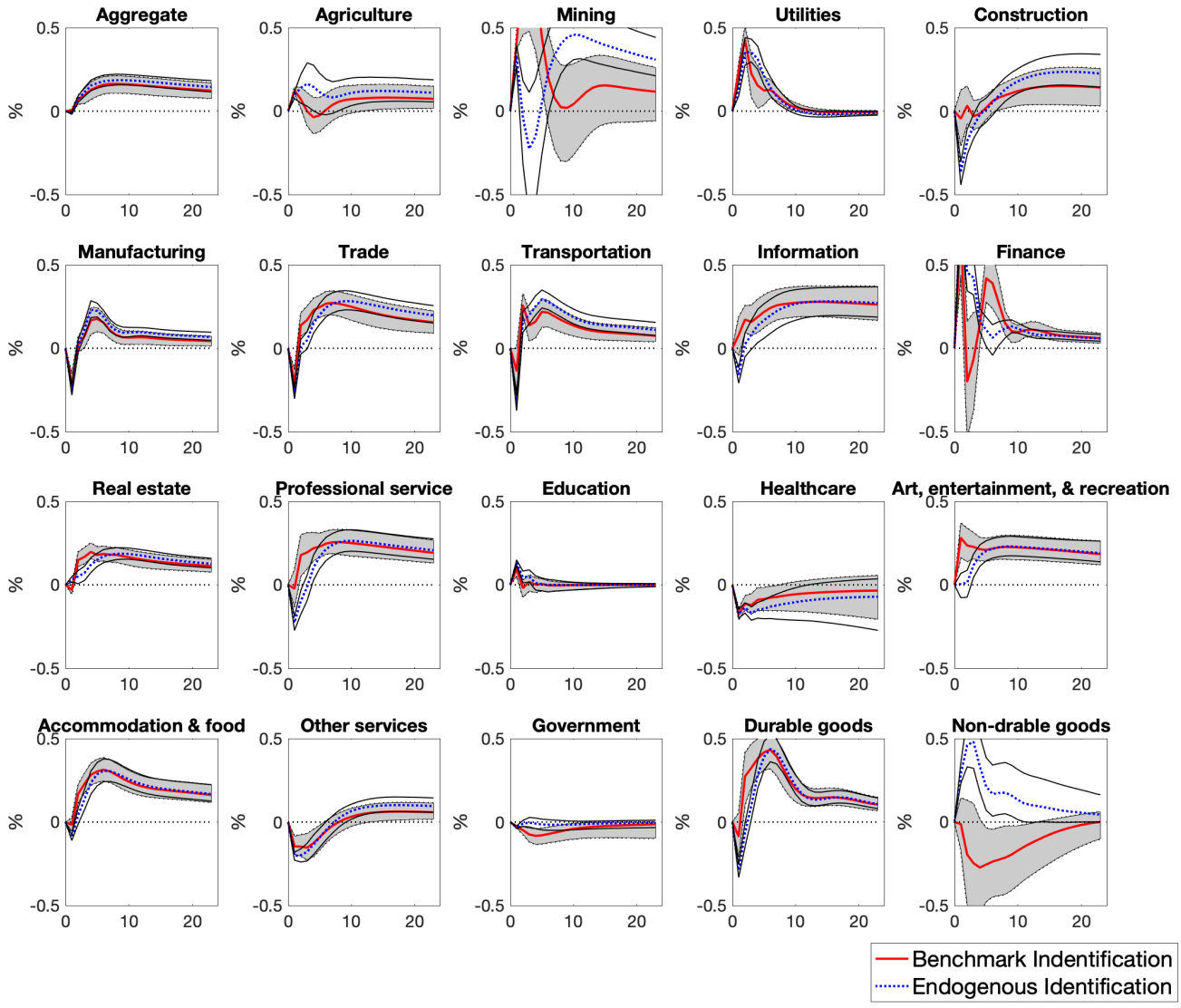
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 14: Japanese - Industry Impulse Response Functions with Different Identification Periods



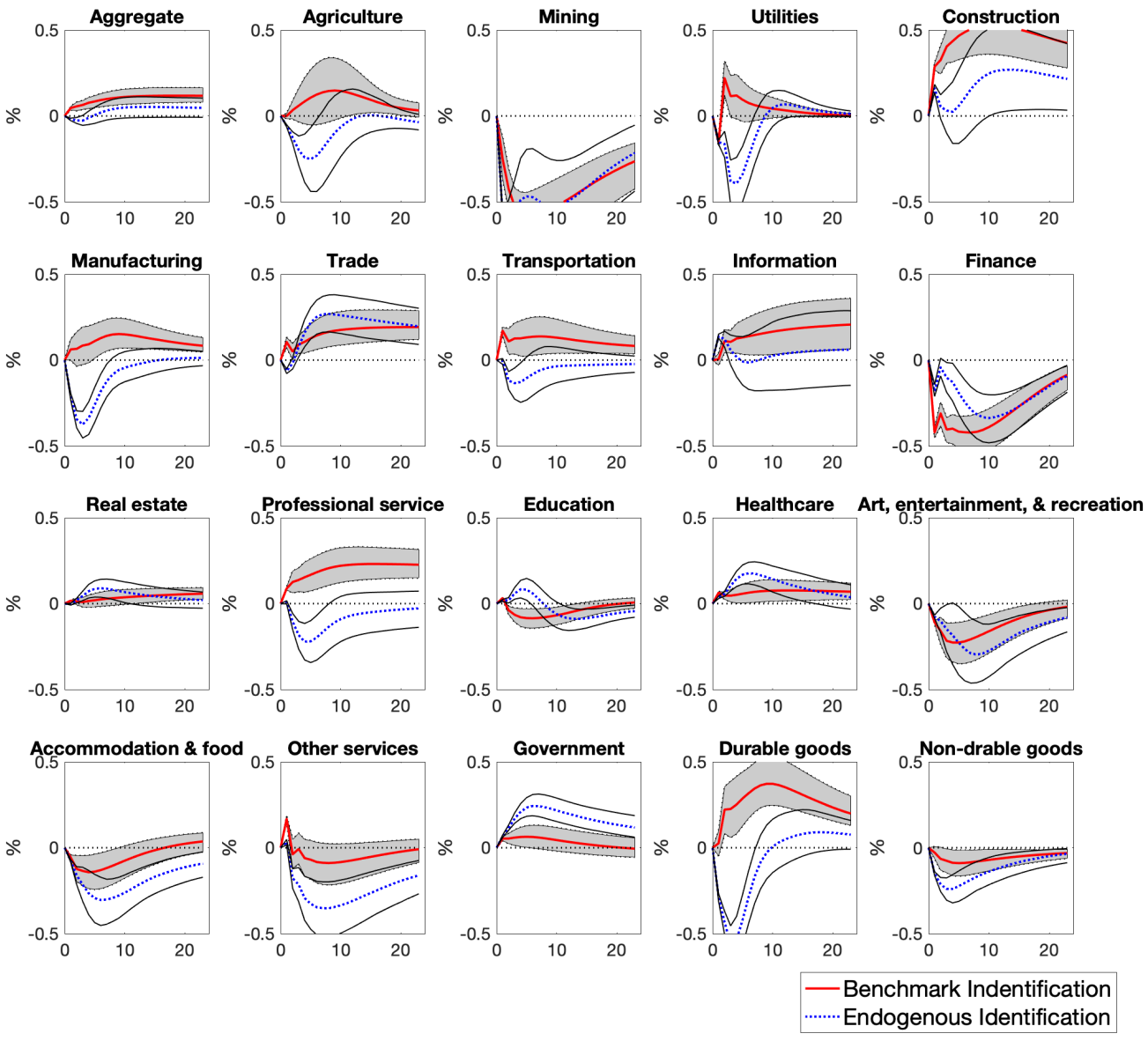
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 15: The United States - Industry Impulse Response Functions with Endogenous Identification



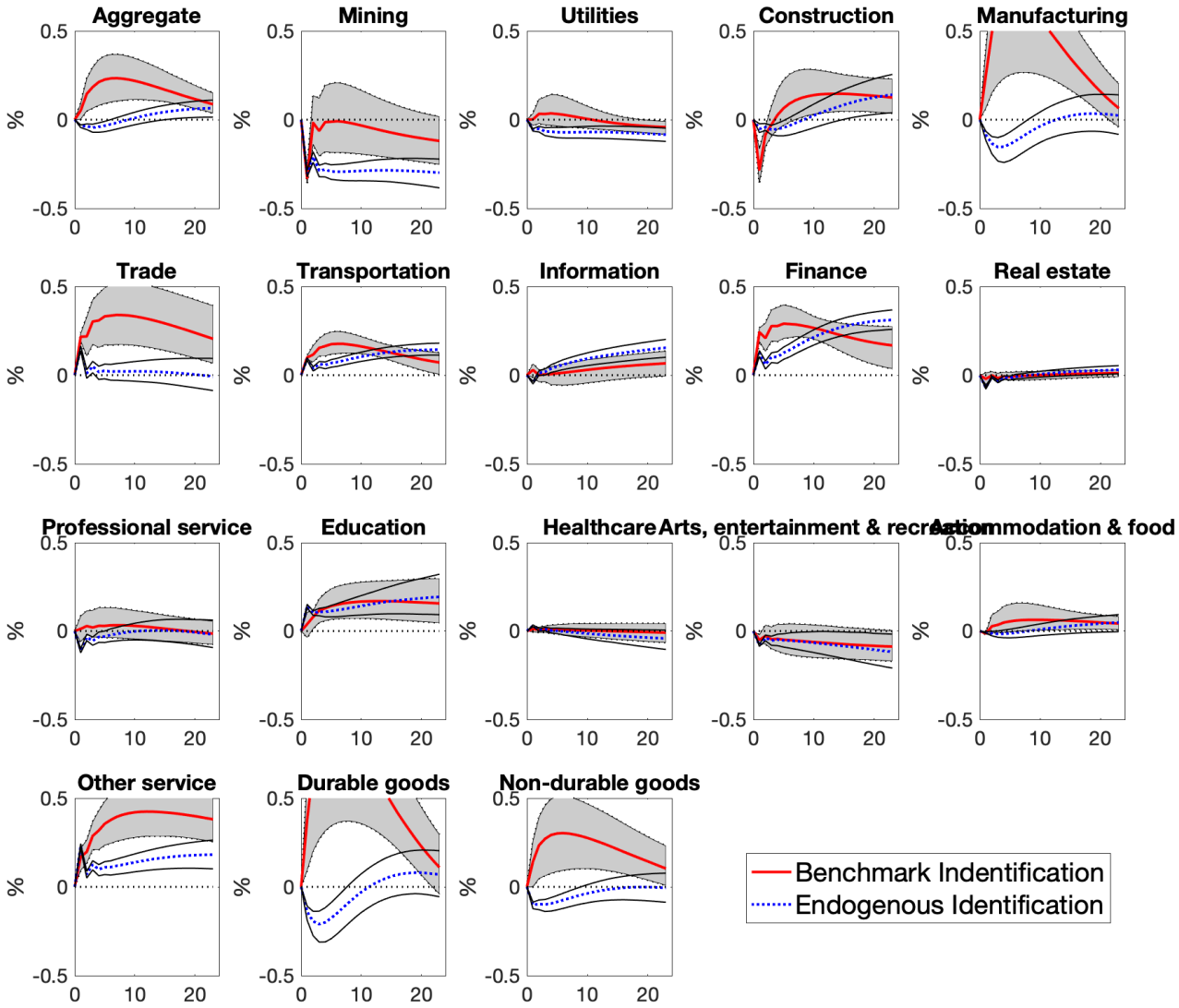
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

Figure 16: The United Kingdom - Industry Impulse Response Functions with Endogenous Identification



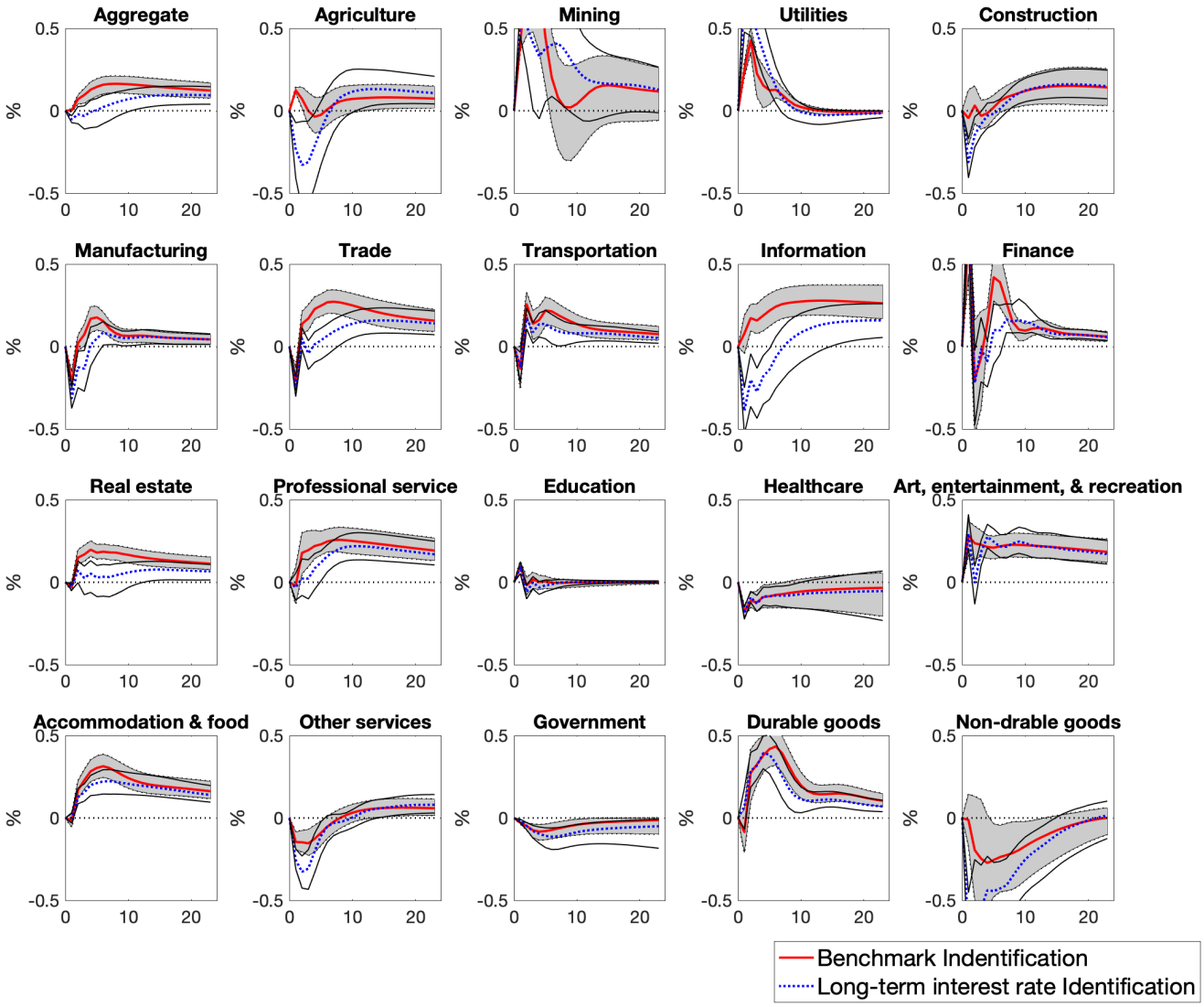
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 17: Japan - Industry Impulse Response Functions with Endogenous Identification



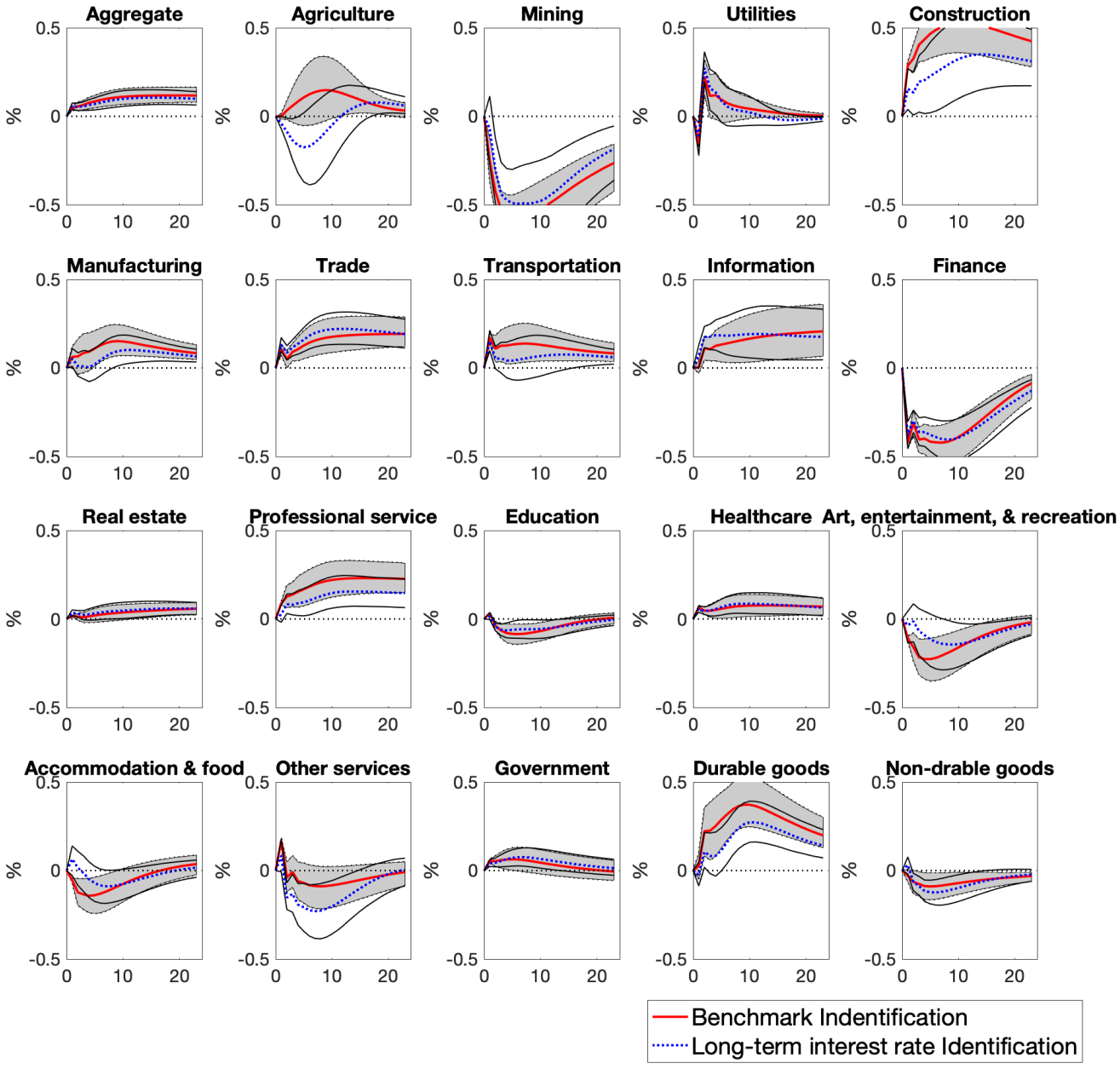
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 18: The United States - Industry Impulse Response Functions with Long-term Interest Rate



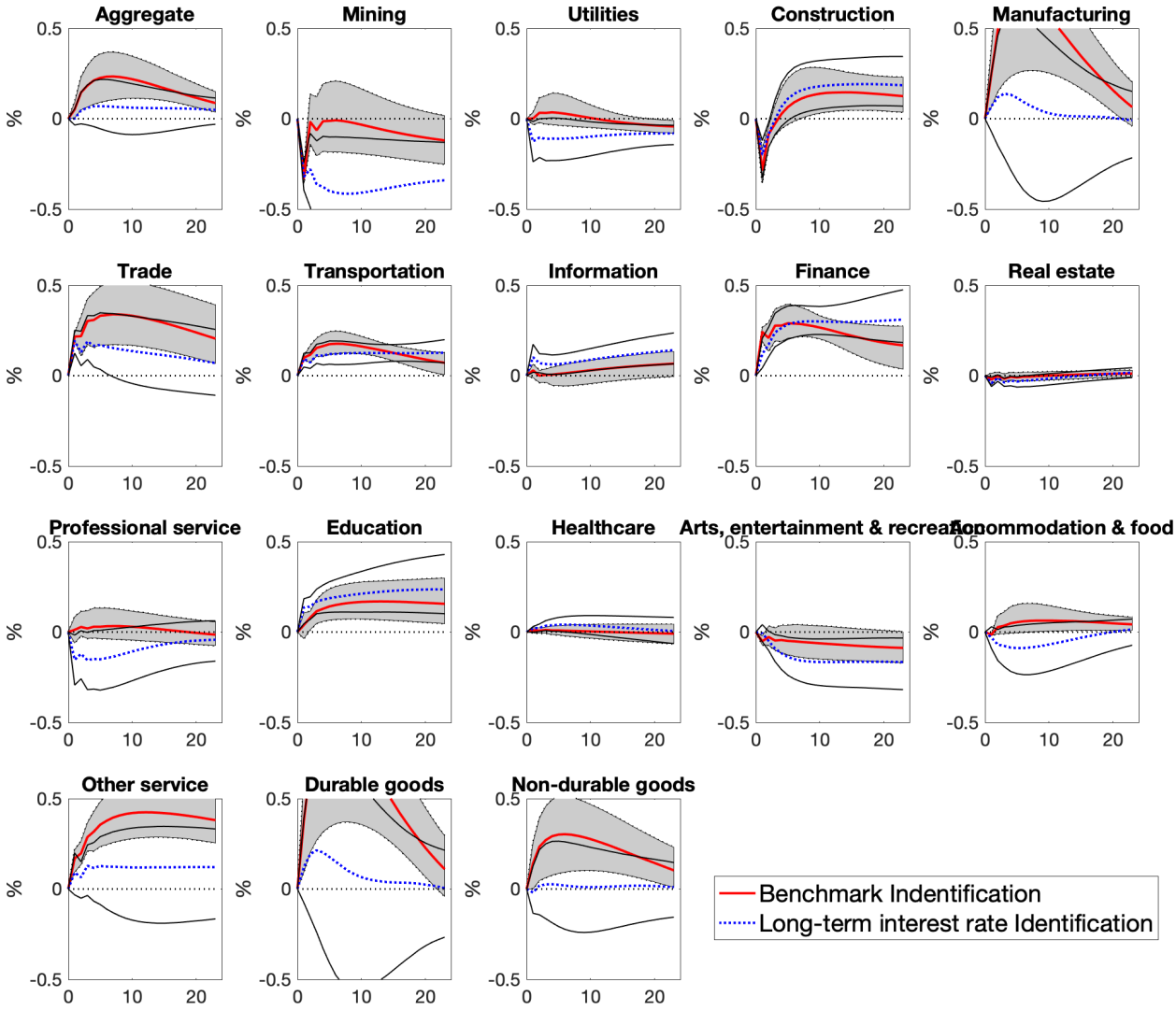
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

Figure 19: The United Kingdom - Industry Impulse Response Functions with Long-term Interest Rate



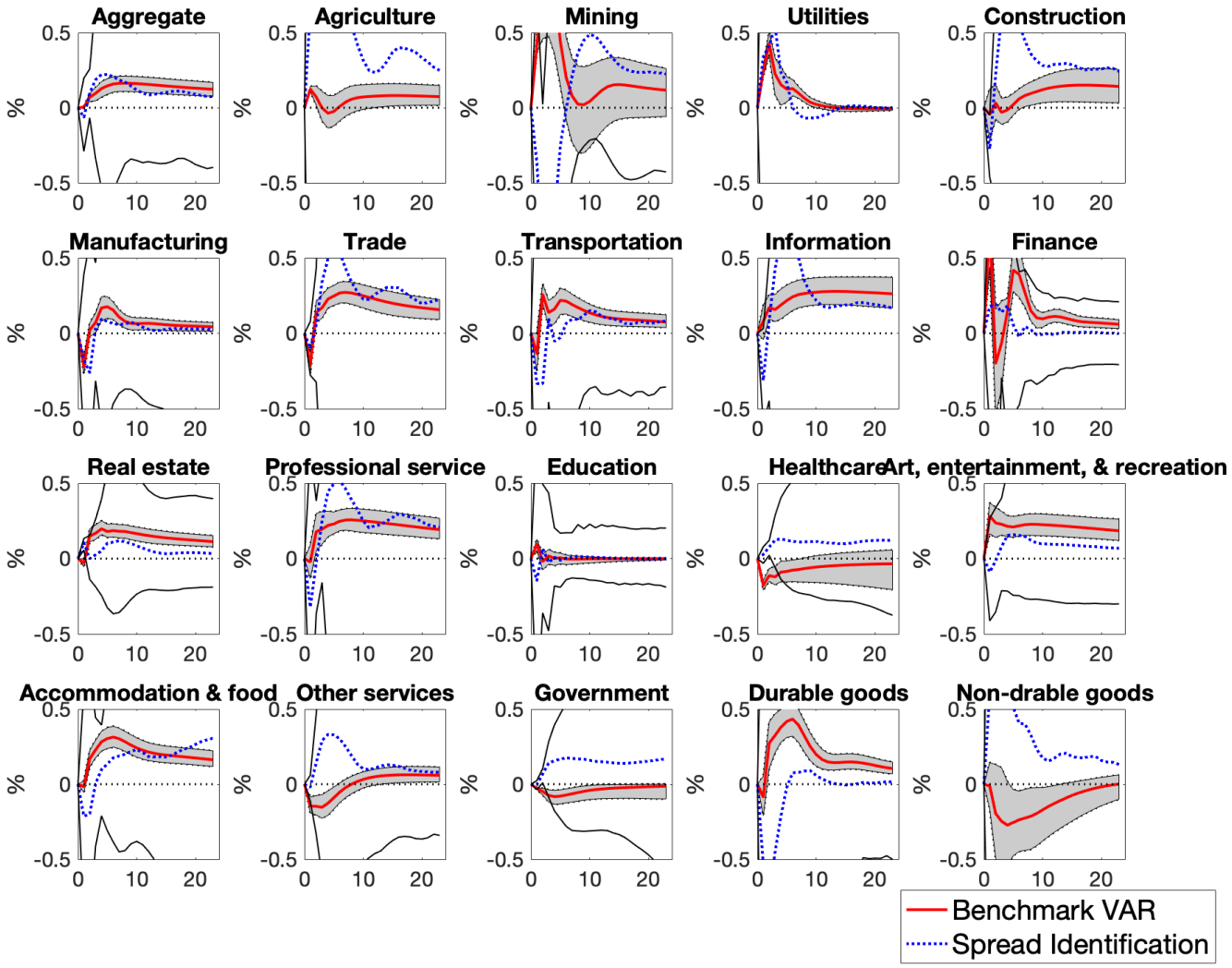
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 20: Japan - Industry Impulse Response Functions with Long-term Interest Rate



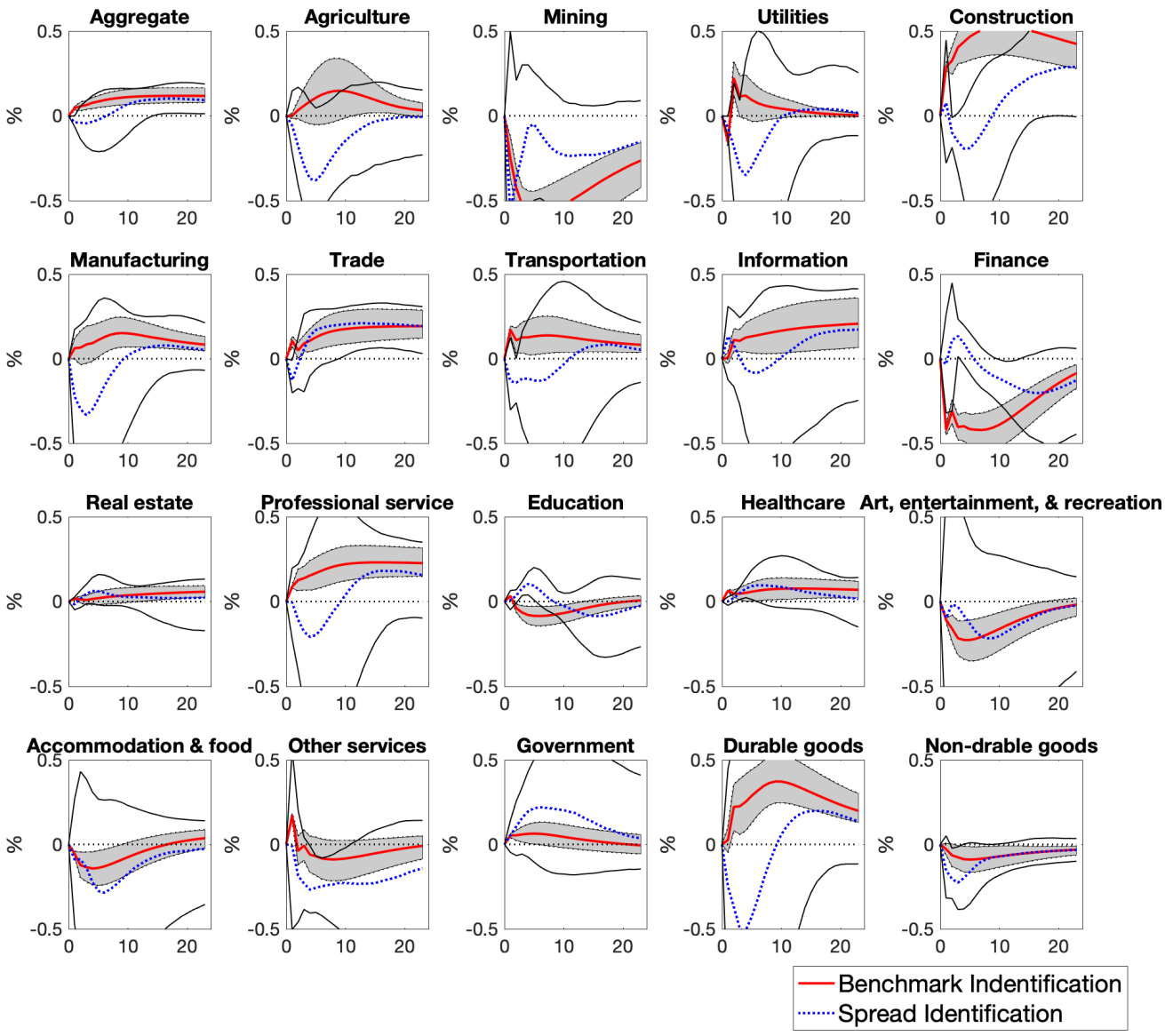
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 21: The United States - Industry Impulse Response Functions with Interest Rate Spread



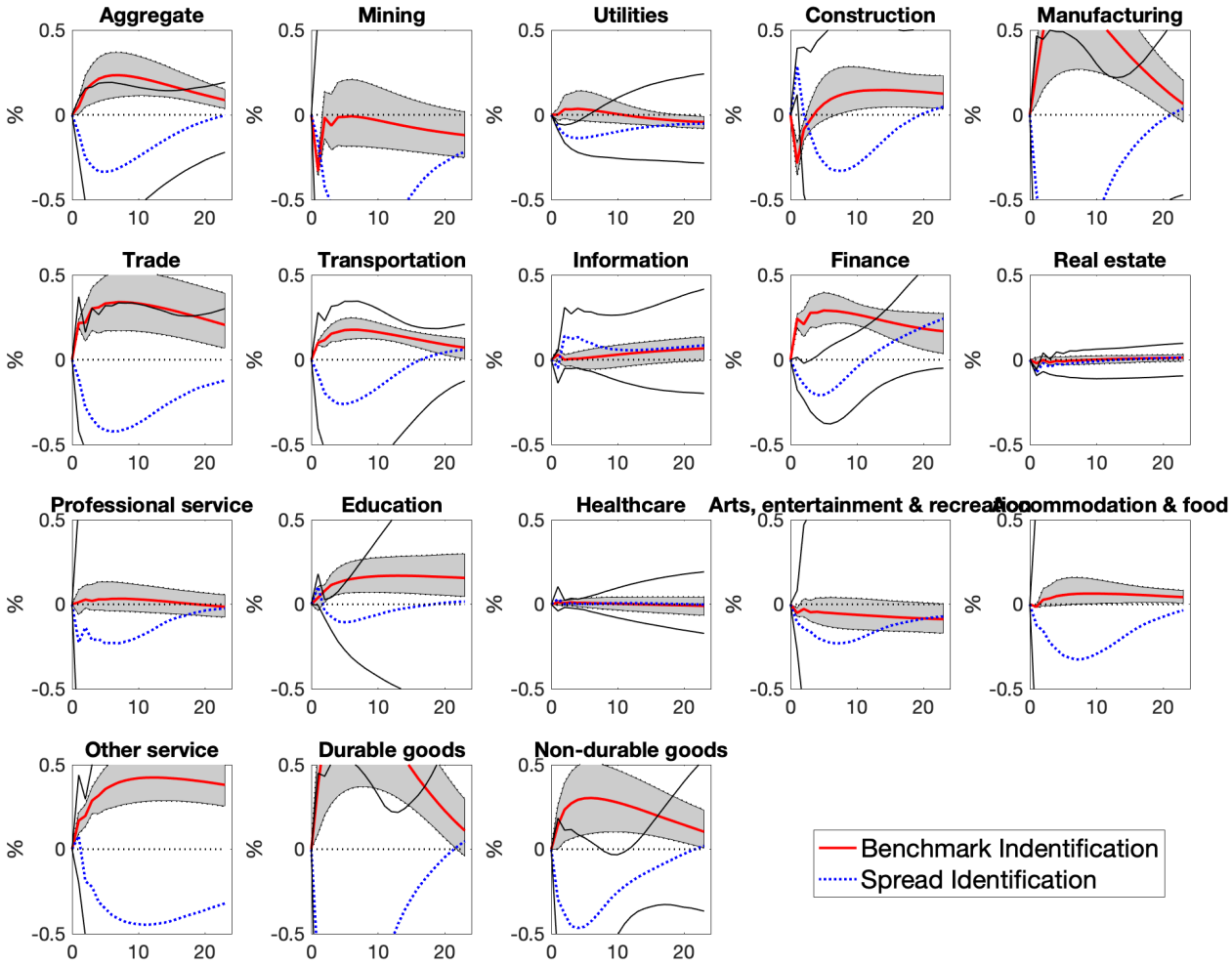
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

Figure 22: The United Kingdom - Industry Impulse Response Functions with Interest Rate Spread



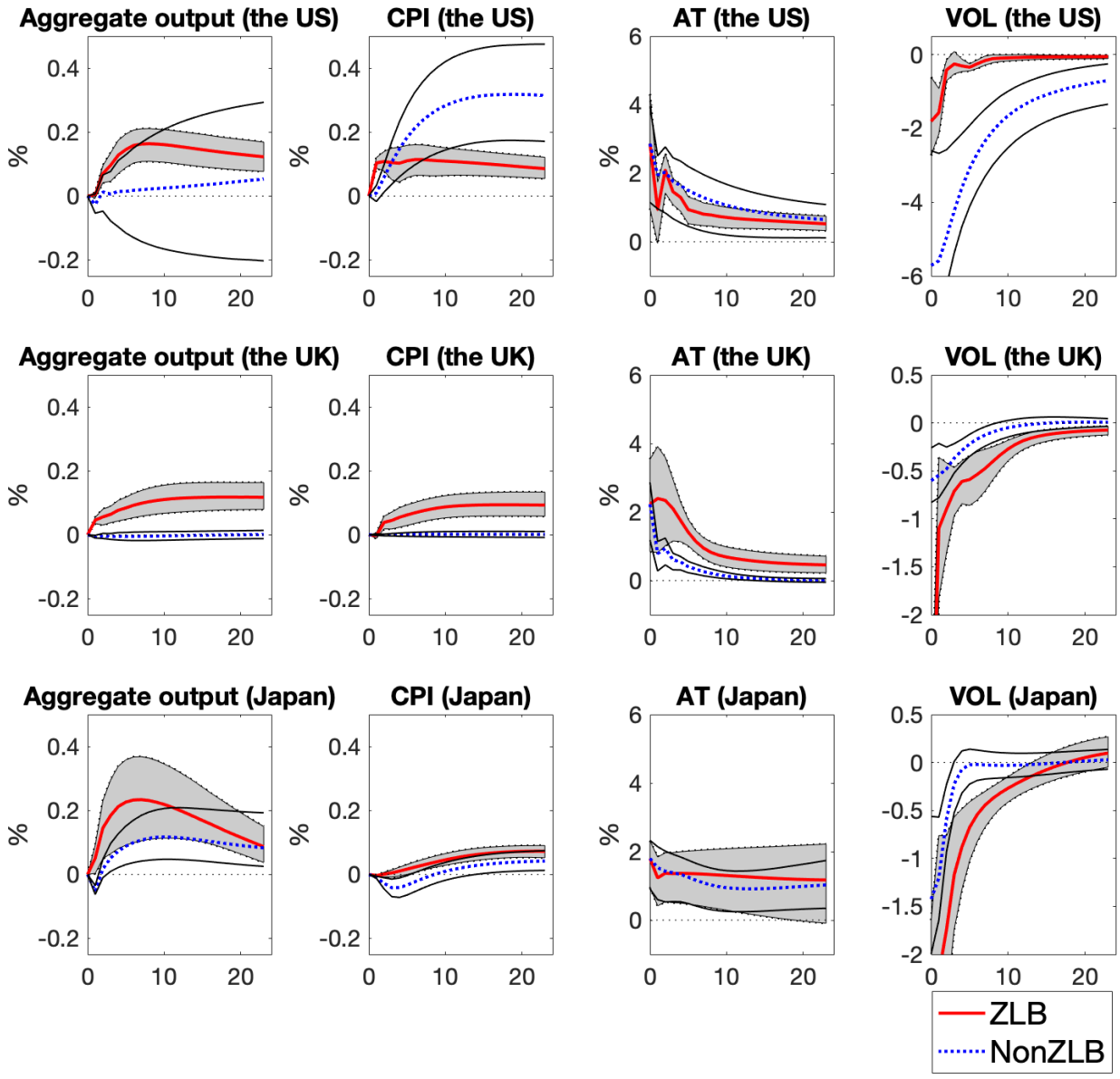
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 23: Japan - Industry Impulse Response Functions with Interest Rate Spread



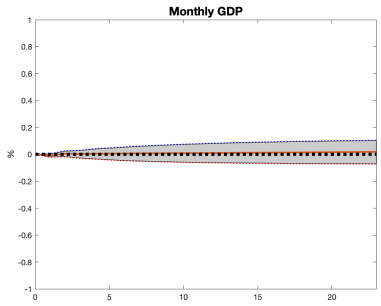
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 24: National Impulse Response Functions During Non-ZLB



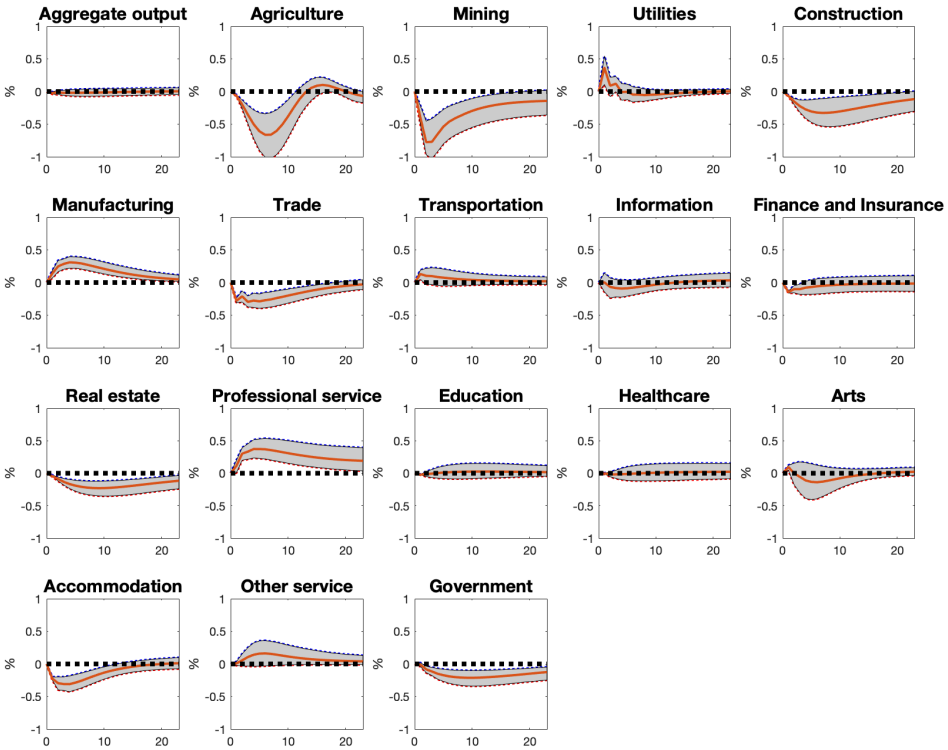
Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon (the US) and Monthly horizon (the UK and Japan).

Figure 25: The United States - National Impulse Response Functions During Non-ZLB



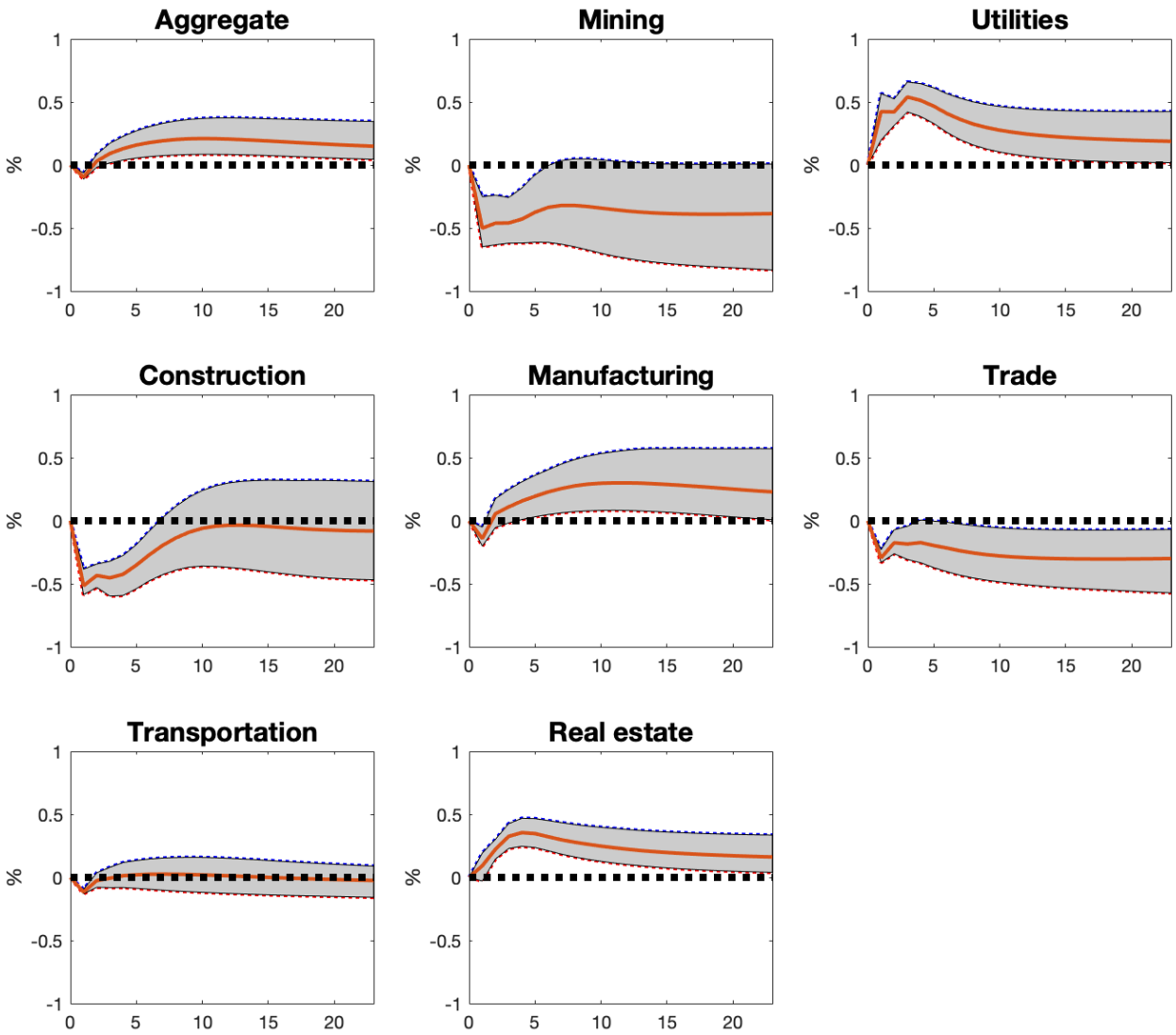
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 26: The United Kingdom - Industry Impulse Response Functions During Non-ZLB



Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 27: Japan - Industry Impulse Response Functions During Non-ZLB



Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

2 Appendix

2.1 Industry Definitions

The following table summarizes the categories of the industries:

Table 2.1: Industry definition

Country	The US	The UK	Japan
Codes	NAICS	UK SIC	JSIC
industries			
Agriculture	11	A	N.A.
Mining	21	B	C
Utilities	22	D, E	F
Construction	23	F	D
Manufacturing	31-33	C	E
Durable goods	321, 327, 33	CC16, CH, CI, CJ, CK,CL,CM	12,13,22-31 323-326
Non-durable goods	31, 322-326	CA, CB, CC17, CC18, CD, CE, CF, CG	09-11,14-21
Trade	42, 44-45	G	I
Transportation	48-49	H	H
Information	51	J	G
Finance	52	K	J
Real estate	53	L	K
Professional service	54-56	M,N	L
Education	61	P	O
Healthcare	62	Q	P
Arts, entertainment, & recreation	71	R	N
Accommodation & food	72	I	M
Other Services	81	S	Q,R
Government	92	O	N.A.

Table 2.2: Number of Periods for the Maximum Response

Country	US	UK	Japan	Country	US	UK	Japan
Industry		Elasticity		Industry		Elasticity	
Aggregate	0.06	0.05	0.13	Information	0.10	0.09	0.04
	(8,3)	(18,3)	(7,2)		(13,2)	(23,2)	(23,11)
Agriculture	0.04	0.06		Finance	0.28	-0.04	0.16
	(1,1)	(9,4)			(1,1)	(23,NA)	(5,1)
Mining	0.35	-0.11	0.00	Real estate	0.07	0.02	0.01
	(3,2)	(1, NA)	(6,NA)		(4,2)	(23,8)	(23,15)
Utilities	0.18	0.10	0.02	Professional service	0.09	0.12	0.02
	(2,1)	(2,2)	(4,2)		(8,2)	(15,2)	(8,2)
Construction	0.05	0.24	0.08	Education	0.03	0.01	0.09
	(17,7)	(10,1)	(14,6)		(1,1)	(1,1)	(13,3)
Manufacturing	0.06	0.07	0.39	Healthcare	-0.01	0.03	0.01
	(5,4)	(9,3)	(5,2)		(23,NA)	(12,1)	(3,1)
Durable goods	0.16	0.17	0.52	Arts, entertainment, and recreation	0.10	-0.01	-0.02
	(6,2)	(9,2)	(5,2)		(1,1)	(23,NA)	(2,NA)
Non-durable goods	0.00	-0.01	0.17	Accommodation	0.12	0.02	0.04
	(23,23)	(1,NA)	(6,2)		(6,2)	(23,20)	(9,3)
Trade	0.09	0.08	0.19	Other services	0.02	0.08	0.24
	(7,2)	(1,1)	(7,1)		(18,10)	(1,1)	(12,3)
Transportation	0.08	0.07	0.10				
	(2,2)	(1,1)	(6,1)				

Note: In parenthesis is how many periods it takes to reach the maximum and 50% of the maximum response (if the elasticity is negative, NA is written) on the left and on the right, respectively. The shock period is 0. Elasticity is the maximum median impulse response function consistent with a 1% increase in central bank total asset.

2.2 Comparison of National Effects Across Unconventional Policy Studies

Table 2.3: Detail Comparison of National Effects Across Unconventional Policy Studies

Authors	Country	Estimate			Sample periods	Estimation	Output variable
		GDP in %	CPI in %	1 STD unconventional policy shock in %			
This paper	US	0.16	0.11	2.86	2008Q1-2017Q4	Bayesian	Quarterly GVA
	UK	0.12	0.09	2.23	2008M1-2018M6	Bayesian	Monthly GDP
	Japan	0.23	0.07	1.80	2003M1-2018M2	Bayesian	Monthly quantity index
Gambacorta et al. (2014)	US	0.10	0.06	2.70	2008M1-2011M6	Frequentist	interpolated GDP
	UK	0.12	0.01	4.50	2008M1-2011M6	Frequentist	interpolated GDP
	Japan	0.10	0.02	1.20	2008M1-2011M7	Frequentist	interpolated GDP
	EU	0.10	0.08	2.40	2008M1-2011M8	Frequentist	interpolated GDP
Bhattarai et al. (2015)	US	0.40	0.10	2.00	2008M1-2014M11	Bayesian	interpolated GDP
Boeckx et al. (2017)	EU	0.10	0.10	1.50	2007M1-2014M12	Bayesian	interpolated GDP
Burriel and Galesi (2018)	EU	0.08	0.03	1.00	2007M1-2015M9	Frequentist	interpolated GDP
Schenkelberg and Watzka (2013)	Japan	0.40	0.05	7.00	1995M1-2010M9	Bayesian	industrial production
Peersman (2011)	EU	0.40	0.07	1.75	1999M9-2009M12	Bayesian	industrial production
Average		0.20	0.06	2.67			
Median		0.10	0.06	2.00			

2.3 Unit-Root and Stationarity Tests

I operate both unit root and stationarity tests. For the unit root test, I use augmented Dickey-Fuller (ADF) and ADF-GLS tests. For the stationarity test, I use the KPSS test. All of these tests are done for each series for each country. The number of lags for the ADF test is chosen by AIC, the number

for ADF-GLS is chosen by Modified AIC (Ng and Perron, 2001), and the number for the KPSS test is determined by $[12(\frac{T}{100})^{0.25}]$. I took the logarithm and then multiplied by 100 of all of the series except stock market implied volatility, since the specification is how each variable enters the VAR model. For both tests, constant and trend terms are included. The following tables (tables 2.4, 2.5, and 2.6) summarizes those tests results.

Table 2.4: The United States - Unit-Root and Stationarity tests

	Total			Agriculture			Mining			Utilities			Construction		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-7.69	-0.99	0.15	-2.17	-1.81	0.09	-0.80	-1.97	0.11	-2.71	-1.52	0.08	-3.39	-0.90	0.14
p-value	0.00		0.05	0.50		0.10	0.95		0.10	0.25		0.10	0.07		0.05
Support	I(0)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)
Overall support		Mix			Mix			Mix			Mix			Mix	
	Manufacturing			Trade			Transportation			Information			Finance		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-2.84	-1.64	0.14	-3.29	-0.81	0.15	-1.44	-1.49	0.10	-1.00	-0.75	0.15	-1.87	-0.90	0.14
p-value	0.20		0.06	0.09		0.05	0.83		0.10	0.93		0.04	0.64		0.06
SupportDF-GLS	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		Mix			I(1)			Mix			I(1)			Mix	
	Real estate			Professional service			Education			Healthcare			Arts, etc		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-3.21	-2.17	0.13	-9.29	-2.21	0.13	-2.11	-1.39	0.13	-0.33	-0.67	0.15	-2.20	-2.15	0.10
p-value	0.10		0.08	0.00		0.07	0.53		0.08	0.99		0.05	0.49		0.10
Support	I(1)	I(1)	I(0)	I(0)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		Mix			Mix			Mix			I(1)			Mix	
	Accommodation			Other service			Government			Durable goods			Non-durable goods		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-2.89	-2.73	0.12	-2.30	-0.82	0.15	-1.77	-1.89	0.10	-4.06	-3.053*	0.10	-3.23	-1.55	0.13
p-value	0.18		0.10	0.44		0.05	0.69		0.10	0.02		0.10	0.10		0.09
Support	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)	I(1)	I(1)	I(0)
Overall support		Mix			I(1)			Mix			I(0)			Mix	
	Agg. Manufacturing			Agg. Service			ln(CPI)			ln(AT)			VOL		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-2.50	-1.35	0.13	-3.40	-1.23	0.15	-2.94	-2.50	0.10	-0.69	-0.71	0.16	-1.63	-1.64	0.13
p-value	0.35		0.08	0.07		0.04	0.16		0.10	0.96		0.04	0.75		0.08
Support	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		Mix			I(1)			Mix			I(1)			Mix	

Table 2.5: The United Kingdom - Unit-Root and Stationarity tests

	Total			Agriculture			Mining			Utilities			Construction		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-4.84	-1.13	0.21	-3.51	-1.94	0.07	-1.21	-0.62	0.26	-2.56	-1.45	0.18	-2.40	-0.99	0.20
p-value	0.00		0.01	0.04		0.10	0.90		0.01	0.32		0.02	0.39		0.02
Support	I(0)	I(1)	I(1)	I(0)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Overall support		Mix			Mix			I(1)			I(1)			I(1)	
	Manufacturing			Trade			Transportation			Information			Finance		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-4.17	-2.37	0.10	-1.98	-0.65	0.23	-5.38	-0.81	0.16	-1.46	-1.08	0.22	-3.18	-2.10	0.14
p-value	0.01		0.10	0.60		0.01	0.00		0.04	0.84		0.01	0.09		0.06
Support	I(0)	I(1)	I(0)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		Mix			I(1)			Mix			I(1)			Mix	
	Real estate			Professional service			Education			Healthcare			Arts, etc		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-0.88	-0.98	0.13	-4.00	-1.51	0.13	-3.05	-1.16	0.14	0.12	-0.68	0.24	-3.08	-1.69	0.10
p-value	0.95		0.08	0.01		0.08	0.12		0.07	1.00		0.01	0.12		0.10
Support	I(1)	I(1)	I(0)	I(0)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		Mix			Mix			Mix			I(1)			Mix	
	Accommodation			Other service			Government			Durable goods			Non-durable goods		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-3.09	-1.46	0.14	-2.76	-2.19	0.13	-1.80	-1.49	0.13	-3.89	-2.58	0.05	-2.05	-0.81	0.21
p-value	0.11		0.06	0.22		0.09	0.69		0.08	0.02		0.10	0.56		0.01
Support	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(1)	I(0)	I(1)	I(1)	I(1)
Overall support		Mix			Mix			Mix			Mix			I(1)	
	Agg. Manufacturing			Agg. Service			ln(CPI)			ln(AT)			VOL		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-1.65	-1.32	0.20	-3.92	-1.60	0.19	-2.95	-2.12	0.23	-3.82	-1.58	0.17	-3.67	-3.63	0.12
p-value	0.76		0.02	0.01		0.02	0.15		0.01	0.02		0.03	0.03		0.10
Support	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)
Overall support		I(1)			Mix			I(1)			Mix			I(0)	

Table 2.6: Japan - Unit-Root and Stationarity tests

	Aggregate			Mining			Utilities			Construction			Manufacturing		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-2.16	-1.85	0.15	-2.33	-1.73	0.17	-2.85	-1.45	0.28	-1.25	-0.97	0.30	-2.59	-2.50	0.10
p-value	0.51		0.05	0.43		0.03	0.18		0.01	0.90		0.01	0.30		0.10
Support	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		I(1)			I(1)			I(1)			I(1)			Mix	
	Trade			Transportation			Information			Finance			Real estate		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-2.65	-1.77	0.11	-1.65	-2.02	0.19	-1.49	-1.70	0.19	-1.65	-1.97	0.19	-3.19	-1.03	0.14
p-value	0.27		0.10	0.76		0.02	0.83		0.02	0.76		0.02	0.09		0.06
Support	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		Mix			I(1)			I(1)			I(1)			Mix	
	Professional service			Education			Healthcare			Arts, etc			Accommodation		
Test	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-2.02	-2.29	0.12	-1.70	-1.57	0.20	-2.06	-1.43	0.15	-2.18	-1.81	0.11	-1.83	-1.48	0.15
p-value	0.58		0.09	0.74		0.02	0.56		0.05	0.50		0.10	0.67		0.05
Support	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)
Overall support		Mix			I(1)			I(1)			Mix			I(1)	
	Other services			Durable goods			Non-durable goods			Agg. Manufacturing			Agg. Service		
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS
Statistic	-3.28	-1.89	0.16	-2.59	-2.39	0.09	-2.17	-2.52	0.16	-2.03	-2.62	0.15	-2.20	-1.40	0.14
p-value	0.07		0.04	0.30		0.10	0.51		0.04	0.57		0.05	0.49		0.06
Support	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
Overall support		I(1)			Mix			I(1)			I(1)			Mix	
	ln(CPI)			ln(AT)			VOL								
TestI(1)	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS	ADF	DF-GLS	KPSS						
Statistic	-1.17	-1.03	0.23	-1.54	-0.95	0.34	0.37	0.00	0.08						
p-value	0.91		0.01	0.81		0.01	0.00		0.00						
Support	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)						
Overall support		I(1)			I(1)			Mix							

2.4 Impacts of National Unconventional Policy Compared to Conventional policy Studies

It is of interest to know the magnitude of unconventional policy compared to the magnitude of conventional policy. The table below lists several conventional policy studies and summarizes the quantitative results of conventional policy from a one standard deviation shock to the policy rate.

Table 2.7: Comparison of National Effects Across Conventional Policy Studies

Authors	Country	Estimate			Sample periods	Output variable	Note
		GDP in %	CPI in %	1 STD conventional policy shock			
This paper	the US	0.16	0.11	2.86	2008Q1-2017Q4	Quarterly GVA	
	the UK	0.12	0.09	2.23	2008M1-2018M6	Monthly GDP	
	Japan	0.23	0.07	1.80	2003M1-2018M2	Monthly quantity index	
Christiano et al. (1999)	the US	0.50	0.15	-0.75	1965Q3-1995Q2	GDP	
Jordà (2005)	the US	0.23	0.13	-0.60	1960M1-2001M2	non-agricultural payroll employment	Local Projection method, price = PCE
Bernanke and Mihov (1998)	the US	0.20	0.30	-0.38	1965M1-1996M12	interpolated GDP	price = GDP deflator
Bagliano and Favero (1998)	the US	0.17	0.07	-0.10	1988M11-1996M3	interpolated GDP	
Dale and Haldane (1995)	the UK	1.00	-1.00	-0.01	1974M6-1992M10	retail sale and indsutrial production	
Mojon and Peersman (2001)	EU	0.10	0.10	-0.30	1980Q1-1998Q4	Real GDP	
Kim (1999)	the US	0.45	0.60	-0.16	1961M3-1994M3	industrial production	
	the UK	0.30	1.00	-0.07	1961M3-1997M3	industrial production	
	Japan	0.30	0.50	-0.30	1965M3-1996M6	industrial production	
Average		0.30	0.44	-0.30			
Median		0.30	0.40	-0.30			

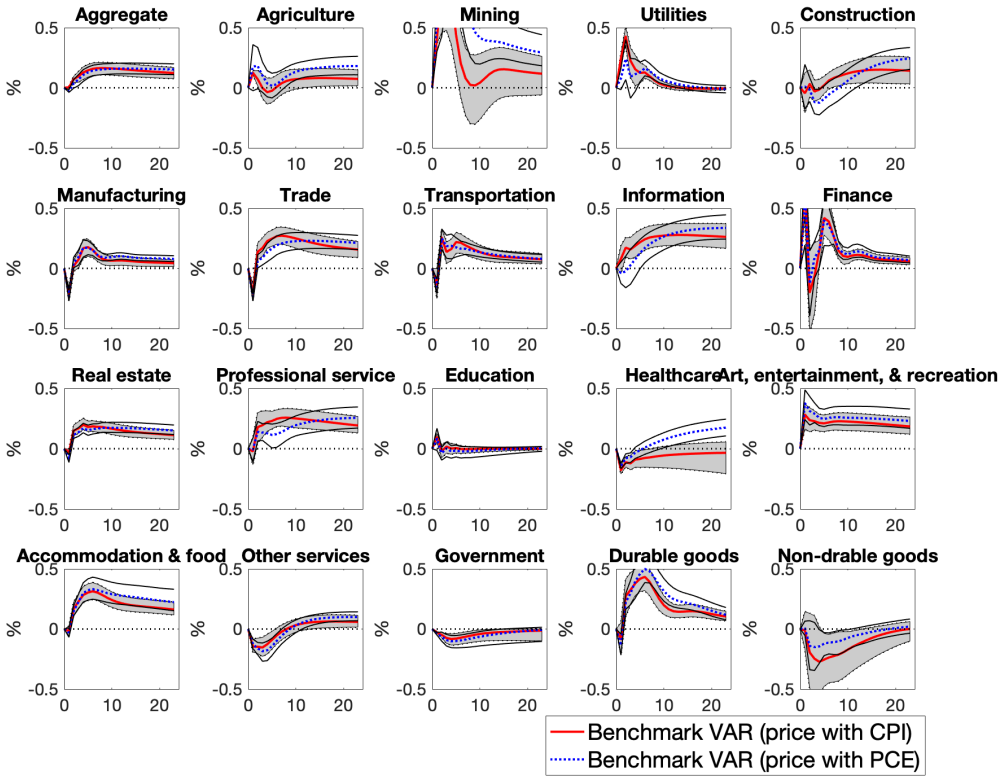
The range of effect lies between 0.1% to 1% for output and between -1% to 1% on price. The averages (medians) are 0.3% (0.3%) for output and 0.44% (0.4%) for price. Compared to this paper's results and other studies from unconventional policy literature, unconventional policy policy seems not as effective as conventional policy in terms of how one standard deviation shock to the monetary policy instruments stimulate the outcome variables. In terms of stimulating output, unconventional policy policy does not seem so weak. Its effect is about $66\%(=\frac{0.2\%}{0.3\%})$ of conventional policy. However, unconventional policy's effect on price seems weak and the effect is only about $13\%(=\frac{0.06\%}{0.44\%})$ of conventional policy on average. This finding is probably due to the periods covered for those studies which are during the high inflationary periods and the model captured the fluctuations. The studies by Bagliano and Favero (1998) and Mojon and Peersman (2001) only include periods after the great moderation and effects are 0.07 and 0.10, which is comparable to the unconventional policy studies. Therefore, the unconventional policy impacts of price may not be so bad. Even though I could not directly compare the effect of unconventional policy with conventional policy, since the policy instruments are different, it seems that effectiveness of unconventional policy is not bad.

2.5 Industry Impacts of Unconventional Policy When Personal Consumption Expenditure is Used

The target price variable of the monetary policy for the Federal Reserve is personal consumption expenditure (PCE). In this paper, I use CPI[7] for the price variable by following Gambacorta et al. (2014). However, the use of CPI can be misspecified. In this section, I estimate the model including the PCE instead of CPI to see whether or not results are radically altered. Figure 28 show the results.

[7]The target variable for the Bank of England and the Bank of Japan is CPI

Figure 28: The United States - Industry Impulse Response Functions when Personal Consumption Expenditure is used

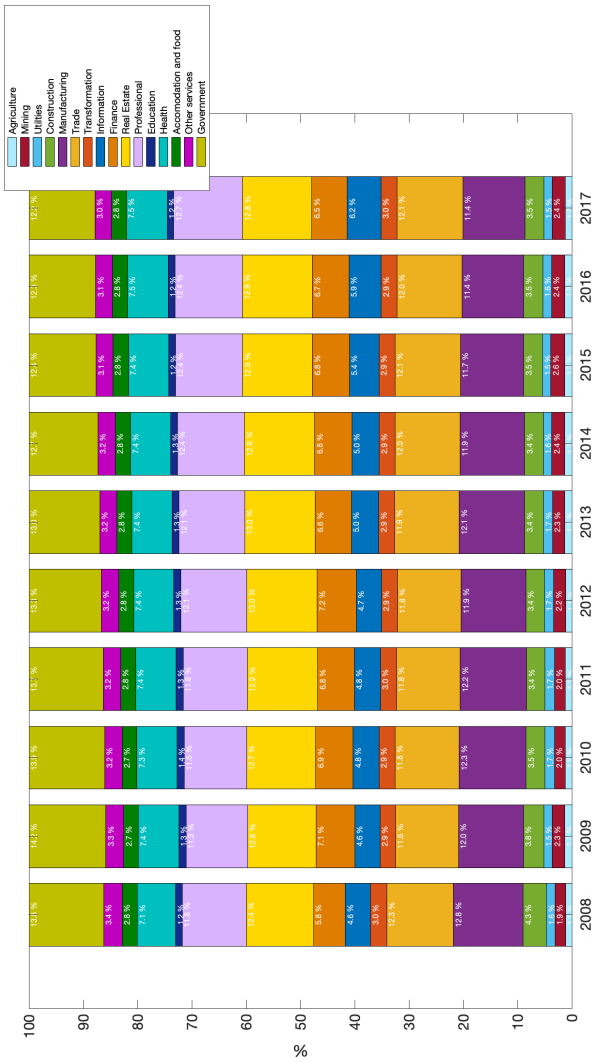


Note: The Median, 16th, and 84th Bayesian percentiles. Quarterly horizon.

There are some industries whose response functions are slightly altered such as agriculture, mining, and healthcare. However, generally the deviation is within the error band and the results are not so qualitatively different.

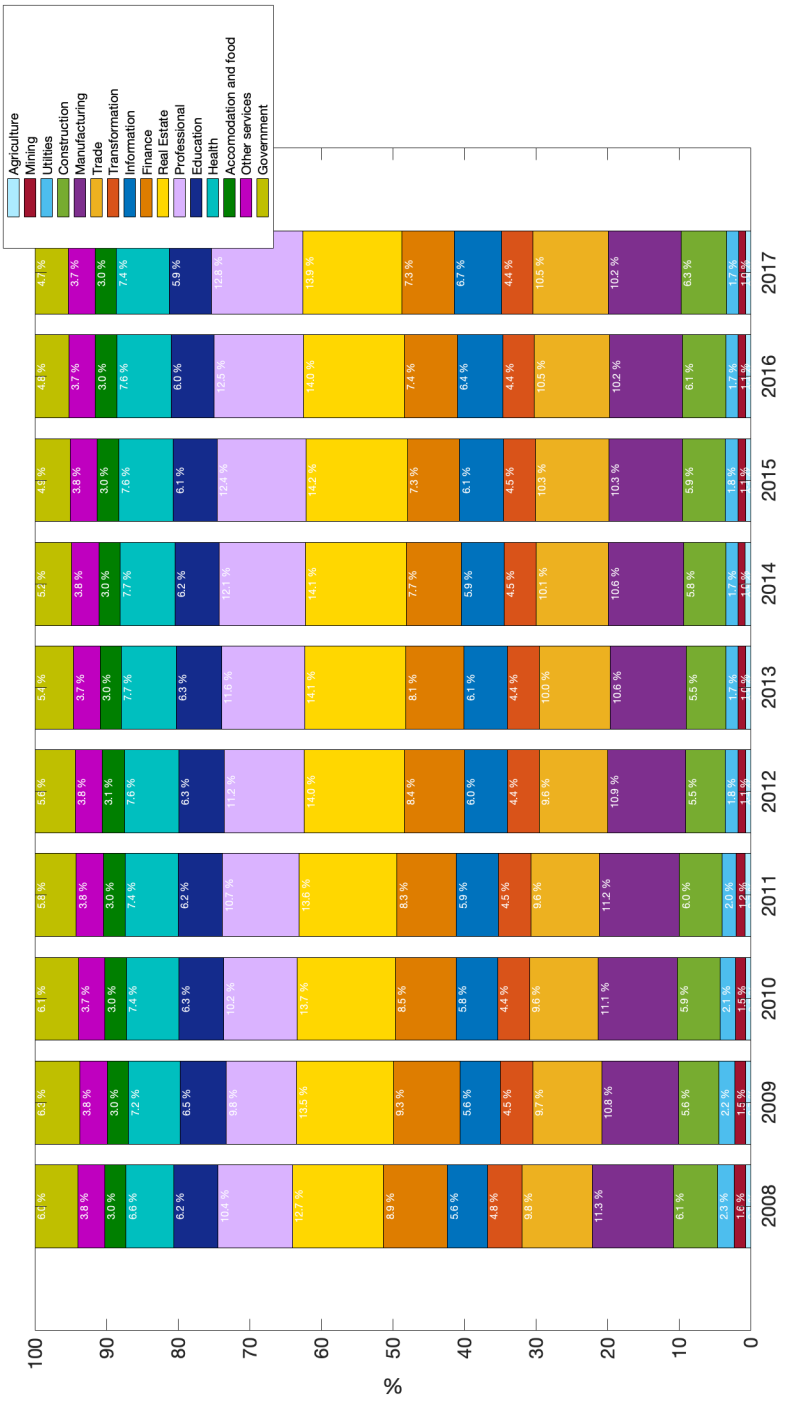
3 Appendix: Figures

Figure 3.29: The United States - Industry Composition



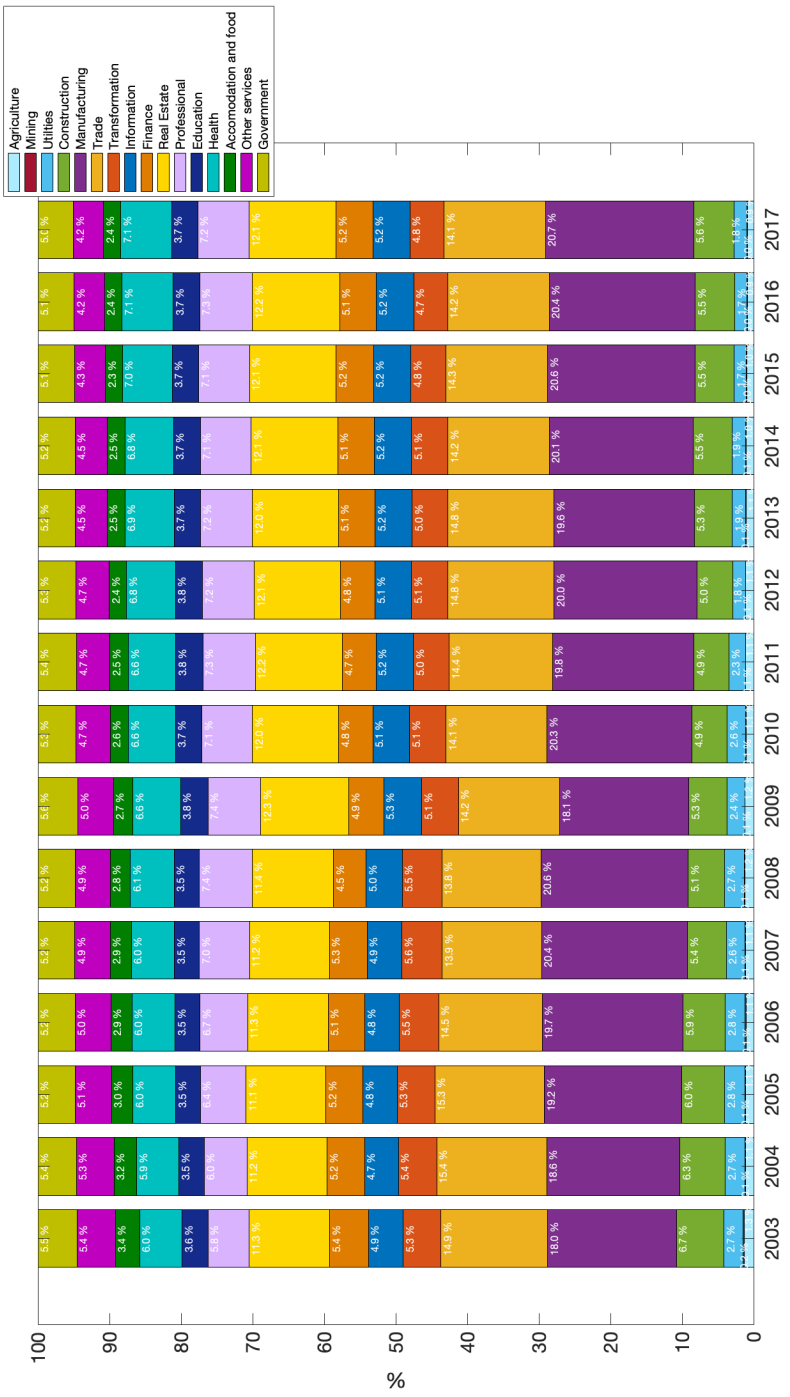
Source: The Bureau of Economic Analysis

Figure 3.30: The United Kingdom - Industry Composition



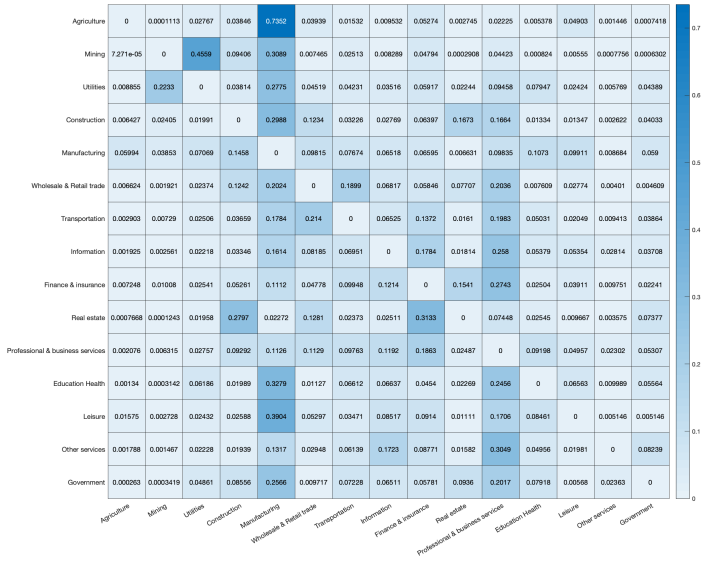
Source: The Office for National Statistics

Figure 3.31: Japan - Industry Composition



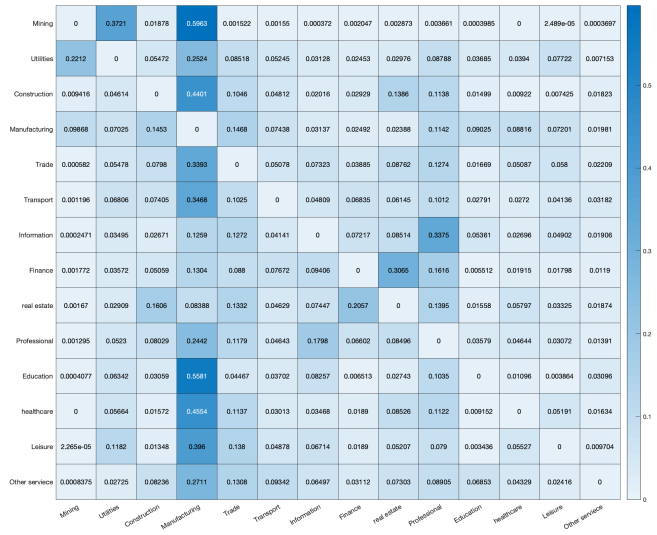
Source: The Cabinet of Japan

Figure 3.32: The UK - The Weighting Matrix



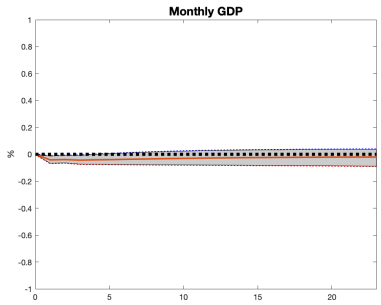
Source: The Office for National Statistics

Figure 3.33: Japan - The Weighting Matrix



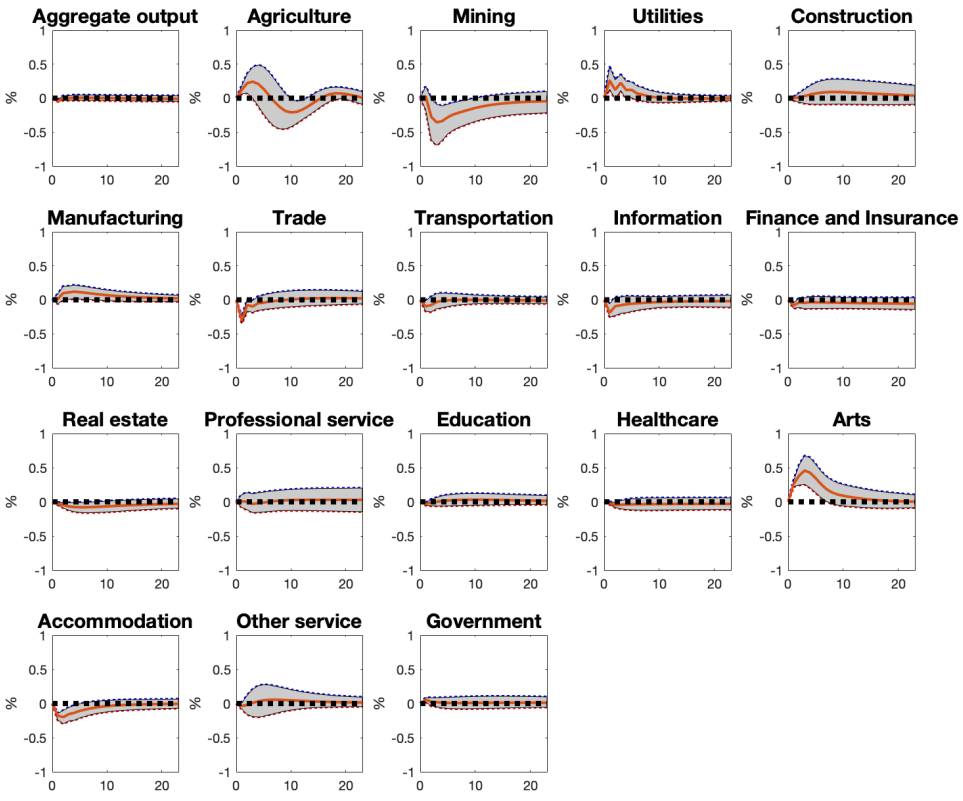
Source: The Ministry of Economy, Trade and Industry

Figure 3.34: The United States - National Impulse Response Functions During Non-ZLB with Policy Rate



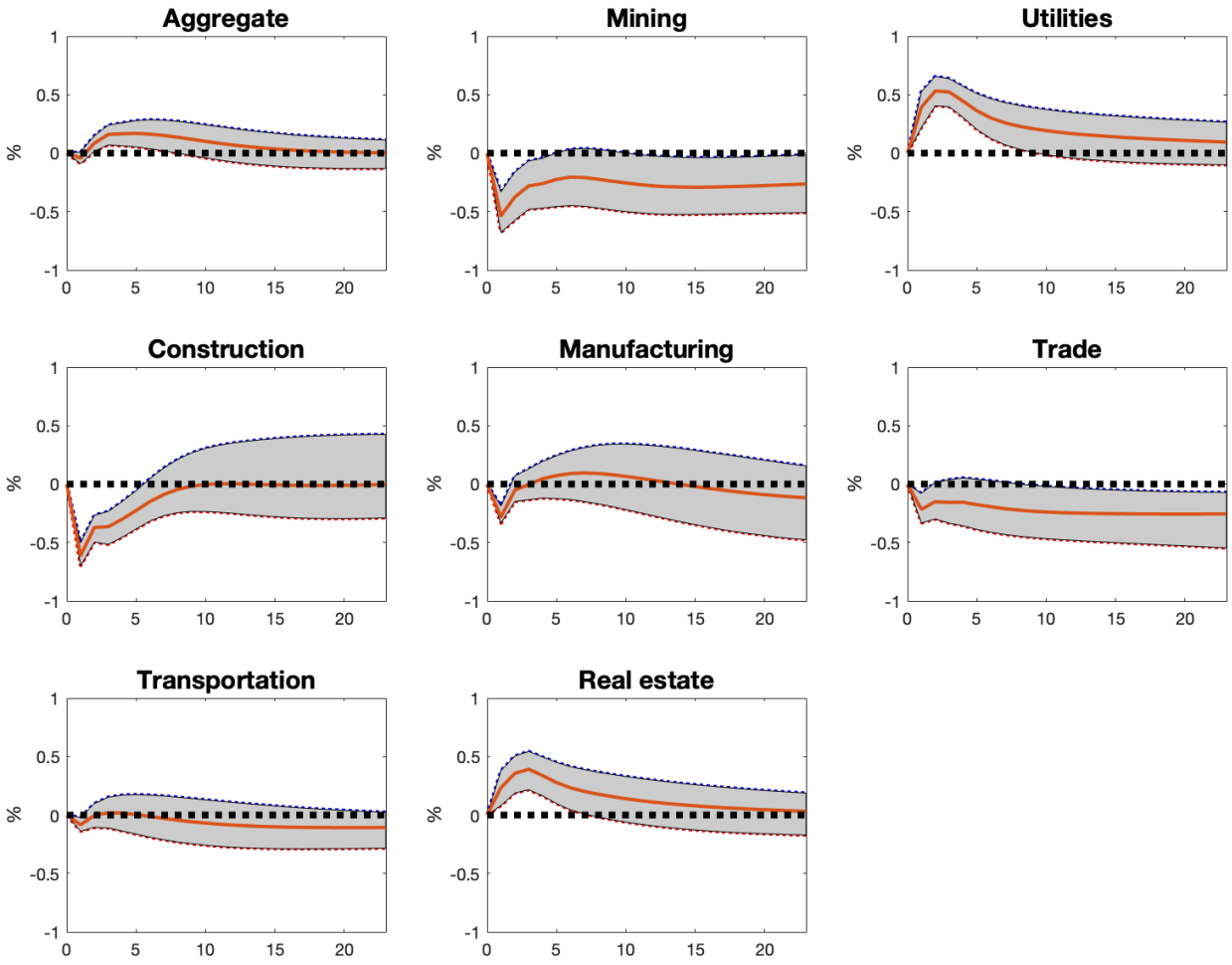
Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 3.35: The United Kingdom - Industry Impulse Response Functions During Non-ZLB with Policy Rate



Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.

Figure 3.36: Japan - industry Impulse Response Functions During Non-ZLB with Policy Rate



Note: The Median, 16th, and 84th Bayesian percentiles. Monthly horizon.