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**A Factor Augmented Vector
Autoregressive (FAVAR) approach for
Monetary Policy: Replication of the
empirical results in “Measuring the
effects of Monetary Policy”**

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A Factor Augmented Vector Autoregressive (FAVAR) approach for Monetary Policy: Replication of the empirical results in “Measuring the effects of Monetary Policy”

1 | INTRODUCTION

In recent paper, Bernanke, Boivin and Elias’s (2005) study presented a model of how the monetary policy rate affects the large subset of the variables that the researcher and policy-maker care about. Several criticisms of the Vector autoregression (VAR) approach which is developed by the considerable literature of Bernanke and Blinder (1992) and Sims (1992) to monetary policy identification center around the relatively small amount of information used by low-dimensional VARs. In that case, FAVAR methodology leads to broadly plausible estimates for the responses of a wide variety of macroeconomic variables to monetary policy shocks. Bernanke, Boivin and Elias also provided empirical support for this model based on an analysis of the federal fund rate and other macroeconomic indicators of US economy between the early 1959s and late 2001. This paper replicates the main empirical findings of Bernanke, Boivin and Elias (2005).

2 | EMPIRICAL RESULTS

Bernanke, Boivin and Elias (2005) estimated the effects of the federal fund rate to large subset of variables by using two different methodologies. The first one is a two-step principal components approach, which provides a nonparametric way of uncovering the common space spanned by the factors. The second is a single-step Bayesian likelihood approach (Gibbs sampling), which differs in various dimensions. In their paper, all series were directly taken from DRI/McGraw Hill Basic Economics Data and results were estimated by the MATLAB software.

We replicate the results of Bernanke, Boivin and Elias (2005) by using same specification (number of factors) and the same methodological approaches, but we estimate and compare the results delivered by different data source and software package. To verify the results of the Bernanke, Boivin and Elias, firstly we use the Federal Reserve Economic Data (FRED) database to take all series¹. Second, author of this replication paper, Davaajargal, created FAVAR add-ins² and BFAVAR add-ins of EViews software and used those two add-ins to estimate the main findings. Figure 1 and 2 shows, for the core results of Bernanke, Boivin and Elias (2005), impulse responses which are estimated with three factors and Federal Fund rate (FFR) by two different methodologies. Table 1 shows the variance decomposition of the policy shock from the two-step principal component approach. Except for 3-month treasury bills and 5-year treasury bonds, the contribution of monetary

¹ Please see the appendix for the data description.

² Add-in package are EViews programs that provides seamless access to user-defined programs using the standard EViews command, menu, and object interface.

policy shock ranges between 0 and 16.1 percent. The replicated results are very similar to those presented in the original article by Bernanke, Boivin and Eliasziw (2005) covering period from January 1959 to August 2001. Sample size for the data is 512 with monthly frequency. Therefore, the results from combination of FRED database and EViews Add-ins confirm the published result from combination of DRI database and MATLAB of Bernanke, Boivin and Eliasziw (2005).

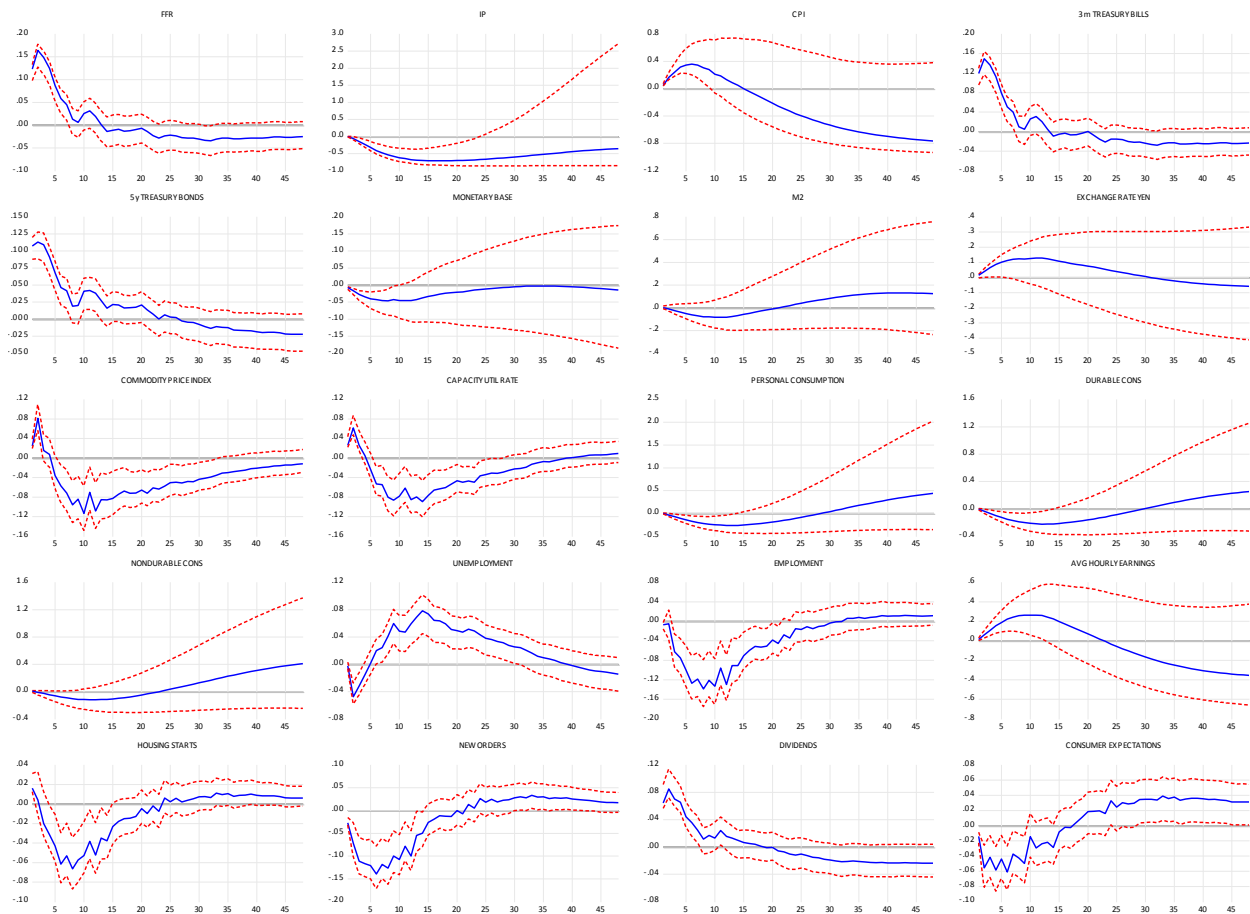


FIGURE 1 Impulse Responses Generated from FAVAR with Three Factors Estimated by Principal Components with Two-Step Bootstrap

TABLE 1 Contribution of the policy shock to variance of the common component

	Variance Decomposition	R2
Ip	0.057	0.693
Cpi	0.079	0.791
3m TREASURY BILLS	0.469	0.994
5y TREASURY BONDS	0.443	0.973
Monetary base	0.014	0.109
M2	0.003	0.043
Exchange rate yen	0.005	0.013
Commodity price index	0.052	0.640
Capacity util rate	0.101	0.779
Personal consumption	0.010	0.119
Durable cons	0.007	0.063
Nondurable cons	0.003	0.054
Unemployment	0.103	0.823
Employment	0.072	0.726
Avg hourly earnings	0.014	0.083
Housing starts	0.024	0.401
New orders	0.081	0.640

Dividends	0.161	0.553
Consumer expectations	0.042	0.679

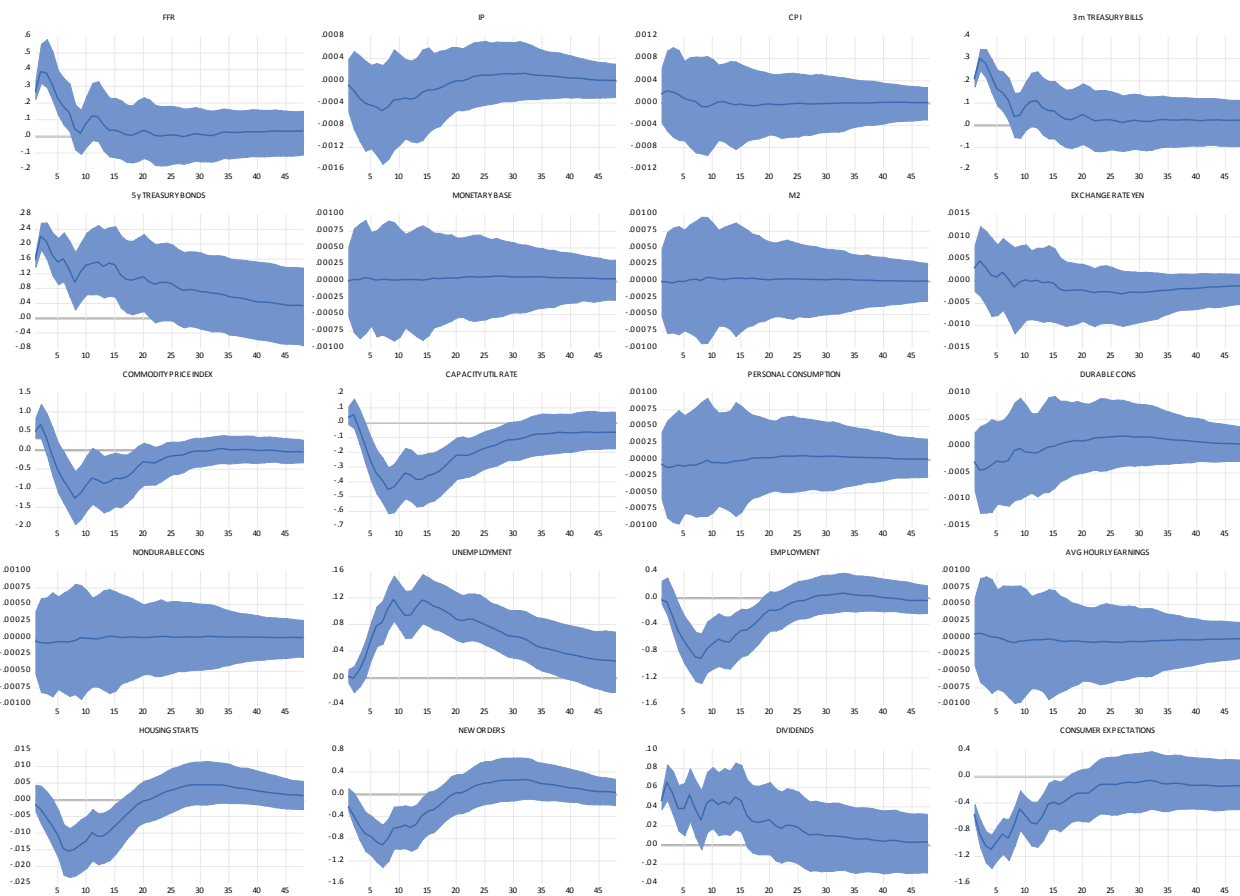


FIGURE 2 Impulse Responses Generated from FAVAR with Three Factors Estimated by Gibbs Sampling

3 | CONCLUSION

In this replication study we re-estimate the main empirical findings in Bernanke, Boivin and Elias (2005) on applying FAVAR model to estimate monetary policy shock. To verify the results of original paper, we used different data source and software package in this replication. Regardless of different data source and software package, the replicated results are very similar to those produced by the authors. Accordingly, this replication paper supports the consistency and accuracy of the empirical findings in Bernanke, Boivin and Elias (2005).

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- Bernanke, B., Boivin, J., & Elias, P. (2005). Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) approach. *Quarterly Journal of Economics*, v120, 387-422.
- Bernanke, B., & Blinder, A. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review*, 901-921.
- Sims, C., (1992). Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy. *European Economic Review*, 36, 975-1000.

APPENDIX

In the appendix, we replicated all results of the paper. We also provided the data description and the source in detail.

Figure 1. Estimated impulse responses to an identified policy shock for alternative FAVAR specification, based on the two-step principal component's approach

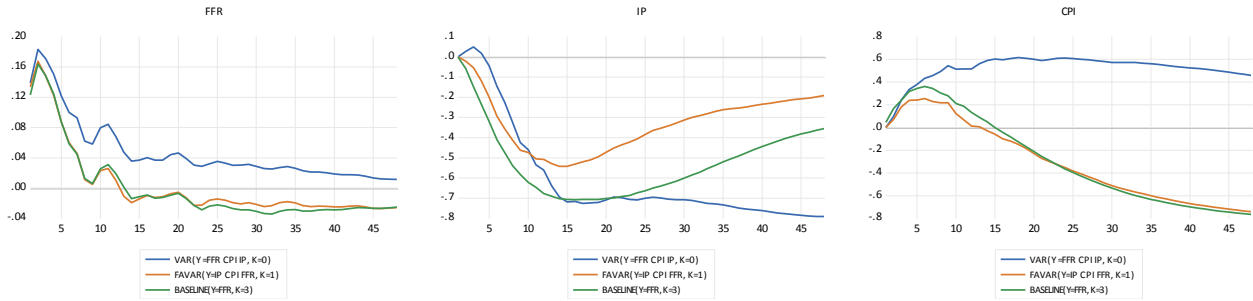


Figure 2. Impulse response generated from FAVAR with three factors and FFR estimated by principal components with two-step bootstrap

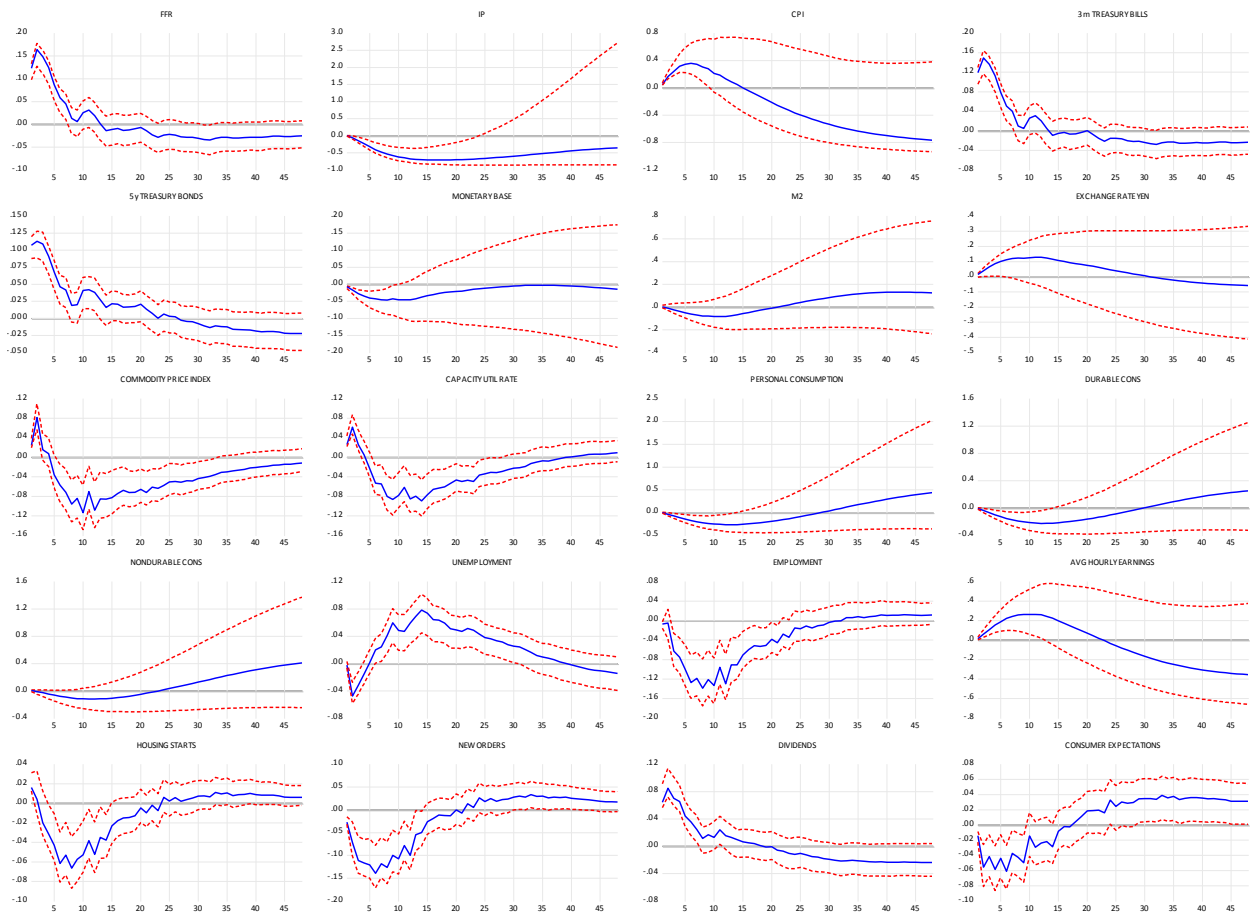


Figure 3. Impulse response generated from FAVAR with five factors and FFR estimated by principal components with two-step bootstrap

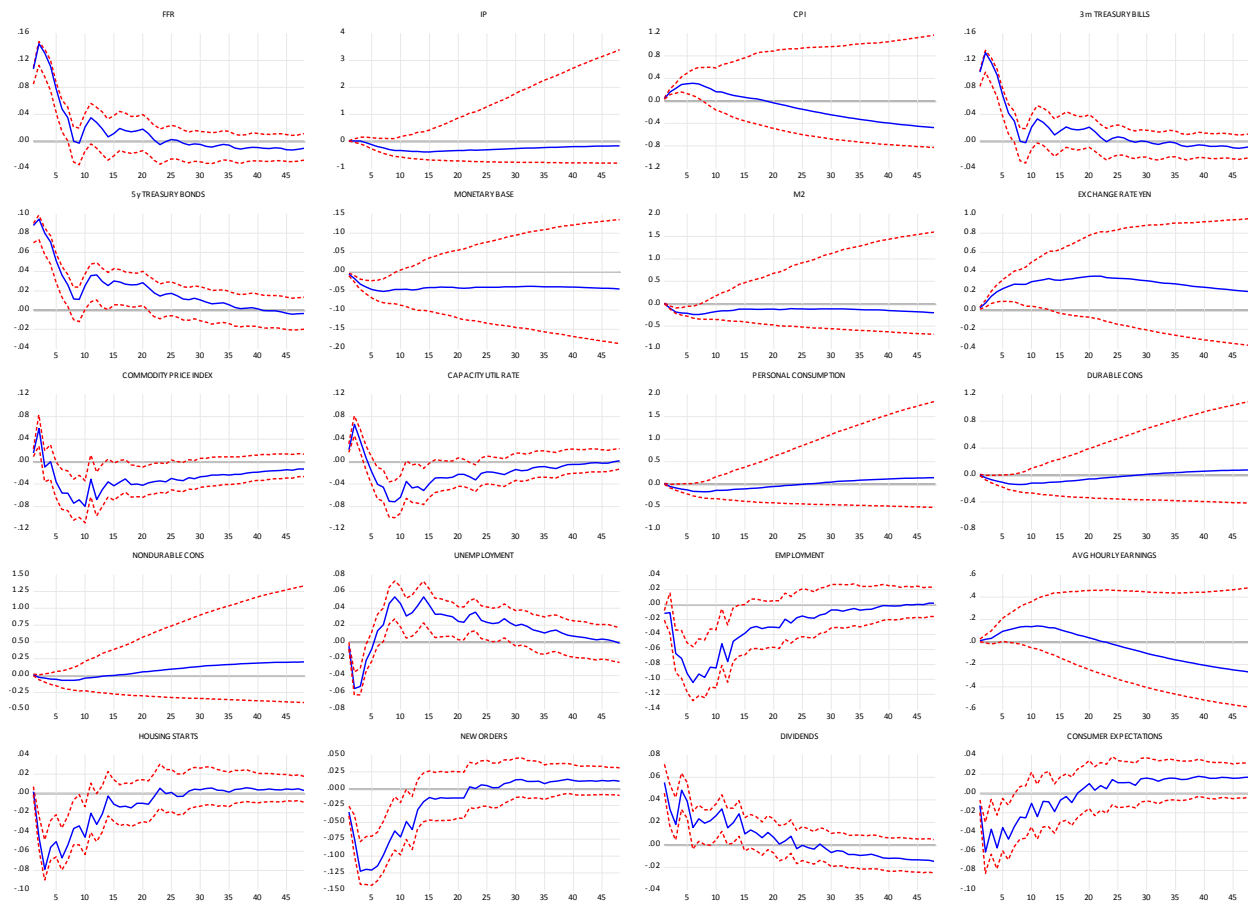


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Avg hourly earnings	0.014	0.083
Housing starts	0.024	0.401
New orders	0.081	0.640

Dividends	0.161	0.553
Consumer expectations	0.042	0.679

Figure 4. Impulse responses generated from FAVAR with three factors and FFR estimated by Gibbs Sampling

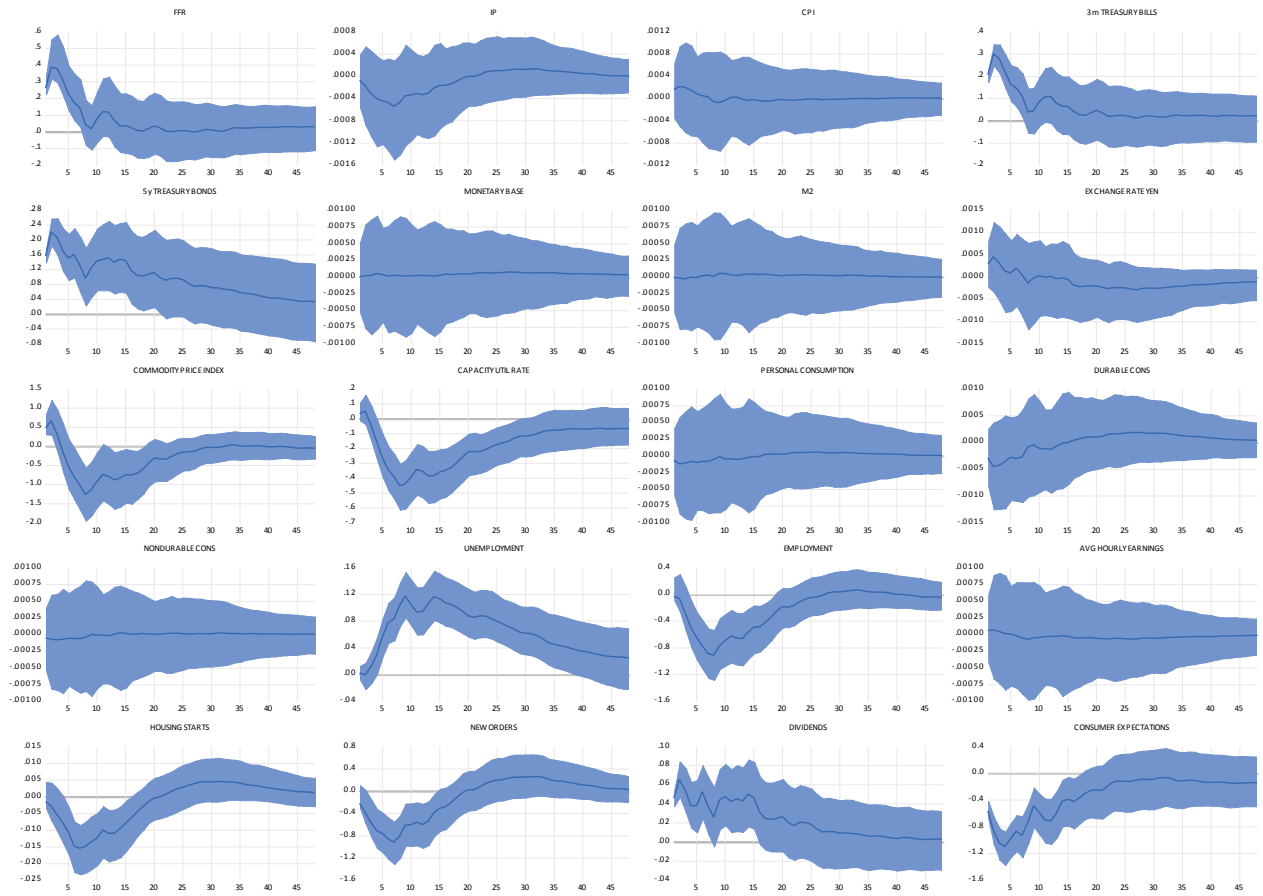
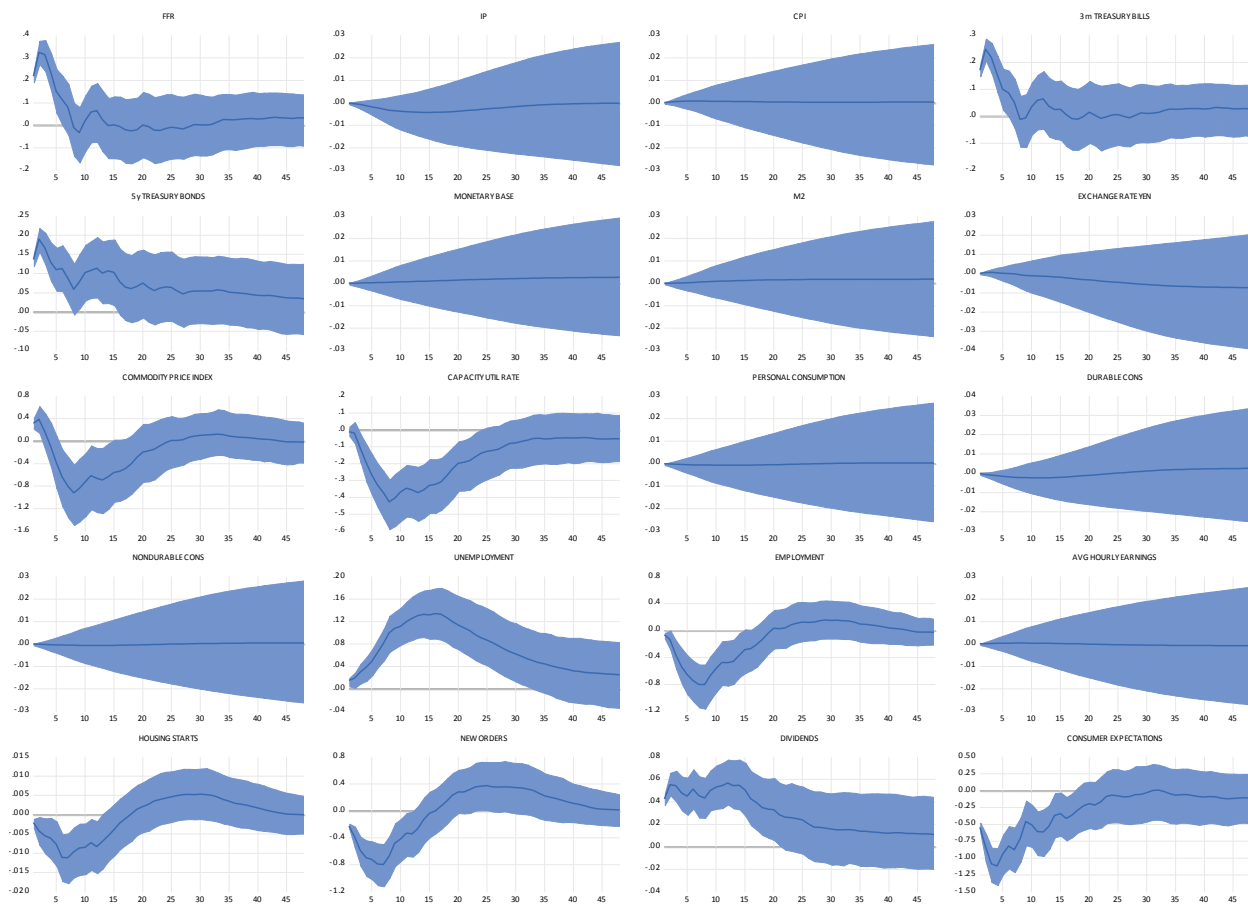


Figure 5. Impulse responses generated from FAVAR with three factors and FFR estimated by Gibbs Sampling



Data description

Bernanke, Boivin and Elias (2005) have taken 120 series from DRI/McGraw Hill Basic Economics Database. In our replication 110 series were retrieved from FRED database³ while the remaining 10 series were missing. The missing series are indicated as red colors. Format is as in Bernanke, Boivin and Elias (2005): series id number; series DRI mnemonic; series FRED mnemonic; transformation code and series description as appears in FRED database. The sample size for all monthly series is 512 (1959:01 to 2001:08).

Table 2. Data description

Real output and income				
id	DRI/McGraw	FRED	TCODE	DESCRIPTION (FRED)
1	IPP	IPFPNSS	5	IP: Final Products and Nonindustrial Supplies
2	IPF	IPFINAL	5	IP: Final Products (Market Group)
3	IPC	IPCONGD	5	IP: Consumer Goods
4	IPCD	IPDCONGD	5	IP: Durable Consumer Goods
5	IPCN	IPNCONGD	5	IP: Nondurable Consumer Goods
6	IPE	IPBUSEQ	5	IP: Business Equipment

³ McCracken and Ng (2015) have compiled large macroeconomic dataset for the United States (FRED-MD), which is available at <https://research.stlouisfed.org/econ/mccracken/fred-databases/>

IPI		IP: Intermediate products
7	IPM IPMAT	5 IP: Materials
8	IPMD IPDMAT	5 IP: Durable Materials
9	IPMND IPNMAT	5 IP: Nondurable Materials
10	IPMFG IPMANSICS	5 IP: Manufacturing (SIC)
IPD		IP: Durable manufacturing
IPN		IP: Nondurable manufacturing
11	IPMIN IPMINE	5 IP: Mining
12	IPUT IPB51222S	5 IP: Residential utilities
13	IP INDPRO	5 IP: Index
14	IPXMCA CUMFNS	1 Capacity Utilization: Manufacturing (SIC)
15	PMI NAPM	1 ISM Manufacturing: PMI Composite Index
16	PMP NAPMPI	1 ISM Manufacturing: Production Index
17	GMPYQ RPI	5 Real personal income
18	GMYPXQ W875RX1	5 Real personal income excluding current transfer receipts

Employment and hours

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
19	LHEL	HWI	5	Help-Wanted Index for United States
20	LHELX	HWIURATIO	4	Ratio of Help Wanted / No. Unemployed
21	LHEM	CLF16OV	5	Civilian Labor Force
22	LHNAG	CE16OV	5	Civilian Employment Level
23	LHUR	UNRATE	1	Civilian Unemployment Rate
24	LHU680	UEMPMEAN	1	Average (Mean) Duration of Unemployment
25	LHU5	UEMPLT5	1	Civilians Unemployed for Less Than 5 Weeks
26	LHU14	UEMP5TO14	1	Civilians Unemployed for 5 to 14 Weeks
27	LHU15	UEMP15OV	1	Civilians Unemployed for 15 Weeks and Over
28	LHU26	UEMP15T26	1	Civilians Unemployed for 15 to 26 Weeks
29	LPNAG	PAYEMS	5	All Employees: Total Nonfarm Payrolls
30	LP	CEU050000001	5	All Employees: Total Private
31	LPGD	USGOOD	5	All Employees: Goods-Producing Industries
32	LPMI	CES1021000001	5	All Employees: Mining and Logging: Mining
33	LPCC	USCONS	5	All Employees: Construction
34	LPEM	MANEMP	5	All Employees: Manufacturing
35	LPED	DMANEMP	5	All Employees: Durable Goods
36	LPEN	NDMANEMP	5	All Employees: Nondurable goods
37	LPSP	SRVPRD	5	All Employees: Service-Providing Industries
38	LPTU	USTPU	5	All Employees: Trade, Transportation and Utilities
39	LPT	USWTRADE	5	All Employees: Wholesale Trade
40	LPFR	USFIRE	5	All Employees: Financial Activities
41	LPS	USSERV	5	All Employees: Other Services

42	LPGOV	USGOVT	5	All Employees: Government
43	LPHRM	AWHMAN	1	Average Weekly Hours : Manufacturing
44	LPMOSA	AWOTMAN	1	Average Weekly Overtime Hours: Manufacturing
45	PMEMP	NAPMEI	1	ISM Manufacturing: Employment Index

Consumption

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
46	GMCQ	DPCERA3M086SBEA	5	Real personal consumption expenditures
47	GMCDQ	DDURRA3M086SBEA	5	Real personal consumption expenditures: Durable goods
48	GMCNQ	DNDGRA3M086SBEA	5	Real personal consumption expenditures: Nondurable goods
49	GMCSQ	DSERRA3M086SBEA	5	Real personal consumption expenditures: Services
	GMCANQ			Real personal consumption expenditures: New cars

Housing starts and sales

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
50	HSFR	HOUST	4	Housing Starts: Total New Privately Owned
51	HSNE	HOUSTNE	4	Housing Starts: Northeast Census Region
52	HSMW	HOUSTMW	4	Housing Starts: Midwest Census Region
53	HSSOU	HOUSTS	4	Housing Starts: South Census Region
54	HSWST	HOUSTW	4	Housing Starts: West Census Region
	HSBR			Housing Authorized: Total New Private Housing
	HMOB			Mobile Homes: Manufacturers' shipments

Real inventories, orders and unfilled orders

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
55	PMNV	NAPMII	1	ISM Manufacturing: Inventories Index
56	PMNO	NAPMNOI	1	ISM Manufacturing: New Orders Index
57	PMDEL	NAPMSDI	1	ISM Manufacturing: Supplier Deliveries Index
58	MOCMQ	A0M008*	5	Mfrs' new orders consumer goods and materials
59	MSONDQ	A0M027*	5	Mfrs' new orders nondefense capital goods

* source: The Conference Board

Stock prices

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
	FSNCOM			NYSE Common Stock Price Index: Composite
60	FSPCOM	S&P 500	5	S&P's Common Stock Price Index: Composite
61	FSPIN	S&P: indust	5	S&P's Common Stock Price Index: Industrials
	FSPCAP			S&P's Common Stock Price Index: Capital goods
	FSPUT			S&P's Common Stock Price Index: Utilities
62	FSDXP	S&P div yield	1	S&P's Composite Common Stock: Dividend Yield
63	FSPXE	S&P PE ratio	1	S&P's Composite Common Stock: Price-Earnings Ratio

Exchange rates

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
64	EXRSW	EXSZUSx	5	Switzerland / U.S. Foreign Exchange Rate
65	EXRJAN	EXJPUSx	5	Japan / U.S. Foreign Exchange Rate
66	EXRUK	EXUSUKx	5	U.S. / U.K. Foreign Exchange Rate
67	EXRCAN	EXCAUSx	5	Canada / U.S. Foreign Exchange Rate

Interest rates

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
68	FYFF	FEDFUNDS	1	Effective Federal Funds Rate
69	FYGM3	TB3MS	1	3-Month Treasury Bill: Secondary Market Rate
70	FYGM6	TB6MS	1	6-Month Treasury Bill: Secondary Market Rate
71	FYGT1	GS1	1	1-Year Treasury Constant Maturity Rate
72	FYGT5	GS5	1	5-Year Treasury Constant Maturity Rate
73	FYGT10	GS10	1	10-Year Treasury Constant Maturity Rate
74	FYAAAC	AAA	1	Moody's Seasoned Aaa Corporate Bond Yield
75	FYBAAC	BAA	1	Moody's Seasoned Baa Corporate Bond Yield
76	SFYGM3	TB3SMFFM	1	3-Month Treasury Bill Minus Federal Funds Rate
77	SFYGM6	TB6SMFFM	1	6-Month Treasury Bill Minus Federal Funds Rate
78	SFYGT1	T1YFFM	1	1-Year Treasury Constant Maturity Minus Federal Funds Rate
79	SFYGT5	T5YFFM	1	5-Year Treasury Constant Maturity Minus Federal Funds Rate
80	SFYGT10	T10YFFM	1	10-Year Treasury Constant Maturity Minus Federal Funds Rate
81	SFYAAAC	AAAFFM	1	Moody's Seasoned Aaa Corporate Bond Minus Federal Funds Rate
82	SFYBAAC	BAAFFM	1	Moody's Seasoned Baa Corporate Bond Minus Federal Funds Rate

Money and credit quantity aggregates

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
83	FM1	M1SL	5	M1 Money Stock
84	FM2	M2SL	5	M2 Money Stock
85	FM3	M3SL	5	M3 Money Stock
86	FM2DQ	M2REAL	5	Real M2 Money Stock
87	FMFBA	AMBSL	5	St. Louis Adjusted Monetary Base
88	FMRRA	TOTRESNS	5	Total Reserves of Depository Institutions
89	FMRNBA	NONBORRES	5	Reserves of Depository Institutions, Nonborrowed
90	FCLNQ	BUSLOANS	5	Commercial and Industrial Loans, All Commercial Banks
	FCLBMC			Wlky RP LG Com. Banks: net change com & ind. Loans

91	CCINRV	NONREVSL	5	Total Nonrevolving Credit Owned and Securitized, Outstanding
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Price Indexes

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
92	PMCP	NAPMPRI	1	ISM Manufacturing: Prices Index
93	PWFSA	WPSFD49207	5	PPI: Commodity for Final Demand: Finished Goods
94	PWFCSA	WPSFD49502	5	PPI: Commodity for Final Demand: Finished Consumer Goods
95	PWIMSA	WPSID61	5	PPI: Processed Goods for Intermediate Demand
96	PWCMSA	WPSID62	5	PPI: Unprocessed Goods for Intermediate Demand
97	PSM99Q*	A0M099	5	Index of Sensitive Materials Prices
98	PUNEW	CPIAUCSL	5	CPI for All Urban Consumers: All Items
99	PU83	CPIAPPSL	5	CPI for All Urban Consumers: Apparel
100	PU84	CPITRNSL	5	CPI for All Urban Consumers: Transportation
101	PU85	CPIMEDSL	5	CPI for All Urban Consumers: Medical care
102	PUC	CUSR0000SAC	5	CPI for All Urban Consumers: Commodities
103	PUCD	CUSR0000SAD	5	CPI for All Urban Consumers: Durables
104	PUS	CUSR0000SAS	5	CPI for All Urban Consumers: Services
105	PUXF	CPIULFSL	5	CPI for All Urban Consumers: All Items Less Food
106	PUXHS	CUSR0000SA0L2	5	CPI for All Urban Consumers: All Items Less Shelter
107	PUXM	CUSR0000SA0L5	5	CPI for All Urban Consumers: All Items Less Medical care

*source: The Conference Board

Average hourly earnings

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
108	LEHCC	CES2000000008	5	Average Hourly Earnings: Construction
109	LEHM	CES3000000008	5	Average Hourly Earnings: Manufacturing

Miscellaneous

id	DRI/McGraw	FRED	TCODE	DESCRIPTION
110	HHSNTN	U0M093*	1	Consumer expectation index (U. OF. MICHIGAN)

*source: The Conference Board

References

Bernanke, B., Boivin, J., & Elias, P. (2005). Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) approach. *Quarterly Journal of Economics*, v120, 387-422.

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