# ONLINE APPENDIX
# Consumer Confidence and Household Investment

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# A.1 Household Investment and Consumer Confidence Measure

## A.1.1 Household investment

To construct Household Investment (HI) series, we use the following BEA's chain aggregation method:

We normalize $HI_T = 1$, where $T$ is reference date and set $T = 1$. Then we set $HI_t = HI_{t-1} \times Q_t$, where $Q_t$ is Fisher Index.

$$Q_t = \sqrt{\frac{P_{t-1}^{DG} DG_t + P_{t-1}^{RI} RI_t}{P_{t-1}^{DG} DG_{t-1} + P_{t-1}^{RI} RI_{t-1}} \times \frac{P_t^{DG} DG_t + P_t^{RI} RI_t}{P_t^{DG} DG_{t-1} + P_t^{RI} RI_{t-1}}}$$

where,

$DG$ = Durable goods

$RI$ = Residential investment

$P^{DG}$ = Price index of durable goods

$P^{RI}$ = Price index of residential investment

## A.1.2 Index of consumer sentiment

We collect consumer confidence data from Surveys of Consumers, University of Michigan. We focus on the Index of Consumer Sentiment (ICS) and Index of Consumer Expectations (ICE), which are based on the following five questions:

- $Q_1$. We are interested in how people are getting along financially these days. Would you say that you (and your family living there) are better off or worse off financially than you were a year ago?
- $Q_2$. Now looking ahead–do you think that a year from now you (and your family living there) will be better off financially, or worse off, or just about the same as now?
- $Q_3$. Now turning to business conditions in the country as a whole–do you think that during the next twelve months we'll have good times financially, or bad times, or what?

- $Q_4$. Looking ahead, which would you say is more likely–that in the country as a whole we'll have continuous good times during the next five years or so, or that we will have periods of widespread unemployment or depression, or what?

- $Q_5$. About the big things people buy for their homes–such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or bad time for people to buy major household items?

$$ICS = \frac{Q_1 + Q_2 + Q_3 + Q_4 + Q_5}{6.7558} + 2.0$$

$$ICE = \frac{Q_2 + Q_3 + Q_4}{4.1134} + 2.0$$

## A.2 Robustness analysis

We conduct a variety of robustness checks. In this section we report four salient robustness checks and have provide others in a detailed online appendix.

### A.2.1 Do confidence shocks reflect future technology developments?

To check whether the confidence shocks are related to future supply side developments in technology, we consider variables such as TFP and RPI as these are viewed as the fundamental supply-side drivers of the business cycle. We regress ICE shocks obtained from a four-variable VAR with ICE, household investment, hours-worked and output, on one- and four-quarter lagged values of TFP and RPI growth. Table 1 shows the results. We find that the coefficients of TFP and RPI growth are not statistically significant, with a low $R^2$ value of 0.008. We also regress ICE residuals on the fourth lag of TFP and RPI growth, respectively, and find that the coefficients are not statistically significant, with a near-zero $R^2$ (i.e. 0.003). These findings indicate that the ICE shocks are not related to future movements in supply-side forces.

We perform a second check to see if confidence shocks reflect TFP news using Jordà (2005) local projections approach as presented in equation (1). The TFP news shocks correspond to the shocks

retrieved from the estimation of the four-variable baseline model of Barsky and Sims (2011), while the ICE shocks are retrieved from the four-variable VAR whose responses are presented in Figure **??**.

$$HI_{t+h} = \alpha_h + \theta_h shock_t + \psi_h(L)X_{t-1} + \text{quadratic trend} + \epsilon_{t+h} \tag{1}$$

where $HI_t$ corresponds to household investment per capita in logs and $X_{t-1}$ is a vector of control variables. These variables are exactly the same as the ones used by Ramey (2016). Specifically, there are two lags of the following variables: the shocks themselves, real GDP per capita in logs, real stock prices per capita in logs, labor productivity (real GDP/total hours worked) in logs, as well as the dependent variable. Figure 1 shows that the response of household investment to a TFP news shock is significantly muted beyond the initial period and turns negative after seven quarters. After the initial two quarters, the response is also outside the confidence bands of the response to an ICE shock. Taken together, these results show that confidence shocks are unlikely to reflect future technology developments.

### A.2.2 The labour market variables and the household investment channel

We replace hours worked with the unemployment rate as an alternative measure to capture the cyclicality in the labour market to analyze whether household investment plays a role in the transmission of consumer confidence over the business cycle. We employ the same procedure as in section 4.2 in the paper, i.e., holding fixed the responses of household investment to consumer confidence shocks at all forecast horizons.

Figure 2 presents the IRFs from a four-variable structural VAR with ICE (ordered first), household investment, unemployment rate and output. The blue solid lines and the red dashed lines correspond to the actual and hypothetical impulse responses, respectively. The actual response of the unemployment rate to a one-standard-deviation consumer confidence shock is negative on impact and followed by a hump-shaped response, and is statistically significant. The response of the unemployment rate to confidence shocks without the household investment channel is substantially muted and consistently lower than the actual response at all forecast horizons. The responses of output to an ICE shock fall from 0.8 percent to 0.4 percent at their peak impact when we force the responses of household

investment at zero for all horizons. These results are consistent with those in section 4.1 in the paper, where we use hours worked and output as business cycle measures. They suggest that household investment plays a significant role in the transmission of confidence shocks over the business cycle.

In order to underline the household investment channel, we estimate the baseline VAR model with four variables, and we shut down the responses of hours worked, instead of household investment. Figure 3 shows the results. The actual and hypothetical response of output to ICE shocks are qualitatively same. However, the response of household investment is substantially stronger relative to the unconstrained response. This 'over-reaction' of household investment compensates for the contribution of hours-worked in propagating the confidence shock.

### A.2.3 Components of household investment

We now investigate the response of both components (i.e. residential investment and durable goods) of household investment to consumer confidence shocks and their role in the transmission of consumer confidence shocks. There are two advantages for conducting a separate evaluation. The first is analyzing the responses of both variables to consumer confidence shocks. Second, we analyze whether only one or both variables is playing a role in the transmission of consumer confidence to the economy.

We show the results from a four-variable structural VAR framework with ICE, residential investment, hours worked and output in Figure 4. An ICE shock has a positive impact effect on residential investment and is statistically significant. The effect is followed by a hump-shaped response. The peak response of residential investment to a one standard deviation ICE shock is about 2.5 percent increase and at a 40 quarter horizon is 0.7 percent. The responses of total hours worked and output to ICE shocks are lower on impact and higher at all forecast horizons relative to when residential investment effects are constrained to zero. These results suggest that residential investment, which is a key component of household investment, plays a crucial role in transmitting the confidence shocks to the broader economy.

Figure 5 shows the results from a four-variable structural VAR framework with ICE, durable goods, hours worked and output. The response of durable goods is positive on impact and followed by hump-shaped response. The response is highly persistent and statistically significant. The peak

response to a one standard deviation ICE shock is about 2.2 percent increase and 1.4 percent at 40 quarter horizons. The constrained responses of hours worked and output to ICE shocks are lower on impact and substantially muted at all horizons than the unconstrained responses. The findings suggest that each component of household investment has a positive response to the ICE shock and plays a role in its transmission over the business cycle.

### A.2.4 Additional variables in the VAR

We now add nominal interest rate in the baseline VAR to examine the response of household investment and output to confidence shocks in the presence of monetary policy effects. These are shown in Figure 6. The responses of household investment, total hours worked and output to one standard deviation consumer confidence shocks are positive on impact and their responses are hump-shaped, and are statistically significant. Figure 7 shows the forecast error variance decomposition of confidence shocks. ICE shocks account for about 31, 27, and 46 percent of the forecast error variance of household investment, total hours worked and output at 40 quarter horizons, respectively. Although the contribution of ICE shocks is slightly smaller, our main results are robust to the presence of monetary policy.[1]

We consider a VAR with six variables (ICE, household investment, business investment, government expenditures, total hours worked, and output). We include government expenditures in the VAR as in Bachmann and Sims (2012). Figure 8 shows the impulse responses of ICE, household investment, business investment, government expenditure, total hours worked and output. Even when we add business investment and government expenditures in the VAR, the results are consistent with our baseline four-variable VAR. The response of household investment to an ICE shock is positive and statistically significant for short and long horizons. The impulse responses of business investment, total hours worked, and output to ICE shocks also have a positive and significant impact. Government spending, however, does not react to the ICE shock in the beginning but only after a few quarters and is statistically significant at longer horizons. The figure also shows the constrained responses when we mute the responses of household investment to confidence shocks in structural VAR system for all

[1]We checked the robustness of our findings to the post-1985 period widely associated with the onset of the Great Moderation period that lasted until 2007. Our baseline findings do not change in any significant manner. The results are available upon request.

forecast horizons. The constrained responses of business investment, total hours worked and output are lower than unconstrained responses for all forecast horizons.

Next, we perform a VAR analysis controlling for financial and technology related variables. We consider eight variables : stock return, ICE, nominal interest rate, utilization-adjusted TFP (Fernald (2014)), RPI, household investment, hours worked and output. Figures 9 and 10 show the impulse responses and forecast error variance decomposition to consumer confidence shocks, respectively. The responses of household investment, hours worked and output to exogenous consumer confidence shock are consistent with the baseline VAR analysis, after controlling for the financial and technology related variables. The contribution of ICE shocks to the forecast error variance of household investment, hours worked and output are qualitatively similar with the baseline VAR model.

### A.2.5 Role of Consumer Services Expenditures

Similar to household investment, does expenditures on consumer services help propagate the ICE shock, hence attenuating the role of household investment channel emphasized in the paper? As depicted in Figure 11, the responses of household investment and output do show a marginal dampening effect, resulting in ICE shocks now accounting for 59 percent of the forecast error variance in output at a 40-quarter horizon. It is noteworthy that these adjustments have not significantly altered our findings, and our results remain consistent.

### A.2.6 Great Moderation Period

The Great Moderation period (about 1985 to 2007:Q3) saw subdued macroeconomic volatility relative to the full post-WWII period. A natural question is whether ICE shocks play less of a role when the economy is relatively more stable? We find that the contribution of ICE shocks is lessened during the Great Moderation period relative to our baseline. One notable outcome is a 27 percent reduction in the variance of ICE shocks in this restricted sample. The impulse responses are presented in Figure 12. It is important to note that these responses may appear less precise, likely due to the reduced sample size, and, as such, we should exercise caution in interpreting these results. Additionally, the response of ICE to its own shock is shorter-lived, resulting in lower persistence in the responses of the aggregate variables. An interesting observation is that the peak response of household investment

is more pronounced in the model estimated with data from the Great Moderation period than in the baseline model covering the full sample. However, when we calculate the cumulative effects over a 40-quarter horizon, these effects are smaller for the model estimated during the Great Moderation period. Regarding the responses of output, they seem to be halved when we restrict our sample to the Great Moderation.

Figure 13 illustrates the Forecast Error Variance Decomposition (FEVD) for the time period covering the Great Moderation. It's worth noting that at a 40-quarter horizon, ICE shocks contribute to household investment as significantly as they do for the full sample, yet the variance decompositions of ICE shocks to output are considerably lower. However, a caveat is that the level of imprecision in the impulse responses for this sample is also high.

# References


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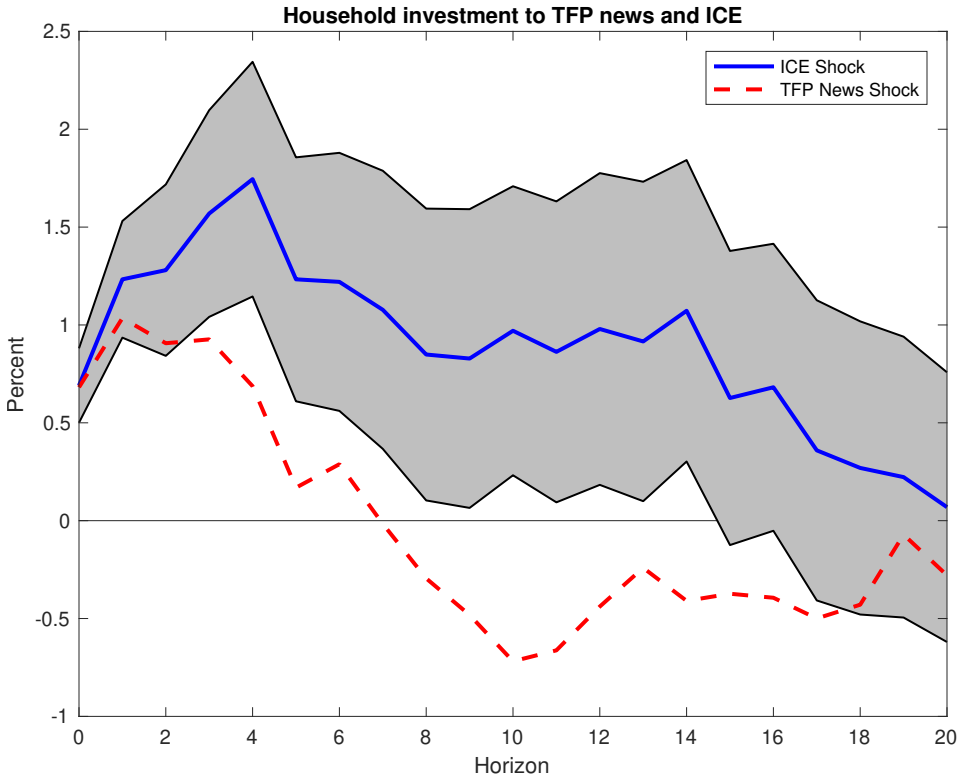
Table 1: Results: ICE residuals on TFP growth and RPI growth

| | (1) | (2) |
|---|---|---|
| Variables | One-step ahead | Four-step ahead |
| TFP growth | -0.361 | -0.230 |
| | (0.639) | (0.636) |
| RPI growth | 1.057 | -0.601 |
| | (0.885) | (-0.601) |
| Constant | 0.007 | -0.003 |
| | (0.007) | (0.007) |
| Observations | 228 | 228 |
| R-squared | 0.008 | 0.003 |

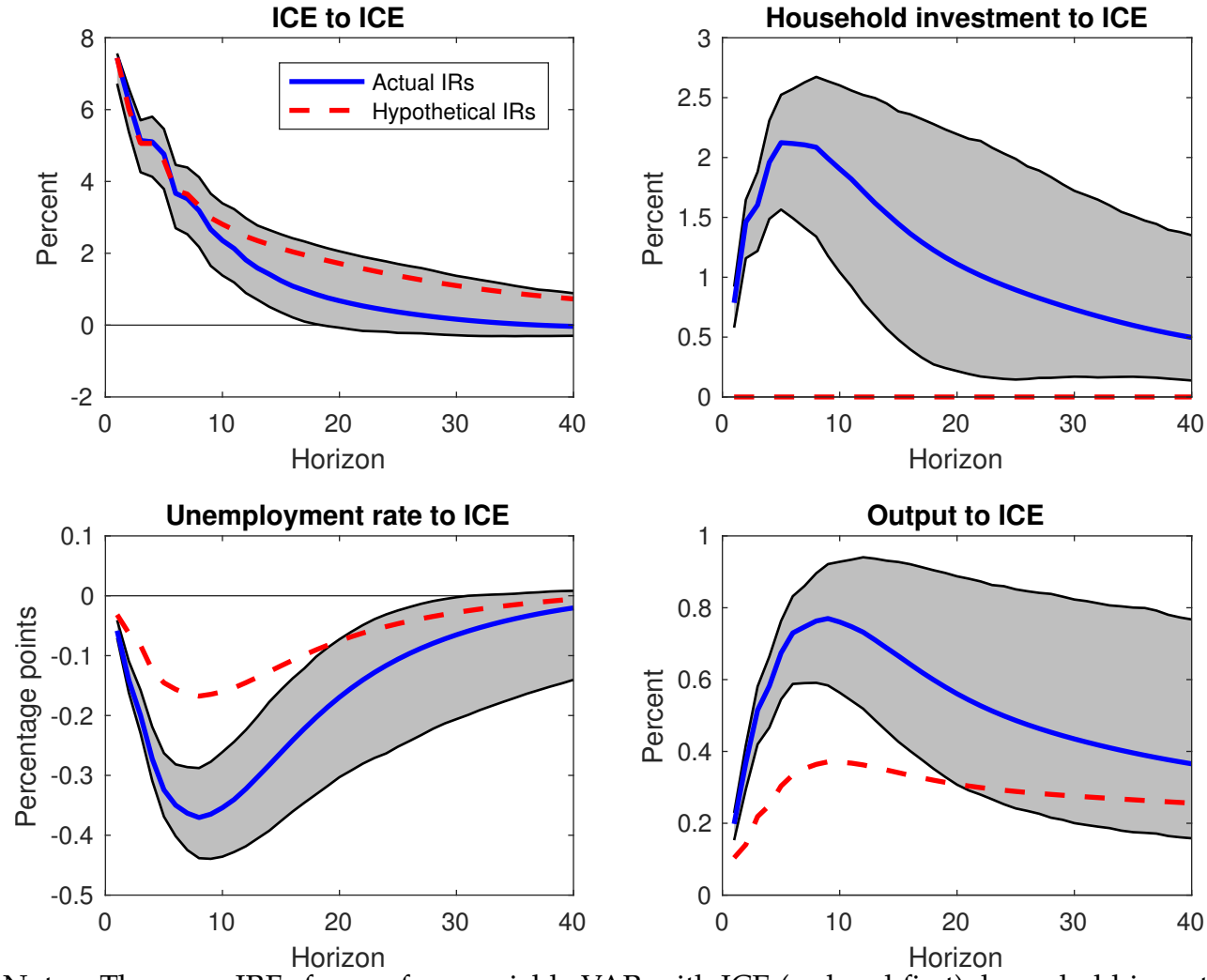
Notes: Standard errors in parentheses. We regress ICE shocks (from a four-variable VAR with ICE, household investment, hours worked and output) on first lag of TFP growth and RPI growth in Column (1) and on fourth lag of TFP growth and RPI growth in Column (2). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 1: Robustness (Section A.2.1): Comparing ICE shock versus TFP news shock



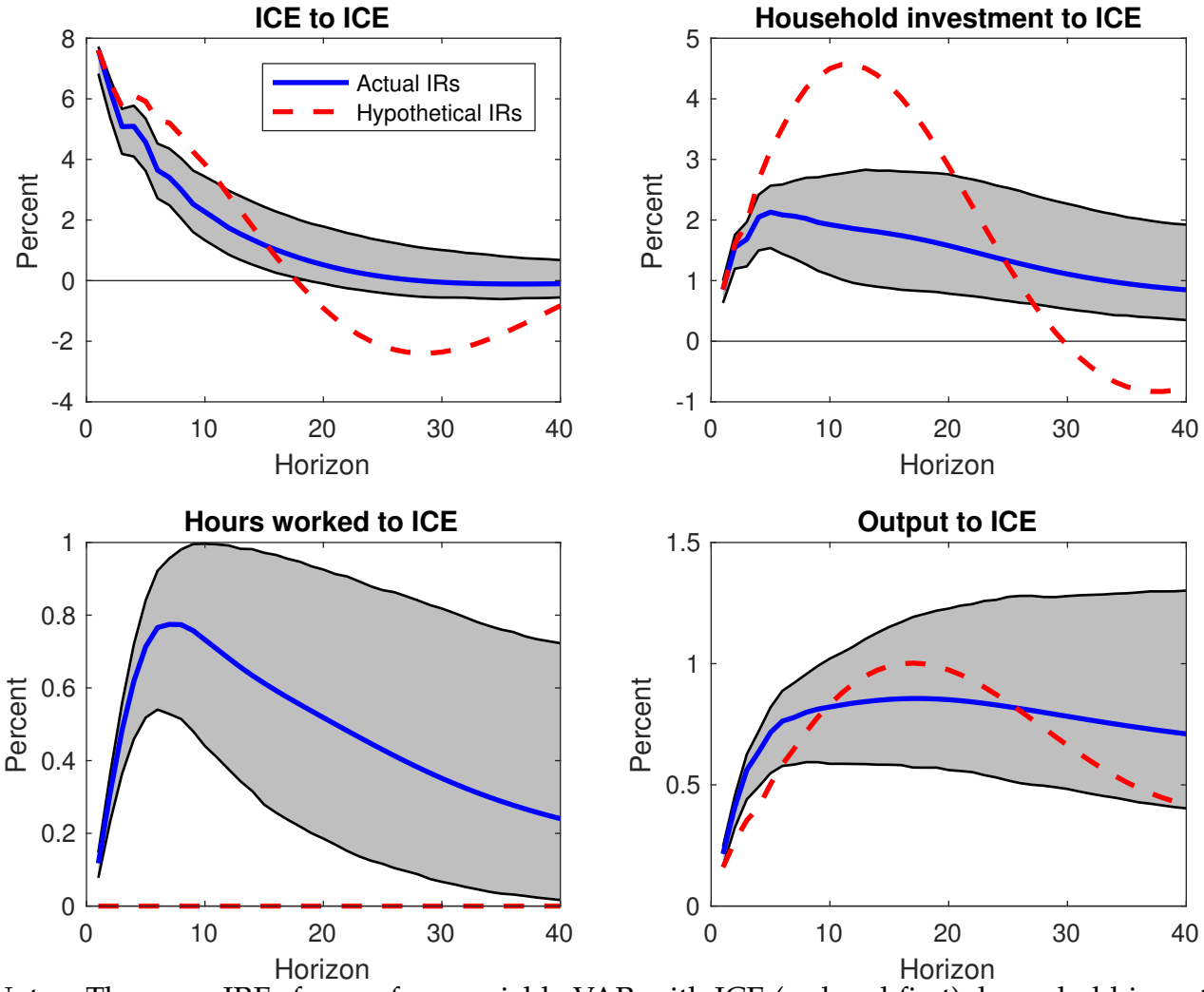

Note: The sample period is 1960Q1 to 2017Q4. The grey shaded area shows the 90% confidence bands.

Figure 2: Robustness (Section A.2.2): Responses to a one standard deviation consumer confidence shock



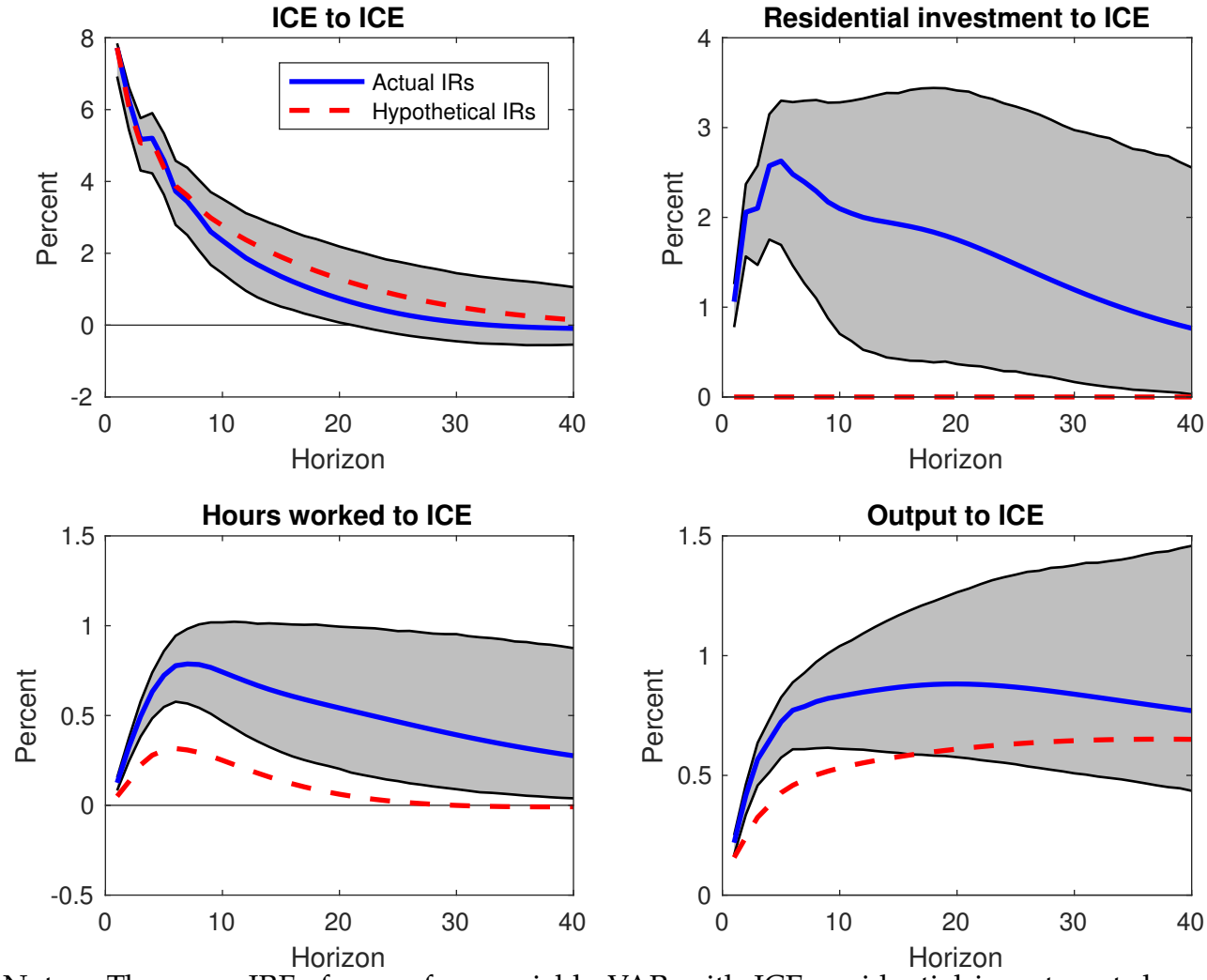

Notes: These are IRFs from a four-variable VAR with ICE (ordered first), household investment, unemployment rate and output. We take natural log for all variables except for unemployment rate. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 3: Robustness (Section A.2.2): Responses to a one standard deviation consumer confidence shock, holding fixed hours worked responses to ICE shocks at all forecast horizons



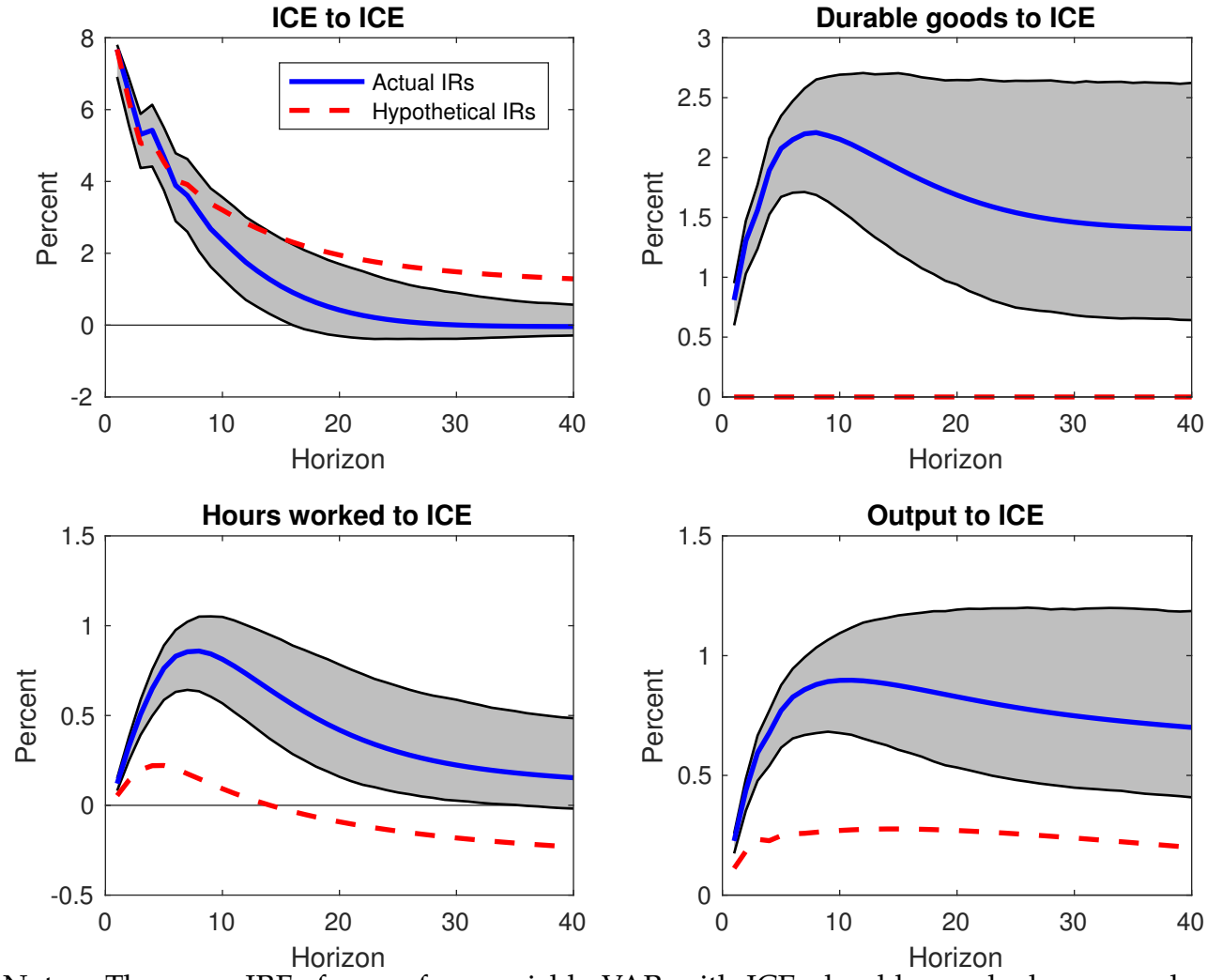

Notes: These are IRFs from a four-variable VAR with ICE (ordered first), household investment, hours worked and output. We shut down the direct responses of hours worked to confidence shocks at all forecast horizons. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 4: Robustness (Section A.2.3): Responses to a one standard deviation consumer confidence shock - the residential investment case



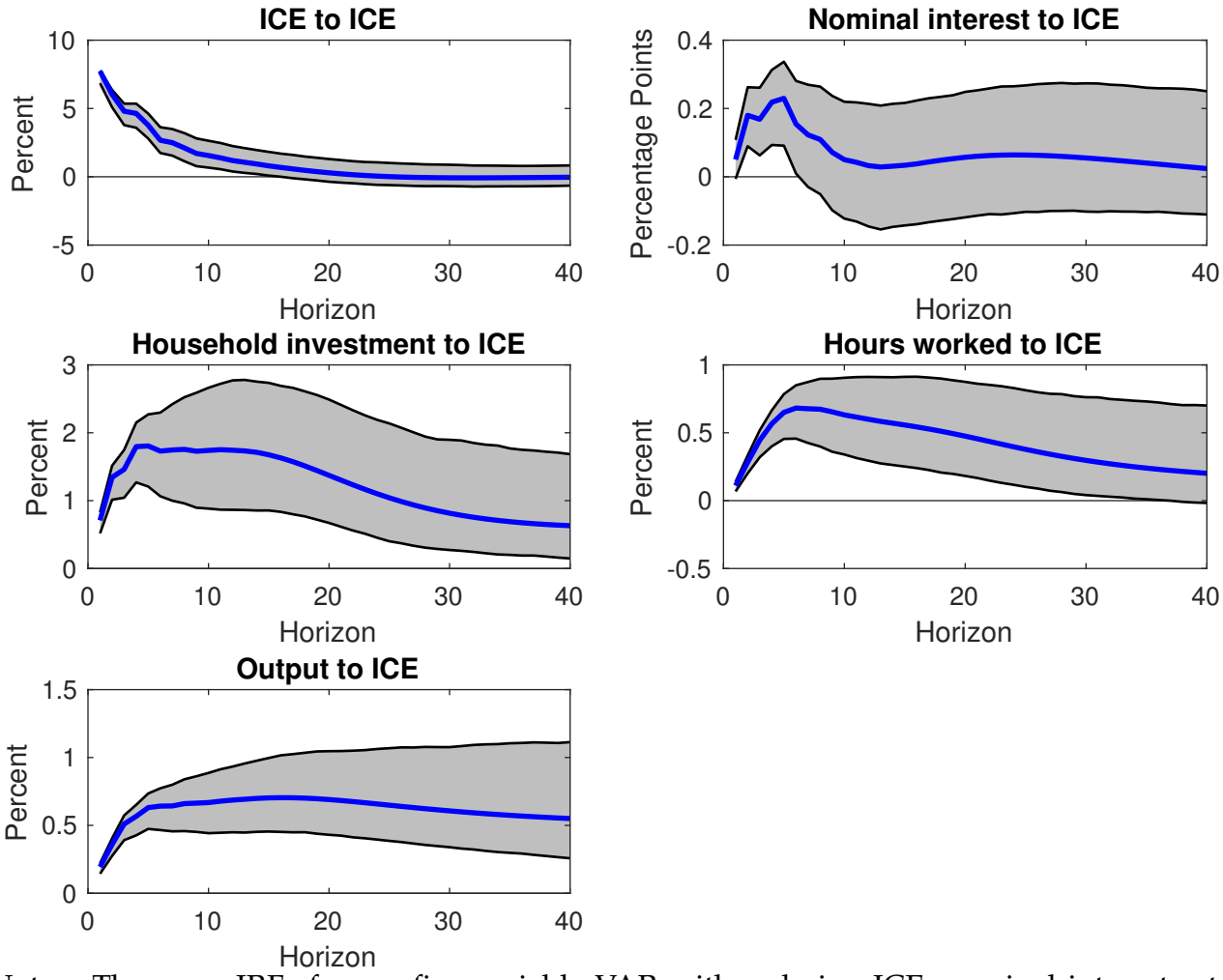

Notes: These are IRFs from a four-variable VAR with ICE, residential investment, hours worked and output. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 5: Robustness (Section A.2.3): Responses to a one standard deviation consumer confidence shock: the durable goods case



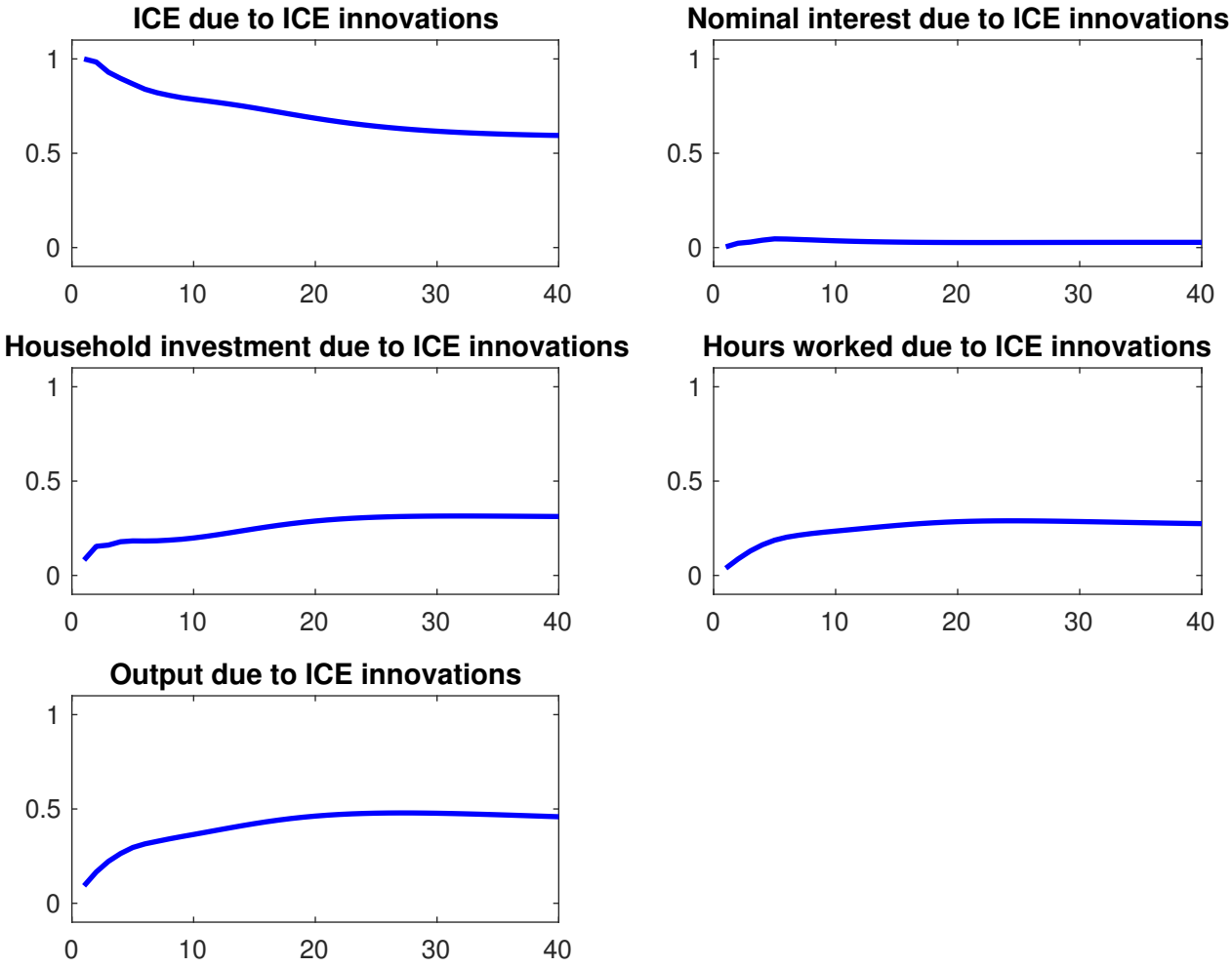

Notes: These are IRFs from a four-variable VAR with ICE, durable goods, hours worked and output. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 6: Robustness (Section A.2.4): Responses to a one standard deviation confidence shock (ICE ordered first)



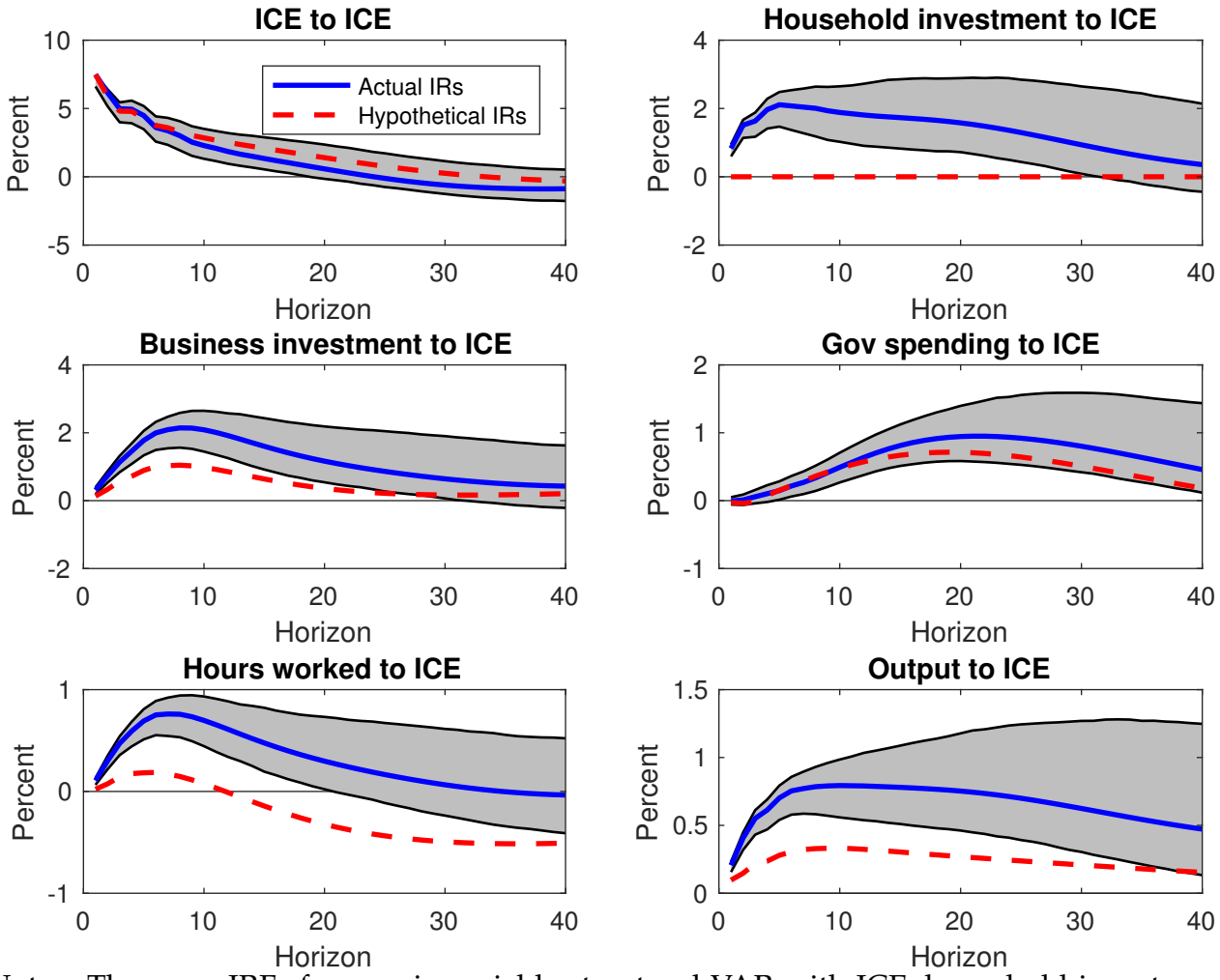

Notes: These are IRFs from a five-variable VAR with ordering ICE, nominal interest rate, household investment, hours worked and output. We take natural log for all variables except for nominal interest rate. The shaded areas are one-standard-error confidence bands based on Kilian (1998) bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 7: Robustness (Section A.2.4): Forecast error variance decomposition of ICE shocks



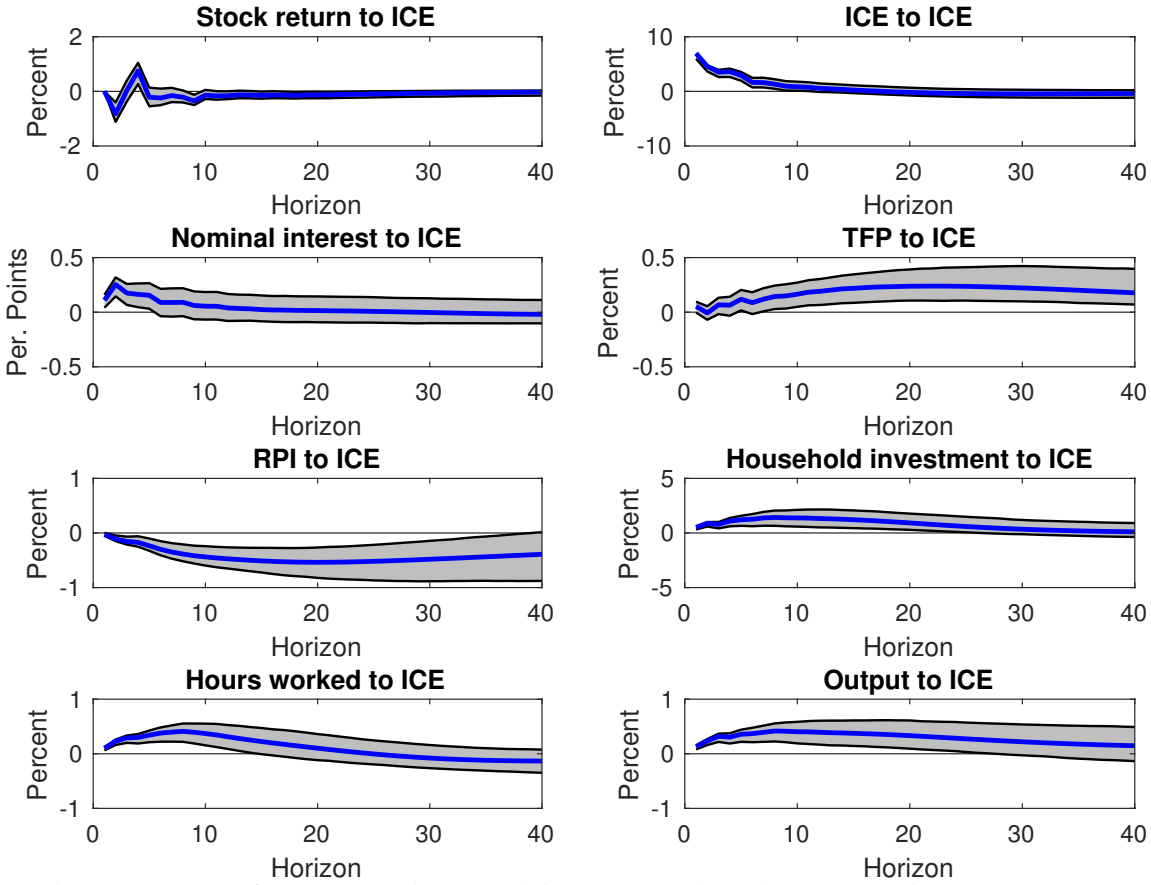

Notes: This figure plots variance decompositions from ICE shocks in the five-variable VAR system with ordering ICE, nominal interest rate, household investment, hours worked and output. We take natural log for all variables except for nominal interest rate. The sample period is 1960Q1 to 2017Q4.

Figure 8: Robustness (Section A.2.4): Responses to a one standard deviation consumer confidence shock in a larger VAR



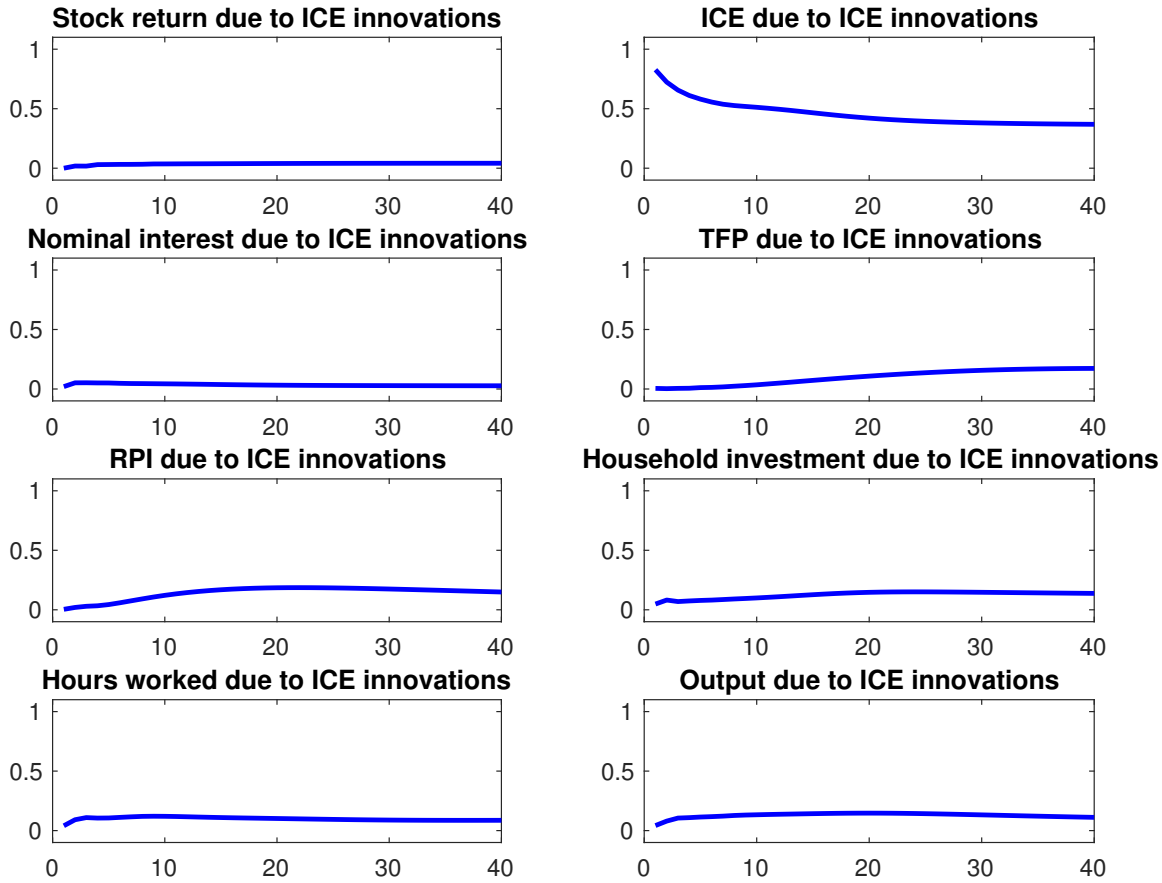

Notes: These are IRFs from a six-variable structural VAR with ICE, household investment, business investment, government expenditure, hours worked and output. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 9: Robustness (Section A.2.4): Responses to a one standard deviation confidence shock



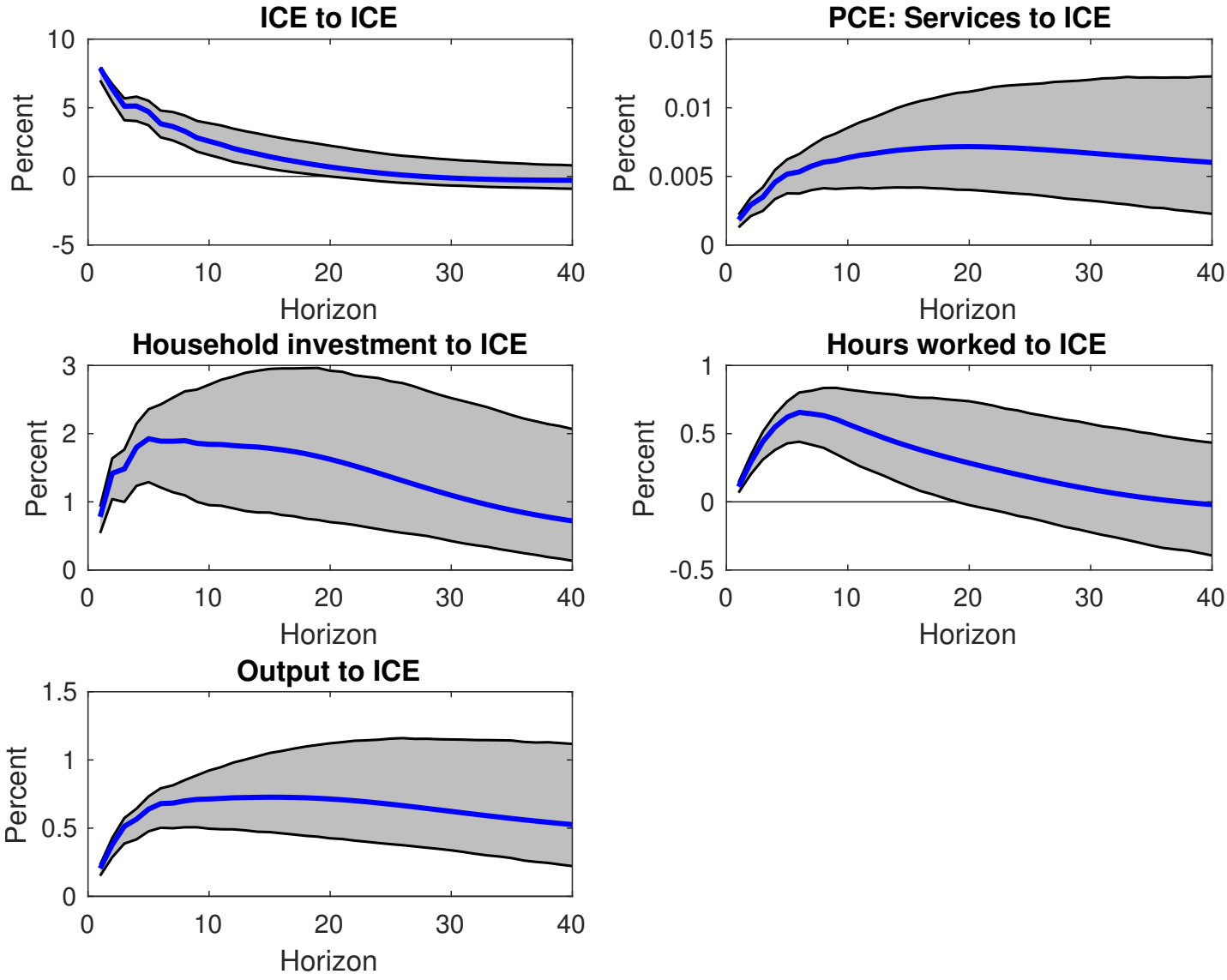

Notes: These are IRFs from an eight-variable VAR with ordering stock return, ICE, nominal interest rate, TFP, RPI, household investment, hours worked and output based on Cholesky identification. BCI is ordered first in the VAR. We take natural log for all variables except for nominal interest rate. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 10: Robustness (Section A.2.4): Forecast error variance decomposition of confidence shock



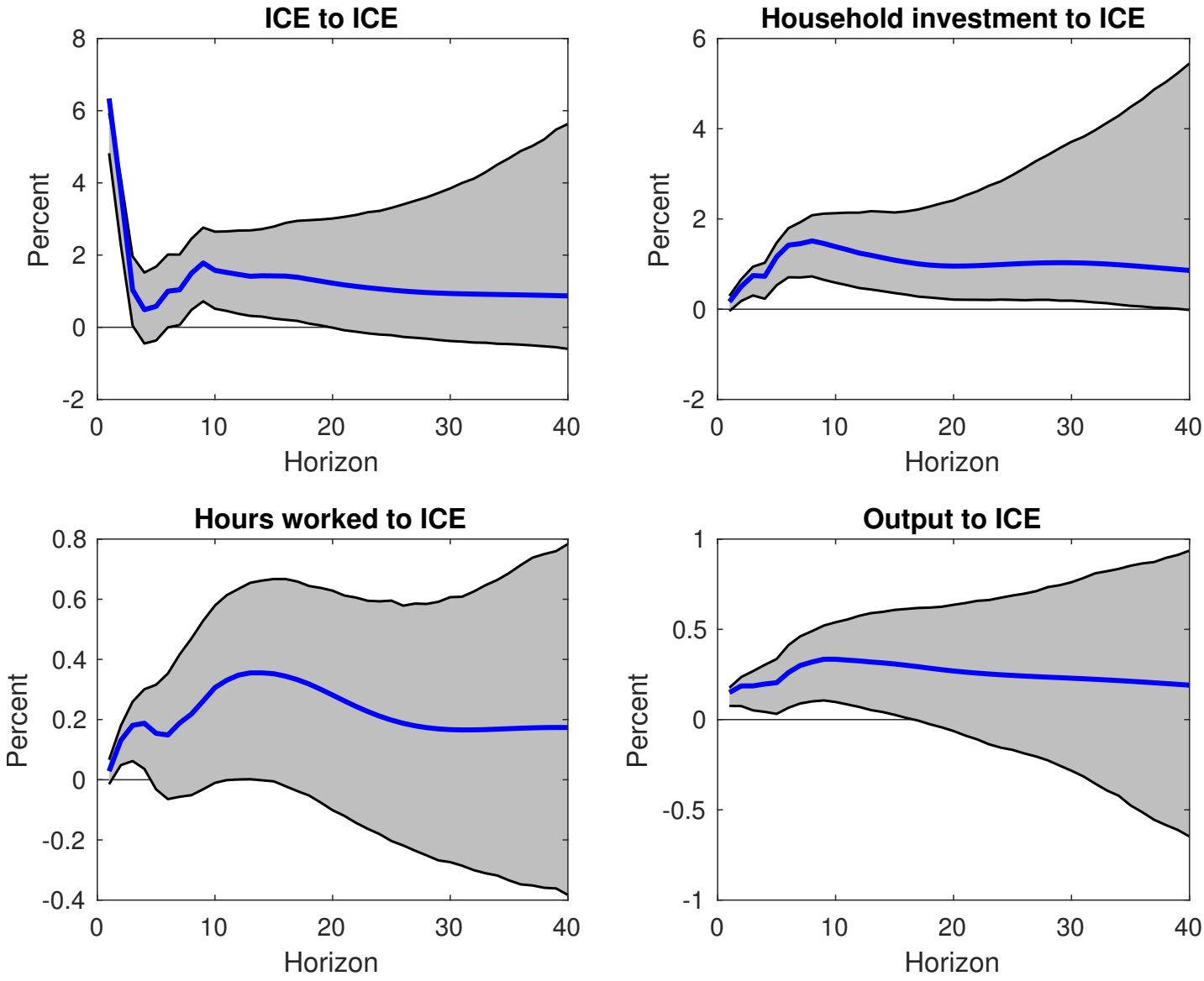

Notes: This figure plots variance decompositions from an eight-variable VAR with ordering stock return, ICE, nominal interest rate, TFP, RPI, household investment, hours worked and output, and their impulse responses are shown in Figure 9. We take natural log for all variables except for nominal interest rate. The sample period is 1960Q1 to 2017Q4.

Figure 11: Responses to a one standard deviation confidence shock



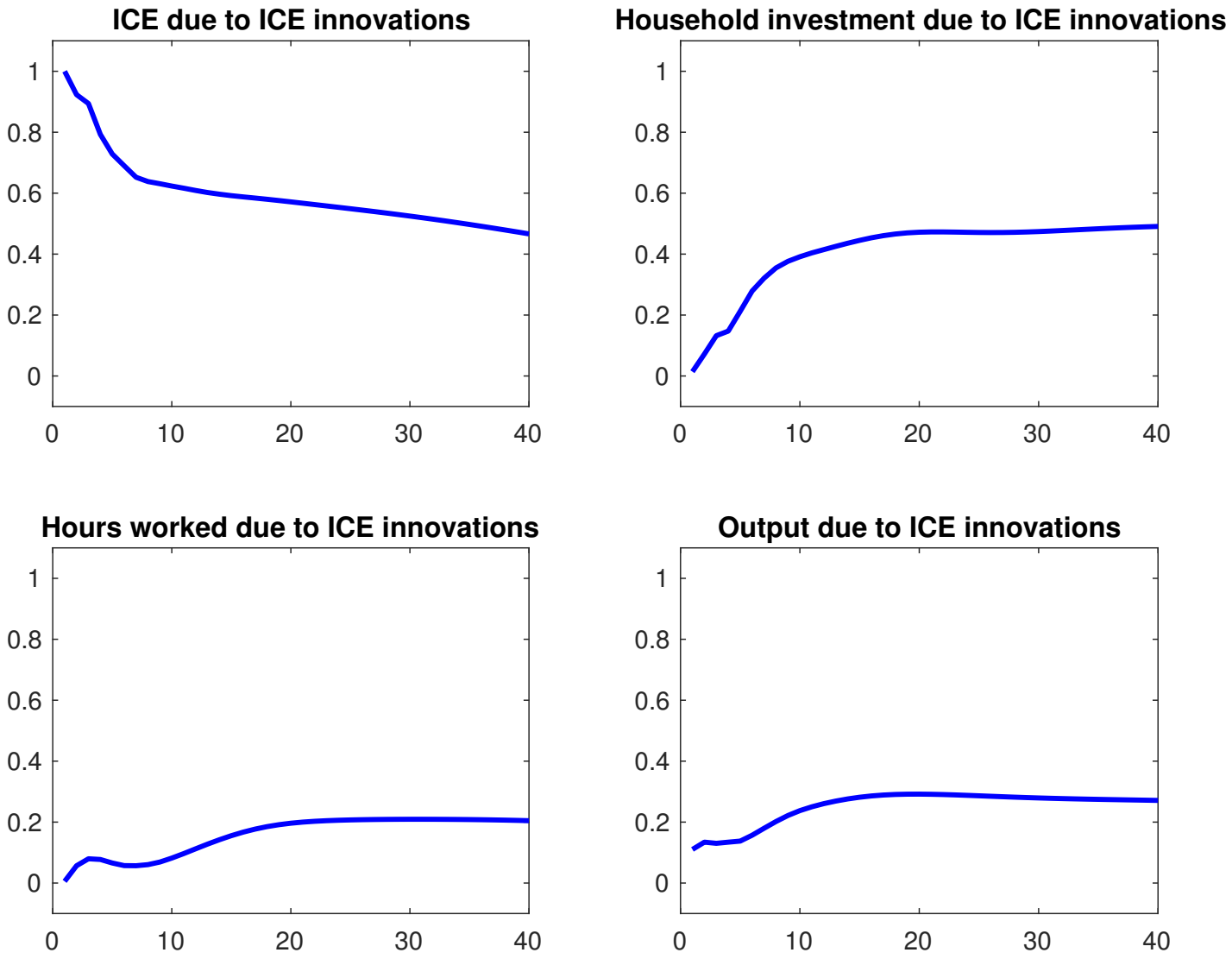

Note: These are IRFs from a five-variables VAR with ordering ICE, PCE: services, household investment, hours worked and output based on Cholesky identification. We take natural log for all variables. The grey shaded areas are one standard error confidence bands constructed using the bias-corrected bootstrap after bootstrap. The sample period is 1960Q1 to 2017Q4.

Figure 12: Responses to a one standard deviation confidence shock




Note: These are IRFs from a four-variables VAR with ordering ICE, household investment, hours worked and output based on Cholesky identification. We take natural log for all variables. The grey shaded areas are one standard error confidence bands constructed using the bias-corrected bootstrap after bootstrap. The sample period is 1985Q1 to 2007Q3.

Figure 13: Forecast error variance decomposition of confidence shocks




Note: this figure plots variance decompositions from the four-variable VAR whose impulse responses are shown in Figure 12. The sample period is 1985Q1 to 2007Q3.