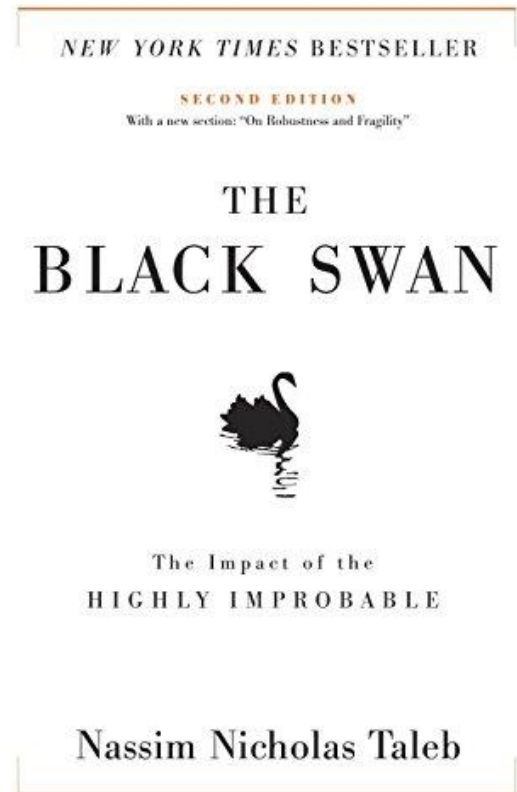
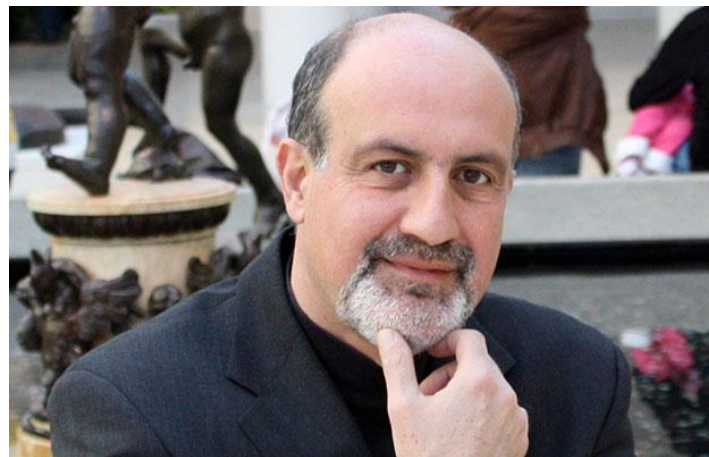


Uncertainty, Consumption, and Housing Market in the United States

Hsiang Huang

May 8, 2020

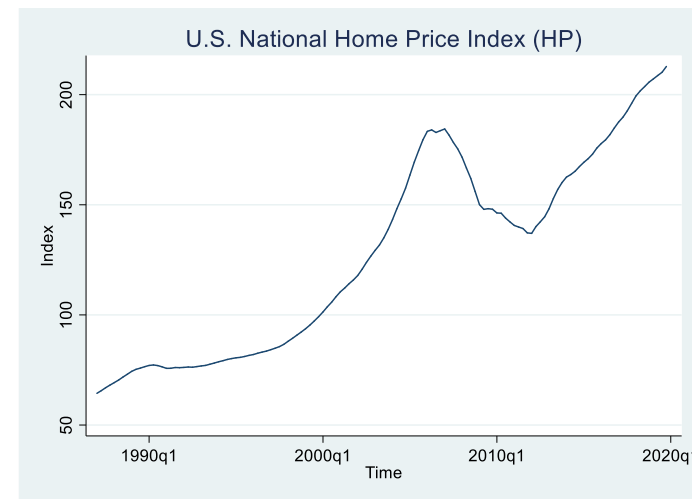
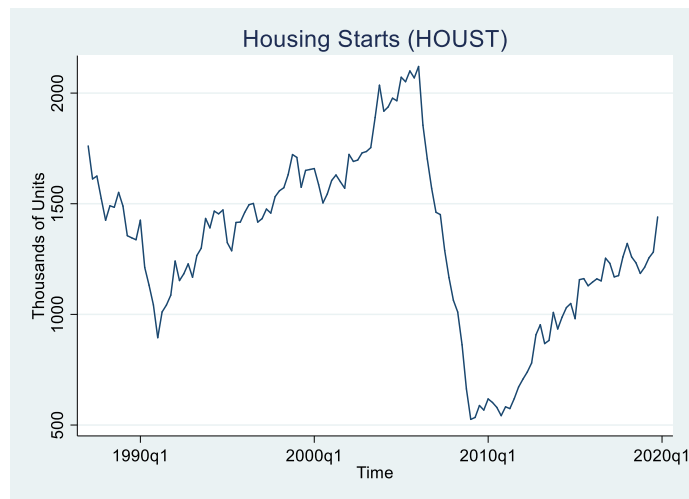
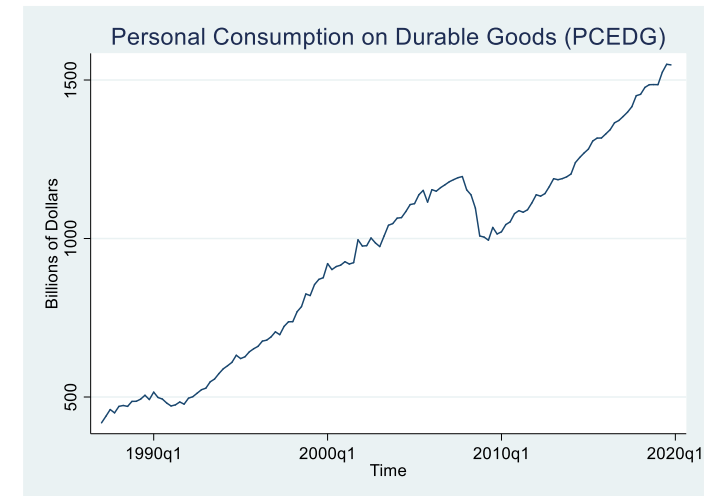
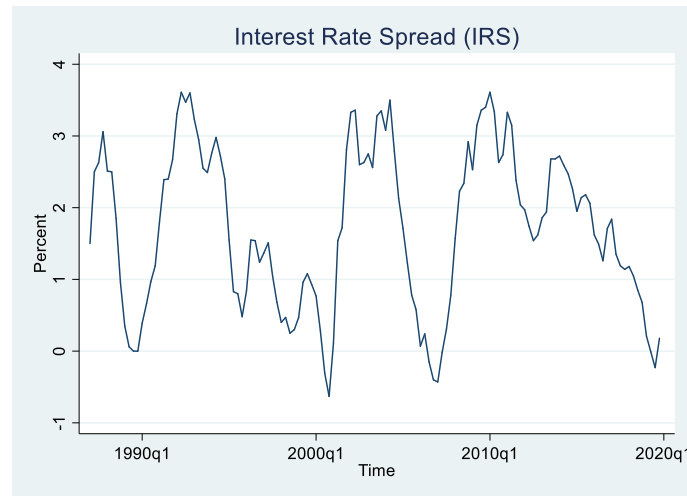
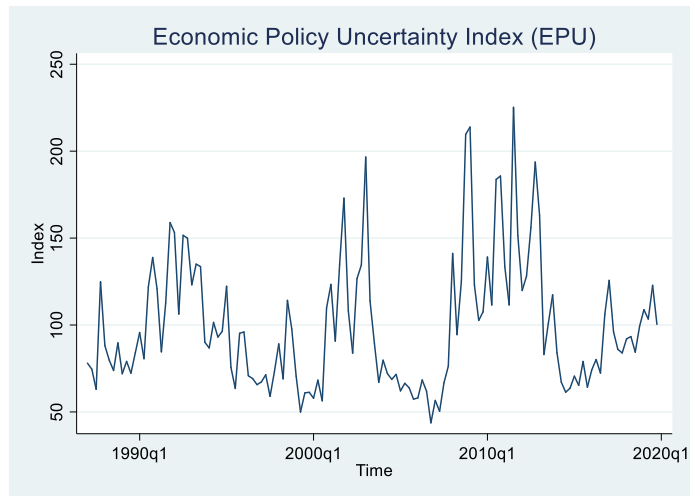
- Objective: To quantify the effect of the economic uncertainty on durable goods and housing consumption.
- Motivation: “Black swan comes from our misunderstanding of the likelihood of surprises.”
 - Nassim Nicholas Taleb (2007)



- **Economic Policy Uncertainty (EPU) Index** carries predictive information for housing returns and the volatility. It tends to increase housing output and decrease house price inflation. (Antonakakis et al., 2015; Christidou and Fountas, 2017)
- **Interest rate spread** has been used to predict the probability of recession, or reflect the pessimistic sentiments for economy in the future by Wall Street and researchers. (Benzoni et al., 2018; Estrella and Mishkin, 1998; Zaloom, 2009)
- Lastrapes and Potts (2006) and Barsky et al. (2007) used VAR to investigate the different responses of the **durable goods consumption** and housing spending to the monetary supply shocks in the United States.
- There are though limited research investigating the shocks from term spread to the consumptions and the housing activities.

- **Structural VAR** model is used to investigate the contemporaneous relations among endogenous variables. The impulse response provides the insight of how shocks in the one variable affect another variable.
- Musso et al. (2011) found that the contractionary monetary policy, or shocks in short term interest rate, does not have strong explanatory ability on mortgage market in the United States.
- Sum and Brown (2012) used SAVR model and found that EPU affects the housing returns but not vice versa during 1985-2011 in the United States.
- Wadud et al. (2012) proposed a 9-variable structural VAR model to quantify the relationship between endogenous variables in Australia, including GDP, inflation, **housing price, housing output**, federal fund rate, exchange rate, etc.

- Quarterly data during 1987Q1 to 2019Q4 (132 observations) retrieved from the Federal Reserve Bank of St. Louis include:



Variable	Description	Form	Order of integration
Economic Policy Uncertainty Index (EPU)	1. 10 major newspapers coverage of “uncertainty” 2. Number of federal tax expired in future years 3. Disagreement with economic forecasting	L_EPU	I(0)
Interest Rate Spread (IRS)	10-Year Minus 3-Month Treasury Constant Maturity, or “Inverted Yield Curve”	M_IRS	I(1)
Personal Consumption Expenditure on Durable Goods (PCEDG)	Tangible commodities purchased by consumers that can be used repeatedly or continuously for a prolonged period	L_PCEDG	I(1)
Housing Price (HP)	S&P/Case-Shiller U.S. National Home Price Index, or residential, repeat-sales real estate prices	L_HP	I(2)
Housing Starts (HOUST)	New privately owned housing units started, or the quantity, activity in housing sector	L_HOUST	I(1)

$$A_0 Z_t = A_1(L) Z_t + B \varepsilon_t$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} L_EPU \\ M_IRS \\ L_PCEDG \\ L_HP \\ L_HOUST \end{bmatrix} = \begin{bmatrix} x & 0 & 0 & 0 & 0 \\ 0 & x & 0 & 0 & 0 \\ 0 & 0 & x & 0 & 0 \\ 0 & 0 & 0 & x & 0 \\ 0 & 0 & 0 & 0 & x \end{bmatrix} \begin{bmatrix} \varepsilon^{L_EPU} \\ \varepsilon^{M_IRS} \\ \varepsilon^{L_PCEDG} \\ \varepsilon^{L_HP} \\ \varepsilon^{L_HOUST} \end{bmatrix}$$

$$\text{where } A_1(L) = \sum_{i=1}^q A_{1i} L^i$$

$$\text{and } \Sigma_{\varepsilon} = E[\varepsilon_t \varepsilon_t'] = I$$

Cholesky decomposition suggests we need at least $\frac{n^2-n}{2}$ restrictions for n variables to avoid the identification problem.

1. Contemporaneous relations
2. Shocks of Economic Policy Uncertainty and Inverted Yield Curve
3. Shocks of Housing Market and Durables Consumption
4. Stability check

1-1 Estimated coefficients (standard error)

	L_EPU	M_IRS	L_PCEDG	L_HP	L_HOUST
L_EPU	1	0	0	0	0
M_IRS	0.0552286 (0.124141)	1	0	0	0
L_PCEDG	0.0202734* (0.006939)	-0.0003781 (0.004898)	1	0	0
L_HP	0.0050291* (0.001852)	-0.0000181 (0.001266)	-0.0272708 (0.022678)	1	0
L_HOUST	-0.0193335 (0.020599)	0.0317347* (0.013704)	-1.282367* (0.246721)	-2.491581* (0.948896)	1

Note: * indicates statistical significance at 97.5% level.

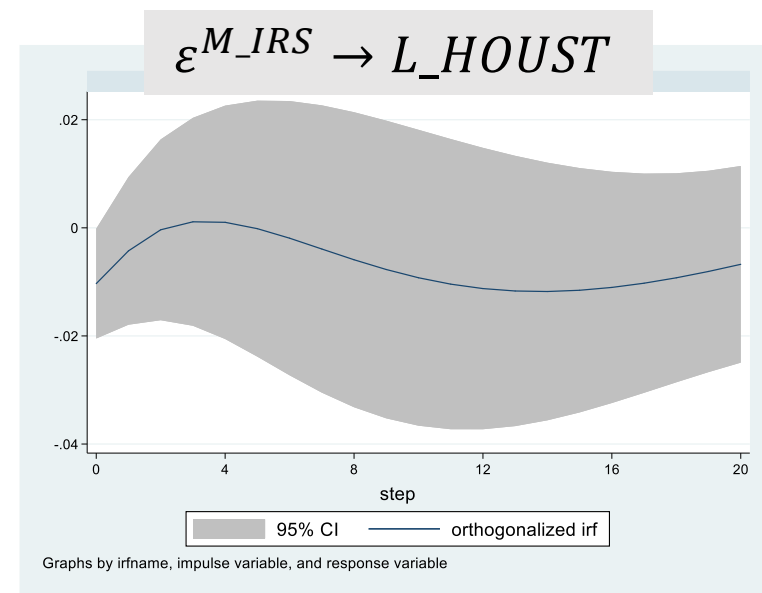
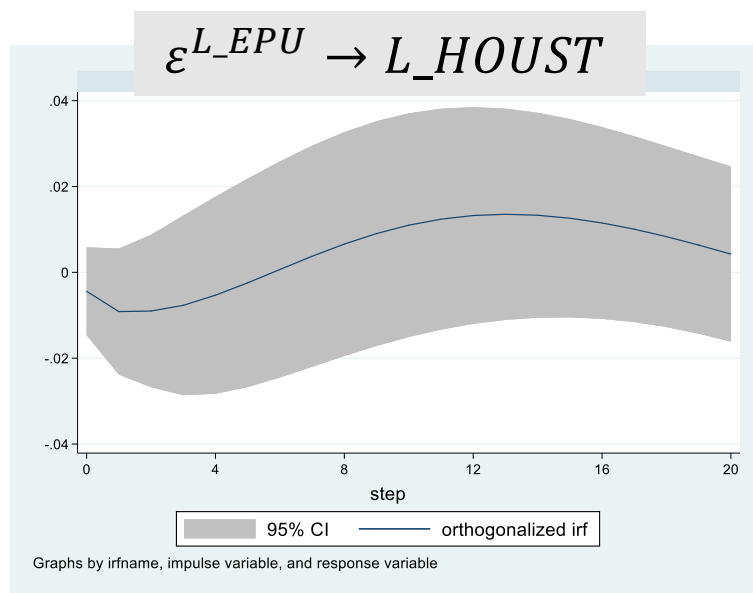
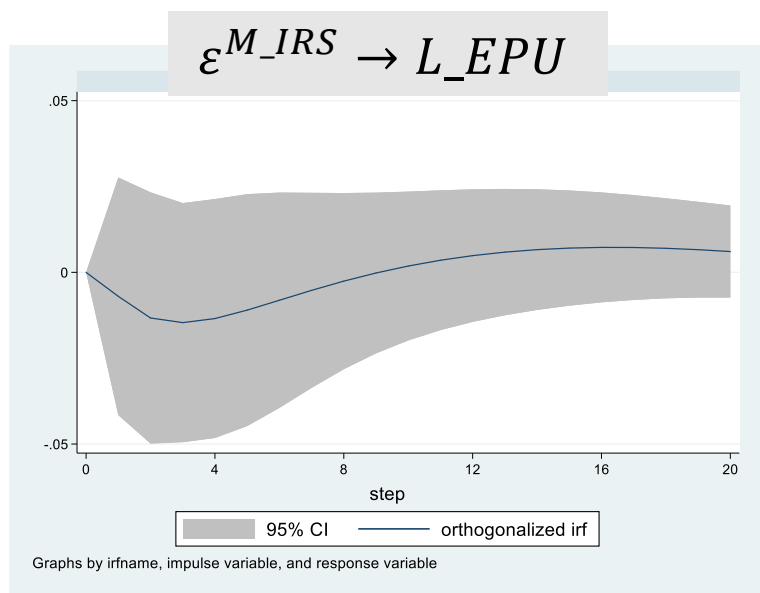
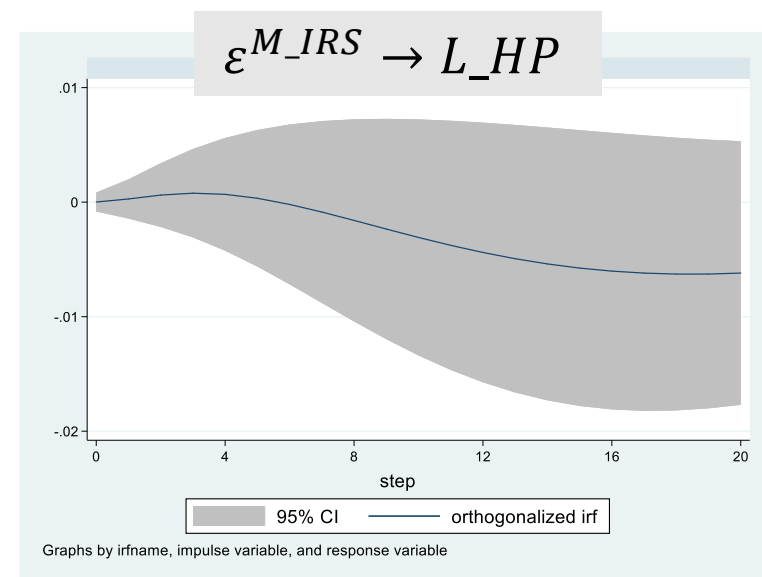
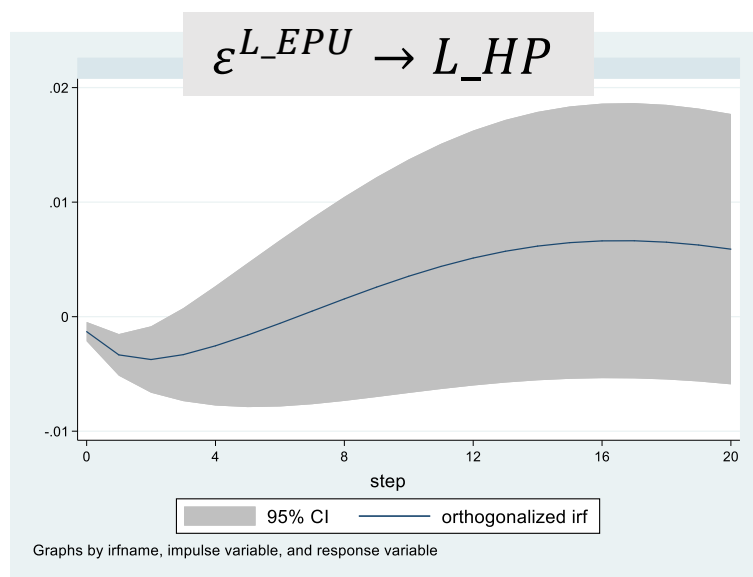
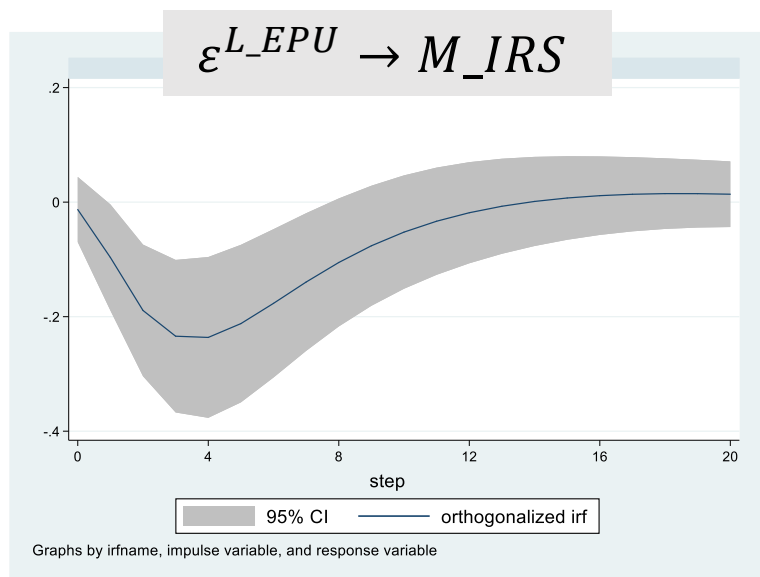
1-2 Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
L_EPU	M_IRS	0.82457	2	0.662
L_EPU	L_PCEDG	0.76269	2	0.683
L_EPU	L_HP	0.10141	2	0.951
L_EPU	L_HOUST	6.2159	2	0.045
L_EPU	ALL	13.355	8	0.100
M_IRS	L_EPUI	15.377	2	0.000
M_IRS	L_PCEDG	5.1074	2	0.078
M_IRS	L_HP	0.26088	2	0.878
M_IRS	L_HOUST	2.4627	2	0.292
M_IRS	ALL	26.092	8	0.001
L_PCEDG	L_EPUI	0.43053	2	0.806
L_PCEDG	M_IRS	2.7278	2	0.256
L_PCEDG	L_HP	7.7156	2	0.021
L_PCEDG	L_HOUST	1.5827	2	0.453
L_PCEDG	ALL	20.928	8	0.007

Equation	Excluded	chi2	df	Prob > chi2
L_HP	L_EPUI	17.422	2	0.000
L_HP	M_IRS	1.9863	2	0.370
L_HP	L_PCEDG	10.475	2	0.005
L_HP	L_HOUST	3.8188	2	0.148
L_HP	ALL	42.483	8	0.000
L_HOUST	L_EPUI	1.4996	2	0.472
L_HOUST	M_IRS	1.1798	2	0.554
L_HOUST	L_PCEDG	4.3719	2	0.112
L_HOUST	L_HP	24.915	2	0.000
L_HOUST	ALL	36.791	8	0.000

H_0 : Coefficients on the two lags of all the endogenous variables are jointly zero.

2-1 Shocks of Economic Policy Uncertainty and Inverted Yield Curve



2-2 Forecast Error Variance Decomposition (FEVD)

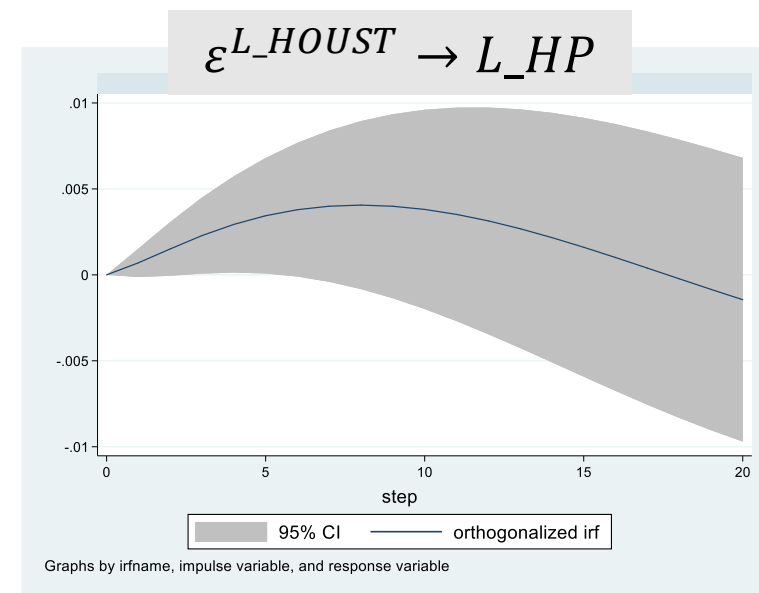
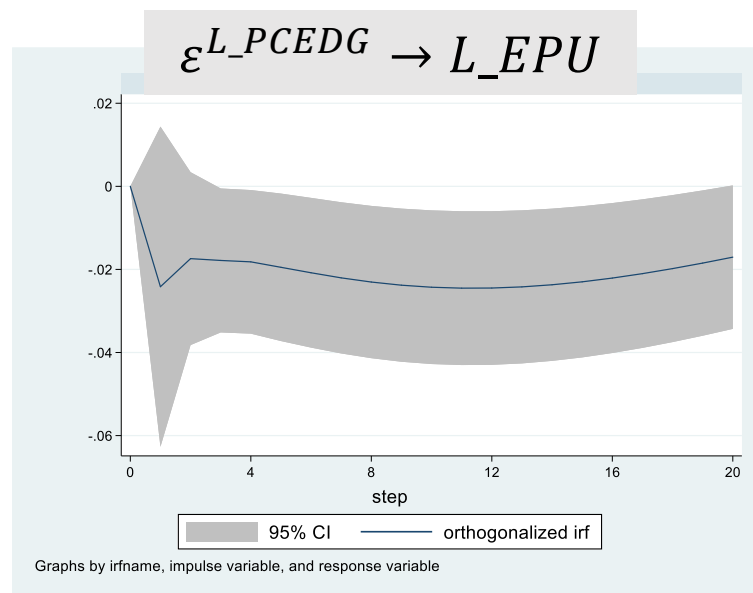
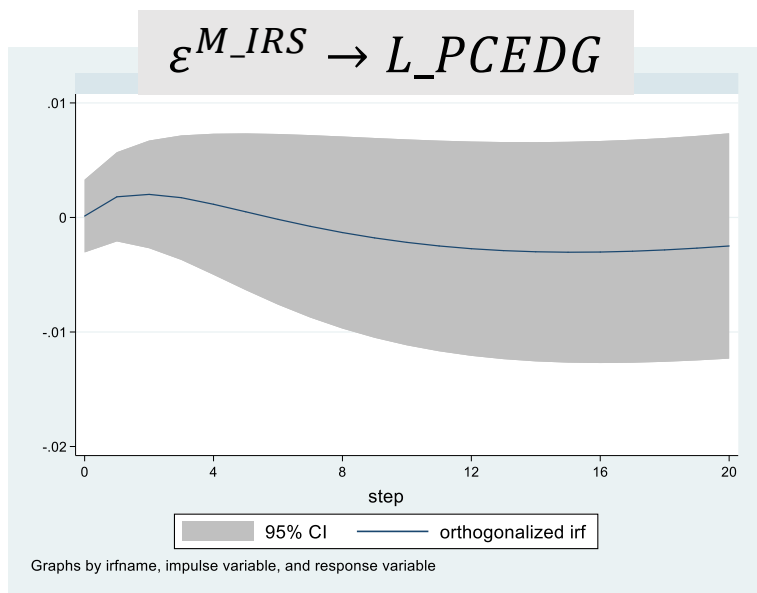
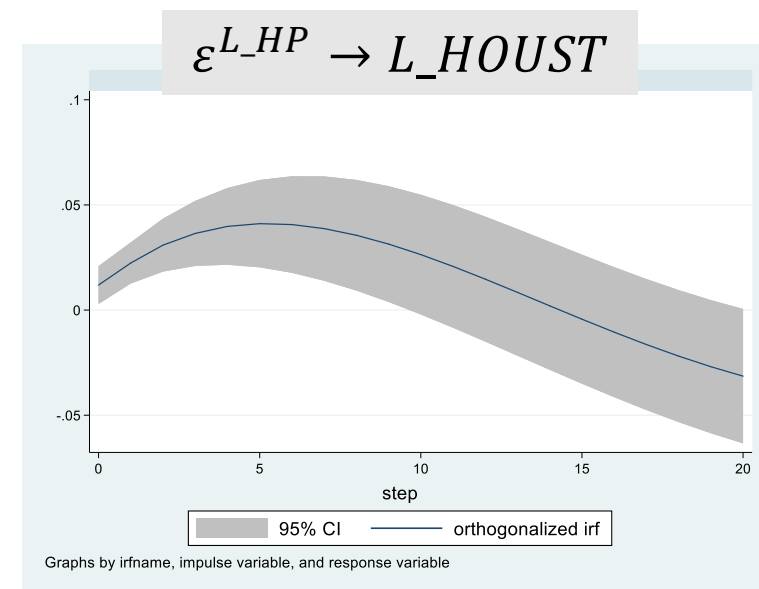
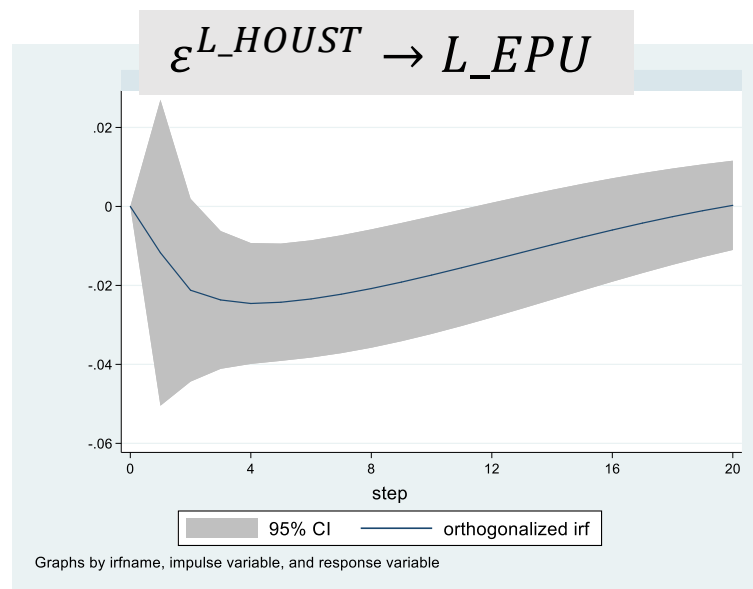
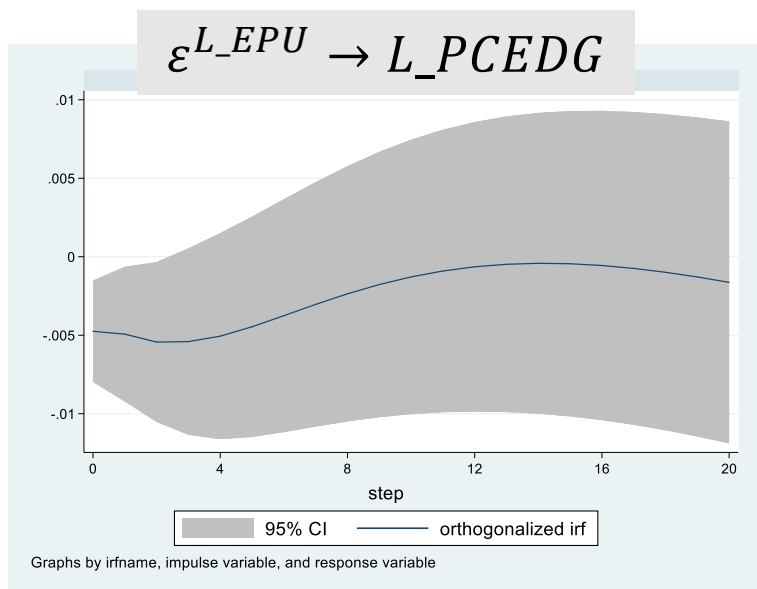
EFVD of economic policy uncertainty (L_EPU)

Step	L_EPU	M_IRS	L_PCEDG	L_HP	L_HOUST
1	1	0	0	0	0
2	0.989529	0.000654	0.007838	0.000132	0.001847
3	0.977534	0.002790	0.010990	0.001402	0.007284
4	0.962368	0.005248	0.014389	0.004279	0.013716
5	0.945710	0.007216	0.017856	0.008836	0.020382
6	0.928487	0.008429	0.021771	0.014700	0.026613
7	0.911351	0.008990	0.026138	0.021345	0.032175
8	0.894793	0.009118	0.030935	0.028197	0.036957
9	0.879220	0.009027	0.036078	0.034735	0.040940
10	0.864958	0.008881	0.041464	0.040549	0.044148
11	0.852225	0.008785	0.046983	0.045364	0.046643
12	0.841128	0.008797	0.052528	0.049045	0.048503
13	0.831667	0.008935	0.057996	0.051585	0.049817
14	0.823744	0.009194	0.063293	0.053090	0.050679
15	0.817184	0.009551	0.068337	0.053749	0.051180
16	0.811762	0.009973	0.073051	0.053809	0.051404
17	0.807220	0.010428	0.077373	0.053551	0.051428
18	0.803289	0.010880	0.081252	0.053262	0.051316
19	0.799711	0.011302	0.084648	0.053217	0.051122
20	0.796248	0.011669	0.087539	0.053656	0.050888

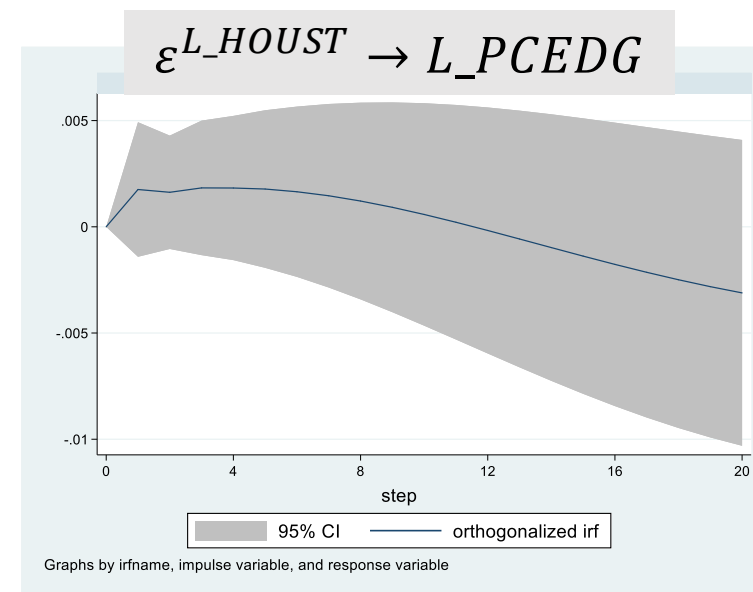
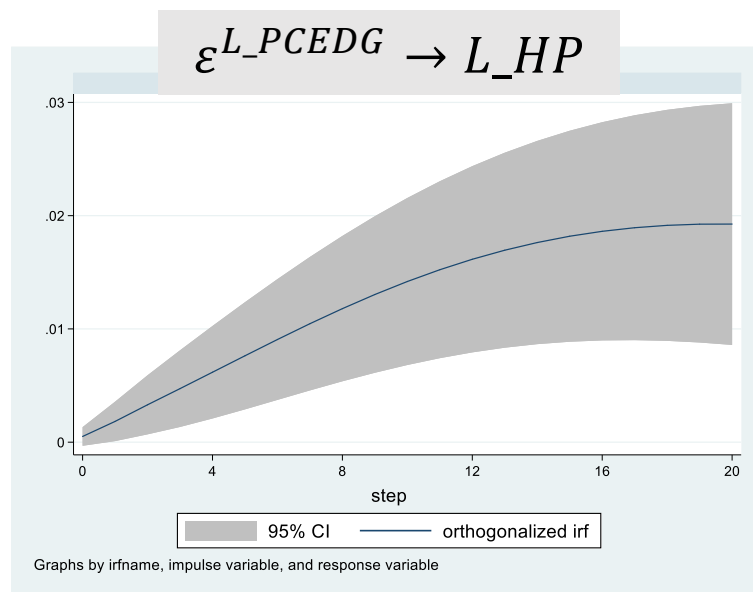
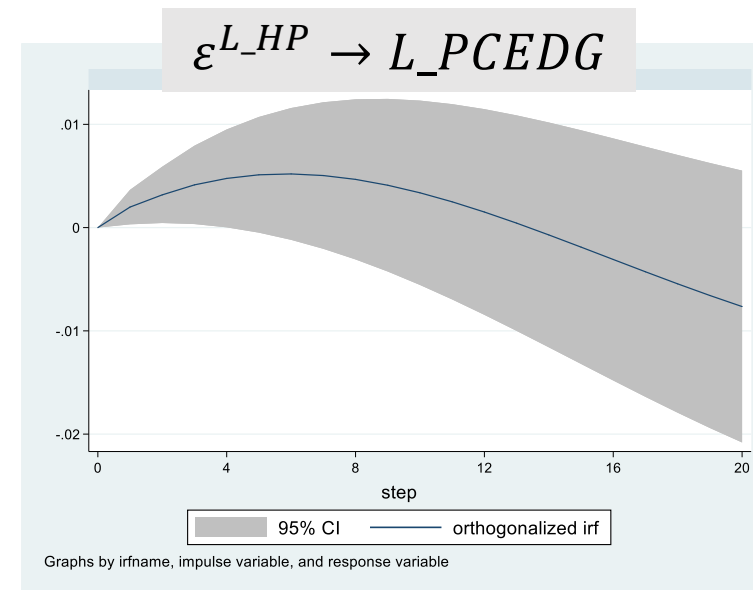
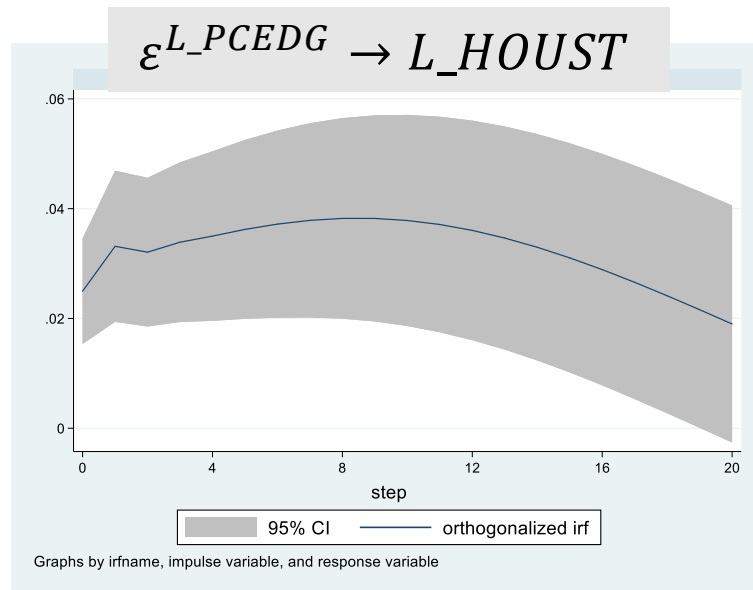
FEVD of inverted yield curve (M_IRS)

Step	L_EPU	M_IRS	L_PCEDG	L_HP	L_HOUST
1	0.001520	0.998480	0	0	0
2	0.032059	0.954282	0.007046	0.000473	0.006140
3	0.092923	0.891234	0.005885	0.001053	0.008905
4	0.153659	0.828315	0.004567	0.001958	0.011501
5	0.200802	0.777772	0.003967	0.003269	0.014189
6	0.232475	0.740818	0.004429	0.005088	0.017190
7	0.251519	0.714612	0.005979	0.007439	0.020451
8	0.261566	0.695825	0.008514	0.010259	0.023836
9	0.265751	0.681798	0.011884	0.013398	0.027169
10	0.266409	0.670745	0.015915	0.016642	0.030289
11	0.265146	0.661595	0.020428	0.019758	0.033074
12	0.262994	0.653768	0.025256	0.022534	0.035448
13	0.260578	0.646974	0.030249	0.024814	0.037385
14	0.258247	0.641070	0.035277	0.026513	0.038893
15	0.256171	0.635972	0.040229	0.027620	0.040008
16	0.254407	0.631603	0.045012	0.028199	0.040780
17	0.252944	0.627875	0.049548	0.028368	0.041265
18	0.251731	0.624683	0.053772	0.028290	0.041524
19	0.250701	0.621902	0.057634	0.028153	0.041610
20	0.249780	0.619401	0.061094	0.028150	0.041575

3-1 Shocks of Housing Market and Durables Consumption



3-2 Shocks of Housing Market and Durables Consumption



3-3 Forecast Error Variance Decomposition (FEVD)

FEVD of housing price (L_HP)

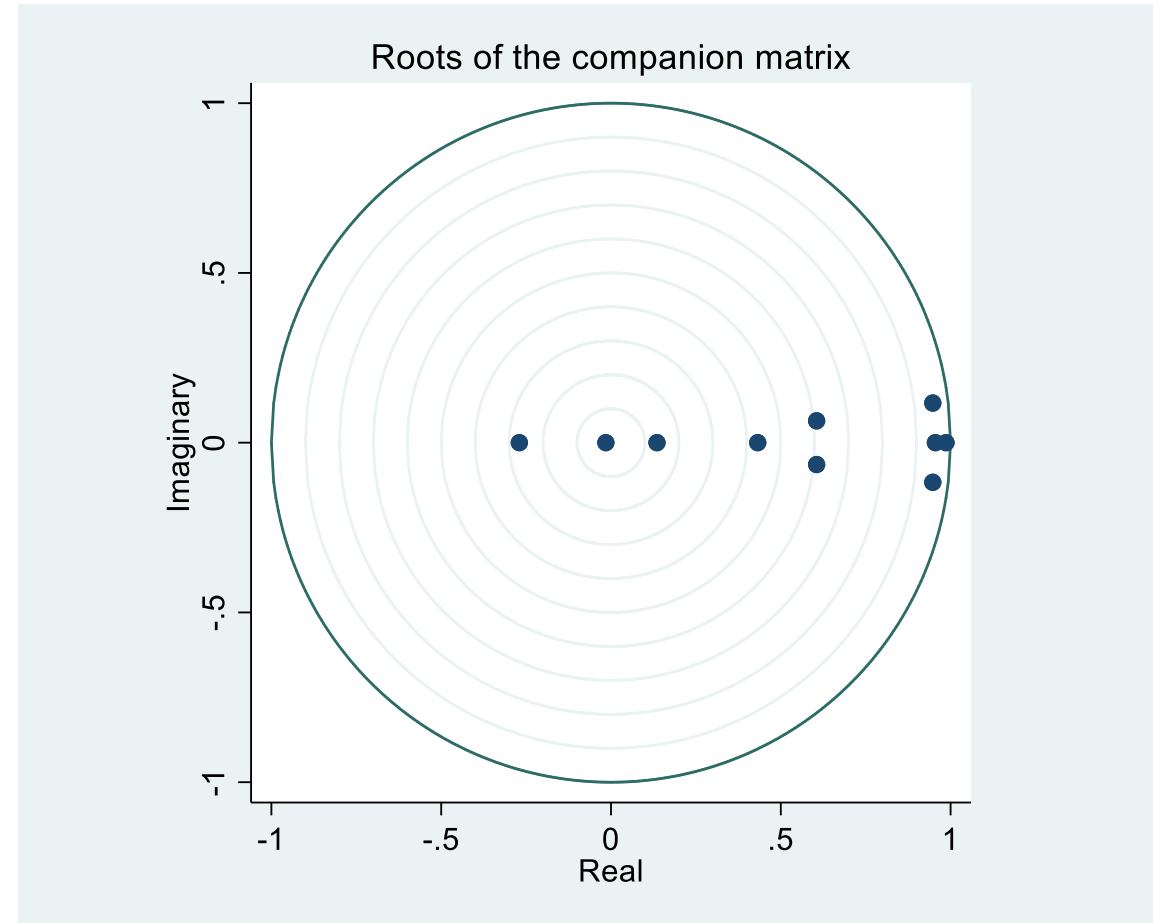
Step	L_EPU	M_IRS	L_PCEDG	L_HP	L_HOUST
1	0.068714	3.60E-06	0.010245	0.921038	0
2	0.109225	0.000653	0.030726	0.855218	0.004178
3	0.090615	0.001539	0.048967	0.849530	0.009350
4	0.066619	0.001876	0.064900	0.852531	0.014074
5	0.047403	0.001638	0.080248	0.852935	0.017774
6	0.033663	0.001181	0.095626	0.849109	0.020421
7	0.024411	0.000871	0.111325	0.841262	0.022131
8	0.018622	0.000953	0.127446	0.829918	0.023061
9	0.015482	0.001543	0.144012	0.815602	0.023360
10	0.014358	0.002662	0.161020	0.798800	0.023160
11	0.014746	0.004268	0.178455	0.779951	0.022579
12	0.016239	0.006290	0.196296	0.759457	0.021718
13	0.018495	0.008643	0.214518	0.737679	0.020665
14	0.021232	0.011239	0.233081	0.714948	0.019500
15	0.024215	0.013993	0.251932	0.691569	0.018291
16	0.027248	0.016825	0.270992	0.667833	0.017102
17	0.030171	0.019660	0.290162	0.644019	0.015987
18	0.032857	0.022430	0.309312	0.620405	0.014995
19	0.035206	0.025074	0.328287	0.597265	0.014168
20	0.037148	0.027535	0.346908	0.574870	0.013539

FEVD of housing starts (L_HOUST)

Step	L_EPU	M_IRS	L_PCEDG	L_HP	L_HOUST
1	0.005449	0.029868	0.174765	0.039784	0.750134
2	0.013974	0.016890	0.233251	0.087177	0.648709
3	0.016068	0.010879	0.239750	0.139240	0.594063
4	0.015371	0.007961	0.246255	0.184809	0.545604
5	0.013382	0.006259	0.252376	0.222085	0.505899
6	0.011225	0.005138	0.260182	0.250538	0.472916
7	0.009592	0.004510	0.269636	0.270746	0.445517
8	0.008860	0.004430	0.280575	0.283571	0.422563
9	0.009168	0.004943	0.292675	0.290032	0.403182
10	0.010473	0.006034	0.305584	0.291216	0.386692
11	0.012610	0.007634	0.318934	0.288257	0.372565
12	0.015339	0.009630	0.332335	0.282320	0.360376
13	0.018384	0.011886	0.345372	0.274588	0.349771
14	0.021471	0.014253	0.357601	0.266240	0.340434
15	0.024346	0.016584	0.368565	0.258424	0.332081
16	0.026801	0.018741	0.377810	0.252202	0.324446
17	0.028687	0.020608	0.384923	0.248497	0.317285
18	0.029927	0.022097	0.389569	0.248022	0.310385
19	0.030519	0.023156	0.391535	0.251221	0.303569
20	0.030531	0.023773	0.390762	0.258231	0.296703

4. Stability check

Eigenvalue			Modulus
0.986292			0.986292
0.955193			0.955193
0.947493	+	.1167337i	0.954657
0.947493	-	.1167337i	0.954657
0.605404	+	.06433314i	0.608812
0.605404	-	.06433314i	0.608812
0.432086			0.432086
-0.269940			0.269940
0.135377			0.135377
-0.015210			0.015207



All the eigenvalues lie inside the unit circle. VAR satisfies stability condition.

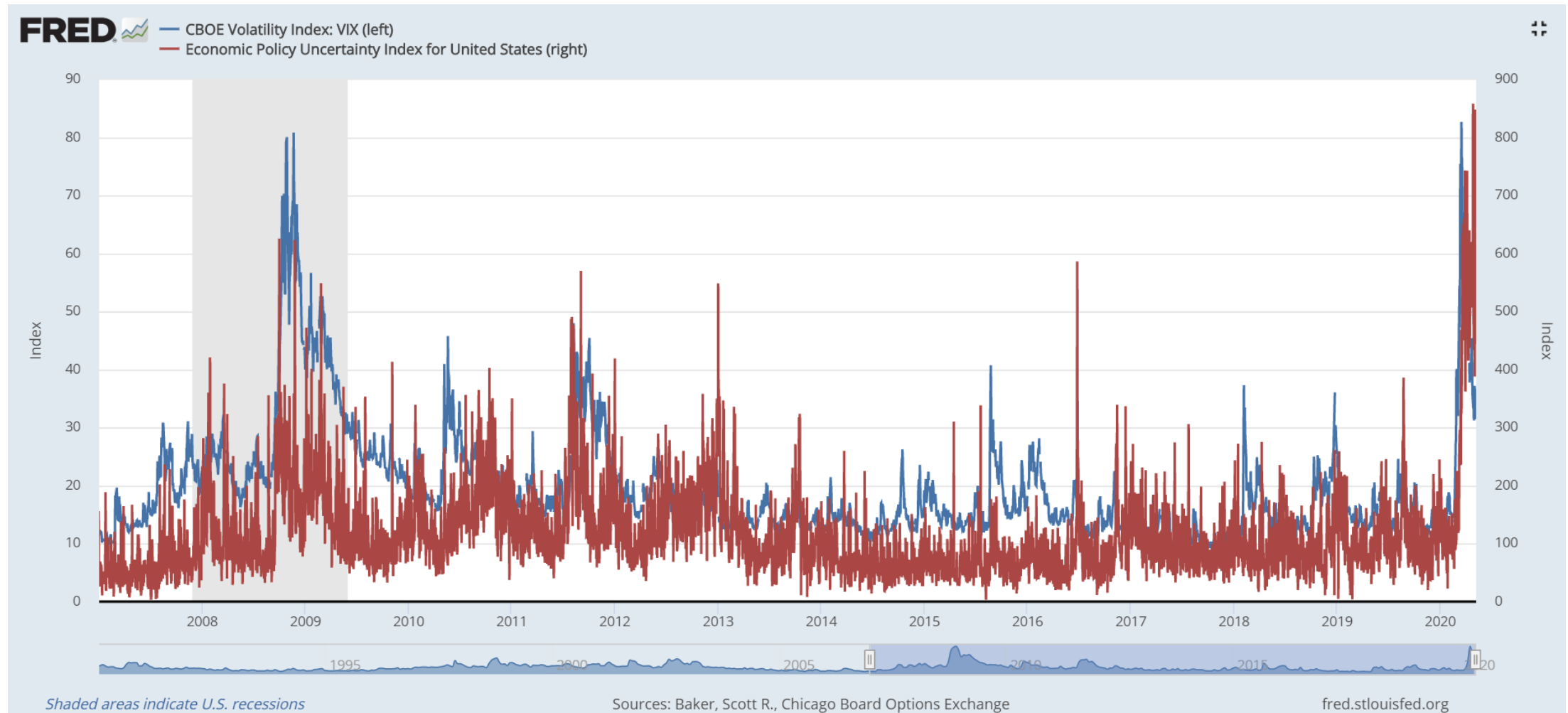
Conclusion

- Compared to the inverted yield curve risk, Economic Policy Uncertainty Index offers a better explanation of the movements of housing price, which is aligned with previous research. (Antonakakis et al., 2015; Benzoni et al., 2018)
- The shock of EPU leads to a decline in housing price and consumption on durable goods. It also causes inverted yield curve risks. Conversely, the shock of inverted yield curve does not have significant effects on other endogenous variables.
- Housing starts is positively affected by the shocks from housing price and durable goods consumption significantly. The shock of durables consumption also significantly increases the housing price.

Future research

- Theoretical model of intertemporal consumer choice, and the tradeoff between durable goods and housing spending, such as Wadud et al. (2012) and Lastrapes and Potts (2006).
- Musso et al. (2011) suggested that Spillover effect of the monetary policy could not be ignored. The inclusion of impact from international capital flows would be relevant in domestic market fluctuation.
- The comparison of subgroups or across different regions could also show the potential structural change in the housing market, such as the framework proposed by Hofmann and Peersman (2017).

Final thought



Thank You

“Uncertainty is the only certainty there is, and knowing how to live with insecurity is the only security.”
— John Allen Paulos.

Table A1. Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
EPU	132	99.39121	37.28452	43.71804	225.2321
IRS	132	1.710227	1.125339	-0.63	3.61
PCEDG	132	940.3111	320.893	418.5	1549.7
HP	132	127.5148	44.83046	64.398	212.797
HOUST	132	1319.497	387.8602	525.6667	2120.333
L_EPU	132	4.536904	0.346859	3.777761	5.417131
M_IRS	132	-1.710227	1.125339	-3.61	0.63
L_PCEDG	132	6.780388	0.377434	6.036677	7.345817
L_HOUST	132	7.134117	0.337533	6.264668	7.659328
L_HP	132	4.783279	0.367114	4.165082	5.360339

Table A2. Unit roots test result

Variables	Level		First Difference		Order of Integration
	With Constant	With Trend	With Constant	Without Constant	
L_EPU	0.0001	0.0007	0.0000	0.0000	I(0)
M_IRS	0.3072	0.6249	0.0000	0.0000	I(1)
L_PCEDG	0.4597	0.8642	0.0000	0.0000	I(1)
L_HP	0.8614	0.9754	0.1250	0.3582	I(2)
L_HOUST	0.5967	0.9372	0.0000	0.0000	I(1)

Table A3. Lag Order Selection Criteria

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-175.819				0.000012	2.82529	2.87056	2.9367
1	878.65	2108.9	25	0.000	1.20E-12	-13.2602	-12.9886	-12.5917
2	1000.36	243.42	25	0.000	2.7e-13*	-14.7712*	-14.2733*	-13.5458*
3	1022.31	43.899	25	0.011	2.80E-13	-14.7236	-13.9993	-12.9411
4	1042.57	40.524*	25	0.026	3.00E-13	-14.6495	-13.699	-12.31

Endogenous: I_EPU M_IRS I_PCEDG I_HP I_HOUST

Exogenous: _cons

Figure A1. Impulse Response Function

