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Hashmat Khan
Carleton University

Jean-François Rouillard
Université de Sherbrooke

Santosh Upadhayaya
Carleton University

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Department of Economics

1125 Colonel By Drive
Ottawa, Ontario, Canada
K1S 5B6

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Hashmat Khan[†] Department of Economics Carleton University

Jean-François Rouillard[‡] Department of Economics Université de Sherbrooke

Santosh Upadhayaya[§] Department of Economics Carleton University

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Abstract

Household investment displays a robust leading indicator property over the US business cycle. It has been challenging to account for this stylized fact. In this paper, we develop the hypothesis that consumer confidence drives household investment. Using a survey-based consumer confidence measure for 1960Q1–2017Q4 we find that it leads household investment by two quarters and housing starts by one quarter, lending support to the hypothesis. We then use VAR analysis to identify a confidence shock. Household investment increases and follows a persistent hump-shaped response after a positive confidence shock. The responses of total hours-worked and output also show a persistent increase and so do real house prices. Confidence shocks account for a substantial share of variation in household investment, total hours-worked and output. We show that household investment plays a quantitatively important role in the transmission of confidence shocks in the economy. Moreover, confidence shocks do not appear to be related to movements in future fundamentals, total factor productivity and the relative price of investment, representing supply side developments. Our findings, therefore, suggest that demand side forces originating in consumers' social and psychological factors may be a fruitful direction for studying household investment dynamics and their relationship with the business cycle.

Key words: Consumer confidence; Household investment; Confidence Shocks; Business cycles

JEL Classification: D12, D83, D84, E22, E32

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[†] *E-mail:* hashmat.khan@carleton.ca

[‡] *E-mail:* j-f.rouillard@usherbrooke.ca

[§] *E-mail:* santosh.upadhayaya@carleton.ca

1 Introduction

A well-known and robust property of US household investment (residential investment plus consumer durables) is that it leads the business cycle by one quarter (see Table 1).[1] This fact is quite remarkable because over the past 70 years, a rise (or fall) in quarterly real Gross Domestic Product (GDP) relative to a long run trend is preceded by a rise (or fall) in household investment. While this leading indicator property is useful to policy makers for assessing the future direction of the economy, it has been challenging to provide an explanation for it.[2] Many recent models proposed in the literature have studied distinct channels within a rational expectations framework (see, for example, Ren and Yuan (2014), Kydland, Rupert and Šustek (2016) and Khan and Rouillard (2018)). It is, however, possible that behavioural factors such as evolving consumer confidence have also played a role in sustaining this property of household investment, possibly either through 'animal spirits' reflecting optimism and pessimism over the business cycle or through anticipations about future fundamentals. A heuristic way to describe this potential channel is as follows:

$$\overbrace{\boxed{\text{Consumer Confidence}}}^{\uparrow} \Rightarrow \overbrace{\boxed{\text{Housing \& Durables}}}^{\text{Demand}\uparrow} \Rightarrow \overbrace{\boxed{\text{House Prices}}}^{\uparrow} \Rightarrow \overbrace{\boxed{\text{Household investment}}}^{\text{Supply}\uparrow} \Rightarrow \overbrace{\boxed{\text{Output}}}^{\uparrow} \tag{1}$$

All else the same, increased confidence affects households' demand for housing and consumer durables putting upward pressure on house prices, then house builders and consumer durable firms respond by adjusting investment and production, which in turn affects aggregate output. The objective of this paper is to develop this hypothesis and investigate the empirical support for it.

There are three reasons that motivate our focus on consumer confidence. First is that the lead of residential investment over GDP originates exclusively from single family structures and 'other structures' but not from multi-family structures (see Table 2).[3] The correlation between current investment

[1]Each component, i.e., residential investment and consumer durables, also displays this property. Brault and Khan (2019) show that unlike the real interest rate and labour productivity, household investment retains its leading indicator property in the post-1985 data. Leamer (2008) has documented that household investment consistently and substantially contributes to the weakness prior to recessions, and eight of the ten recessions were preceded by severe problems in housing in the past fifty years. Leamer (2015) further stresses the importance of housing for the business cycle.

[2]The early literature on home production features studies that do not reproduce the lead in residential investment over the business cycle (see, for example, Benhabib, Rogerson and Wright (1991), Greenwood and Hercowitz (1991), McGrattan, Rogerson and Wright (1997), and Gomme, Kydland and Rupert (2001)).

[3]The component 'other structures' in residential investment consists primarily of manufactured homes, im-

in single family structures and one quarter ahead cyclical output is the largest in the sample, indicating the one-quarter lead. A similar pattern exists for 'other structures'. In the post-1985 sub-sample, the leading property of 'other structures' investment has become even stronger, leading output by four quarters. Together with consumer durables, these components of household investment may be affected by optimism and pessimism of a family decision-making unit and/or reflect responses to news about future fundamentals that affects confidence contemporaneously. Second is that many empirical studies (discussed below) have found that consumer confidence has predictive power for a variety of macroeconomic variables. However, to the best of our knowledge, we are first to examine the role of consumer confidence in the context of the leading indicator property of household investment. Third is that there is renewed interest in studying the role of consumer confidence in understanding and interpreting business cycles from a variety of perspectives (we provide a literature review in section 2). However, this body of work has not yet studied the role of confidence for household investment.

We use the University of Michigan's Surveys of Consumers and focus on its Index of Consumer Expectation (ICE) as the measure of consumer confidence in our empirical analysis.[4] There are three 'forward-looking' questions underlying the construction of ICE. These index questions, listed as Q_2, Q_3, and Q_4 in the Survey, are as follows:[5]

- 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?*

In constructing ICE, first a relative score is computed (the percent giving favourable replies minus the percent giving unfavourable replies, plus 100) for each of the index questions. Then the relative

provements, dormitories, net purchases of used structures, and brokers' commissions on the sale of residential structures.

[4]http://www.sca.isr.umich.edu/

[5]The other two questions are about current conditions. These are presented in the Appendix.

score is rounded to the nearest whole number. And lastly, using the formula shown below, where the sum of the scores is divided by the base-year value of 4.1134, and 2.0 is added as a constant to correct for sample design changes from the 1950s. Thus, ICE is constructed as follows:

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

A crucial first step in our empirical analysis is to determine whether consumer confidence leads household investment because if it does not, then consumer confidence cannot be a potential driver of household investment. We proceed in the standard way (see, for example, Kydland and Prescott (1990) and Cooley and Prescott (1995)) and compute cross-correlations between ICE and the cyclical component of household investment, and define the lead based on the largest cross-correlation (including contemporaneous correlation) in absolute terms. Specifically, we take the natural log of household investment and de-trend it with the Hodrick-Prescott (HP)-filter (using a smoothing parameter of $\lambda = 1600$).[6] Since ICE is stationary, we do not de-trend it.

We find that ICE leads household investment by two quarters over the sample period 1960Q1-2017Q4. This is a remarkable property. It means that when consumer confidence is high, household investment will be high in the near future, followed by business investment, output, and hours. In addition, we find that ICE Granger-causes household investment but the reverse causality is not present in the data. This suggests that movements in ICE contain information that can help predict future household investment.

Next, we conduct a Vector Autoregression (VAR)-based analysis to obtain the impulse responses of household investment to a one-standard deviation ICE shock. As a baseline, we consider a four-variable VAR that includes ICE (ordered first), household investment, hours-worked, and output, and use Cholesky decomposition to identify the ICE shock. We find that household investment, hours-worked, and output all increase following the ICE shock. These impact responses are statistically different from zero. The effects on all the three variables build up over time. Both household investment and hours-worked have a hump-shaped response, with the peak responses occurring between one to two years after the shock. The responses are highly persistent, in particular, that of output and are all statistically significant. Variance decomposition results show that confidence shocks account

[6]Using the recently proposed filter in Hamilton (2017) produces similar results.

for 46, 38, and 74 percent of the forecast error variance of household investment, total hours worked and output, respectively, at a 40 quarter horizon. Remarkably, the correlations based on historical decomposition conditional on the ICE shock also show that confidence leads household investment. This finding reinforces the empirical support for our hypothesis.

Does household investment play a role in transmitting confidence shocks to the broader economy? To answer this important question, we apply the methodology used in Bernanke et al. (1997), Sims and Zha (2006), Kilian and Lewis (2011), and Bachmann and Sims (2012). We construct a hypothetical impulse response of output to confidence shock, holding the response of household investment fixed at all forecast horizons. We find that the response of output is lower at all horizons when household investment is forced to not respond to the confidence shock relative to when it is left unconstrained. Thus, consumer confidence influences household investment dynamics which then get transmitted to future movements in output.

We find that confidence shocks do not appear to be related to movements in future fundamentals, specifically, one- and four-quarter ahead Total Factor Productivity (TFP) and the Relative Price of Investment (RPI) that represent supply side drivers of the business cycle. On the other hand, real house prices rise in response to a confidence shock in a hump-shaped manner, consistent with demand outpacing supply in the housing market in the aftermath of the confidence shock as indicated in (1). These findings, therefore, suggest that demand side forces originating in consumers' social and psychological factors may be a fruitful direction for studying household investment dynamics and their relationship with the business cycle.

The rest of the paper is organized as follows. In section 2 we present the related literature. In section 3, we provide the construction and sources of the data, the cross-correlations and Granger-causality results between the variables. In section 4, we discuss the effects of ICE shocks on macroeconomic variables of interest. In section 5, we present a variety of robustness checks and section 6 concludes.

2 Related literature

Our paper is related to previous research that examined the lead of household (and residential) investment over output. That literature, however, did not investigate consumer optimism and pessimism as drivers of household investment. Kydland, Rupert and Šustek (2016) study the dynamic behaviour of the US residential investment. They build a model showing that the cyclical properties of long term fixed rate mortgage loans can explain the fact that residential investment leads the business cycle in the US and coincident movement in European countries. Khan and Rouillard (2018) find that severeness of home-owners' borrowing constraints drive the lead of residential investment over output in a multi-agent model. Ren and Yuan (2014) use a dynamic stochastic partial equilibrium model with Total Factor Productivity (TFP) news shocks, collateral constraints and agent heterogeneity to explain the lead of residential investment over output. These recent studies are within the standard rational expectations framework. By contrast, in this paper we explore the role of consumer's beliefs or attitudes as potential drivers of the household investment dynamics over the business cycle. Our analysis is empirical as we are interested in determining whether or not consumer confidence can play a driving role for household investment dynamics.

A large body of the literature studies whether consumer confidence has the ability to forecast the macroeconomic variables, such as output, consumer spending, employment and productions. In early work on the predictive value of consumer attitudes or sentiments, Tobin (1959), Adams (1964) and Friend and Adams (1964) estimated consumption functions and found mixed results. Relatedly, Fuhrer (1993), Carroll, Fuhrer and Wilcox (1994) , Bram and Ludvigson (1998), Ludvigson (2004) and Cotsomitis and Kwan (2006) find that lagged consumer confidence has some explanatory power for current changes in household spending after using control variables. Lahiri, Monokroussos and Zhao (2016) use real time data and find evidence that consumer confidence helps in predicting household expenditures. Moreover, Matsusaka and Sbordone (1995) use a VAR specification to assess the Granger-causality between consumer confidence and economic fluctuations after controlling for economic fundamentals and find that consumer confidence Granger-causes gross national product. On the other hand, Leeper (1992) studies the role of consumer attitudes in forecasting economic activities and finds that attitudes do not improve the forecasting accuracy of production and unemployment when financial variables, stock market price and short term interest rate, are taken into account. Throop (1992) establishes that consumer sentiment is a significant determinant of household's purchases of durable goods. In this paper we study how the consumer sentiment shock affects not only durable goods but, importantly, residential investment. In addition, our focus is on business cycle dynamics of household investment.

Beaudry, Nam and Wang (2011) examine the role optimism and pessimism shocks, estimated using stock price and consumption data, in driving US output and hours over the business cycle. Barsky and Sims (2012) study whether the shocks in consumer confidence reflect 'animal spirits' or 'news about future fundamentals'. Bachmann and Sims (2012) consider the role of confidence in the transmission of government spending shocks during a recession. Angeletos, Collard and Dellas (2018) study the quantitative role of consumer confidence for the business cycle, and Hintermaier and Koeniger (2018) present a dynamic model with consumer confidence to study how it interacts with household debt to generate the observed fluctuations in house prices and consumption. Benhabib and Spiegel (2019) conduct a state-level analysis of how sentiments influence future state economic activity. None of these papers examine the role of confidence for household investment which is our objective.

Aastveity, Anundsenz and Herstadx (2017) find that residential investment is useful in predicting recessions, using both in-sample and out-of-sample tests for 12 Organization for Economic Co-operation and Development (OECD) countries. However, their paper does not consider the role of consumer confidence as a precursor to business cycle movements in residential investment as we do.

Barsky and Sims (2012) assess the response of macroeconomic aggregates to an exogenous shift in consumer confidence shocks, using a trivariate VAR model. They find that surprise changes in consumer confidence are associated with long-lasting movements in output and consumption of (non-durable) goods and services. The impulse responses of consumption and output to one-standard consumer confidence shocks are hump-shaped and permanent. Our focus, by contrast, is on household investment.[7] Bachmann and Sims (2012) study the role of confidence in the transmission of fiscal policy change. They find that confidence is part of the transmission of government spending shocks

[7] Barsky and Sims (2012) mainly focus on non-durable goods and mention that the response of consumer durables is similar. As mentioned above, our central focus is on household investment which includes consumer durables.

during recessions. We pursue a similar approach and show that household investment is central in the transmission of a consumer confidence shock.

3 Data and preliminaries

3.1 Data

Our data span the period 1960Q1–2017Q4. We use National Income and Product Accounts (NIPA) Table 1.1.3 of the Bureau of Economic Analysis (BEA) to obtain the quantity series of real gross domestic product (GDP), personal consumption expenditures on durable goods, residential investment, non-residential investment and government consumption expenditure. We obtain total population from NIPA Table 7.1. The housing starts series (Housing Starts: Total: New Privately Owned Housing Units Started), total hours worked, unemployment rate and durable goods (industrial production) are from the FRED database of the Federal Reserve Bank of St. Louis. We use NIPA Table 1.1.4 to obtain price indices of durable goods, residential investment, equipment investment and GDP. We use the federal funds rate as measure of the nominal interest rate when the zero lower bound is not binding. When it is binding, we use the estimates for nominal interest rates from from Wu and Xia (2016). The utilization-adjusted series on TFP growth is from Fernald (2014) and we convert it to a log-level series. The stock return is the log difference of real S&P composite stock price index and we obtain the index from Robert Shiller's webpage.[8] We define RPI as the equipment investment price index divided by the GDP price index.

We define household investment as the sum of residential investment and consumption expenditures on durable goods. We provide the details of the household investment construction in the Appendix. We normalize all of these variables by the population. The consumer confidence data is from the University of Michigan's Surveys of Consumers. We mainly focus on the ICE. Finally, we obtain the business confidence index from the OECD database.

Panel (a) in Figure 1 shows the quarterly series of ICE and household investment for the period 1960Q1–2017Q4. The household investment has an overall upward trend with decreases occurring around the NBER recession dates. In particular, household investment decreases heavily during the

[8] http://www.econ.yale.edu/ shiller/

Great Recession of 2007–2009. Notably, all the recessions are preceded by a fall in ICE and all the major falls in ICE are followed by large decreases in household investment which precede the recessions. Panel (b) shows the relationship between cyclical household investment moves and ICE over the business cycles. The cyclical peaks and troughs in household investment follow the corresponding movements in ICE.

3.2 Does consumer confidence lead household investment?

Table 3 shows the cross-correlation of ICE with macroeconomics variables at various leads and lags (i.e. $Corr(ICE_t, X_{t+j})$ for $j = \pm 4, 3, 2, 1, 0$) for the period 1960Q1–2017Q4. Panel (a) shows that ICE is positively correlated with future cyclical household investment (HI), housing starts, output, hours worked, and business investment. The cyclical components are based on the HP filter. The largest correlation (0.33) between ICE at t and HI is at $t + 2$, which implies that ICE leads household investment by two quarters. This is a remarkable property and it provides prima-facie support to the hypothesis in (1) enabling subsequent empirical analysis in this paper. For other variables, ICE leads housing starts by one quarter, and output, hours worked, and business investment by four quarters. Panel (b) shows that the conclusion regarding the leading property of ICE for household investment remains robust to using an alternative filtering method proposed in Hamilton (2017), with the exception of housing starts where the relationship is contemporaneous.

3.3 Does consumer confidence Granger-cause household investment?

We perform Granger causality tests to check whether or not ICE Granger-causes household investment. We take the natural log for all the variables and use the Akaike Information Criteria (AIC) to choose the lag length of the variables. Table 4 shows the results of Granger causality tests using a bivariate VAR model. The null hypothesis that ICE does not Granger cause household investment is strongly rejected since the associated p-value is 0.001. Moreover, the hypothesis of reverse causality is rejected. That is, household investment does not Granger cause ICE. The tests also show that ICE Granger-causes total hours worked and output but not vice-versa. We also check whether ICE Granger-causes the components of household investment (i.e. residential investment and durable goods). We find that ICE Granger-causes residential investment and durable goods, but conversely, these components of household investment do not Granger-cause ICE. These findings suggest that consumer confidence contains information that can help predict household investment and other macroeconomic variables.

4 VAR analysis

In this section, we assess the macroeconomic effects of ICE shocks—the exogenous shifts in consumer confidence—using a VAR framework. A key difference relative to the previous literature on confidence shocks is that our main variable of interest is household investment. Since we are interested to see how changes in ICE can propagate to the economy through the household investment channel, we also include hours worked and real GDP in our analysis.

4.1 The effects of consumer confidence shocks

In the baseline case, we consider a four-variable VAR with ICE, household investment, total hours worked and real output.[9] All four variables enter the VAR in log-levels with four lags.[10] We use AIC to choose the lag length. Given our findings in the previous section, we order ICE first in the VAR and use the Cholesky orthogonalization to identify the ICE shock.

Figure 2 shows the impulse responses to an ICE shock. The shaded areas are one-standard-error confidence bands based on the Kilian (1998) bias-corrected bootstrap after bootstrap procedure. A one standard deviation positive ICE shock has a positive impact on household investment, total hours worked and output. These effects are statistically significant at 5 percent level. The impact effects are followed by hump-shaped and highly persistent responses of these variables. The peak response of household investment to a one standard deviation ICE shock is 2.2 percent. The peak responses of output and total hours worked are 0.8 percent and 0.75 percent, respectively. The responses of household investment and output are very persistent; at a horizon of 40 quarters, they remain statistically significant at a 5 percent level. The size of the response of hours worked for the same horizon is not as high, yet it is also statistically significant at a 5 percent level.

[9] Total hours worked and output are good indicators of the business cycle.

[10] We follow the common practice in the literature of putting variables in levels in the VAR. First differencing may loose information and it produces no gain in asymptotic efficiency in an autoregression process (see, Fuller (1976)).

Barsky and Sims (2012) examine the response of non-durable consumption and real output to a confidence shock (using the confidence measure based on sub-question $Q4$ in ICE denoted as E5Y) in a three-variable VAR. They showed that the consumer confidence has powerful predictive implications for the future paths of macroeconomic variables. The impulse responses of consumption and output to a one standard deviation consumer confidence shock are gradually increasing and statistically significant, and remain positive in the long run. Although our variables, except for output, are different from theirs, the response of output is quantitatively similar.

To consider the possibility that our confidence measure may contain information already contained in other variables in the VAR, we put ICE last in the VAR system. Figure 3 displays the impulse responses to one-standard-deviation shock to ICE for this orthogonalization. The impulse responses of household investment, total hours worked and output to ICE shock are not significantly different from reordering the variables in the VAR system. In this case, a positive shock to ICE does not have an initial impact on household investment, total hours worked and output by construction since ICE is ordered last in the VAR. However, a one standard deviation ICE shock still produces a hump-shaped pattern and highly persistent responses of household investment, total hours worked and output. The responses of household investment and output to a one-standard-deviation shock are nearly 0.6 percent at the 40 quarter horizon, and remain statistically significant. These responses are slightly smaller than in the case when ICE is ordered first.

Figure 4 displays the variance decompositions of ICE, household investment and output to an ICE shock from both orderings—ICE at first and last—in the VAR system. When ICE is ordered first in the VAR, the ICE shocks account for around 46, 38, and 74 percent of the forecast error variance of household investment, total hours worked and output at 40 quarter horizons, respectively. When ICE is ordered last in the VAR, the ICE shocks account for 28, 20, and 43 percent, respectively. ICE shocks account for 78 percent and 75 percent of their own forecast error variance, ordering ICE first and last, respectively. Note that the variation in ICE is mostly due to its own shock, which is consistent with our finding that household investment, total hours worked and output do not Granger-cause ICE.[11]

[11] We also consider a different measure of confidence, namely, the Index of Consumer Sentiment (ICS) instead of ICE in the same four variable VAR system. There are no significant differences in the responses of household investment, total hours worked and output across the two shocks. This finding suggests that information content of $Q1$ and $Q5$ in the Surveys of Consumers has little effect on macroeconomic variables.

4.2 Household investment as a business cycle transmission channel

Does household investment play a role in the transmission of confidence shocks over the business cycle? To answer this question, we follow the approach developed in Bernanke et al. (1997) and Sims and Zha (2006) and used in Kilian and Lewis (2011), and Bachmann and Sims (2012).[12] Specifically, we consider an impulse response of output to an ICE shock, holding household investment fixed at all forecast horizons. Comparing this *constrained* impulse response with the actual response of output to a confidence shock provides a measure of how the response of household investment contributes to the propagation of the ICE shock.

Our exposition of the approach below closely follows Bachmann and Sims (2012). We consider the following structural VAR(p) representation (with the constant term suppressed for notational convenience):

$$A_0 Y_t = \sum_{j=1}^{p} A_j Y_{t-j} + \varepsilon_t, \tag{2}$$

where, Y_t is $k \times 1$ vector that contains four variables, namely ICE, household investment, total hours worked and output, A_j is $k \times k$ matrix that includes the autoregressive coefficients, p is the number of lags of the variables and j identifies the order of the lag. Finally, the $k \times 1$ vector ε_t denotes the mutually uncorrelated structural shocks and the A_0 is the $k \times k$ lower triangular impact matrix.

We express the above model in a reduced form as:

$$Y_t = \sum_{j=1}^{p} A_0^{-1} A_j Y_{t-j} + u_t, \tag{3}$$

where the reduced-form shocks, $u_t = A_0^{-1}\varepsilon_t$, and ε_{1t}, ε_{2t}, ε_{3t} and ε_{4t} are the structural ICE shock, household investment shock, total hours worked shock and output shock, respectively. The vector of structural shocks, ε_t, is a zero mean white noise process with covariance matrix $E(\varepsilon_t \varepsilon_t') \equiv \Omega_\varepsilon = I_k$ such that the reduced-form shocks covariance matrix is $E(u_t u_t') \equiv \Omega_u = A_0^{-1} A_0^{-1\prime}$.

We impose restrictions on the impact matrix A_0 in order to uniquely recover the structural VAR as follows:

[12] Using this approach, Bernanke et al. (1997), Sims and Zha (2006) and Kilian and Lewis (2011) shed light on the transmission of monetary policy shocks, and Bachmann and Sims (2012) study the role of consumer confidence in the transmission of government shocks.

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{2,1} & 1 & 0 & 0 \\ a_{3,1} & a_{3,2} & 1 & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & 1 \end{bmatrix}_{(k \times k)}.$$

We order ICE first, then household investment, total hours worked and output. We employ a Cholesky factorization of the variance-covariance matrix of reduced-form shocks, Ω_u, to implement the identification assumption. Our assumption is that household investment, total hours worked and output react contemporaneously to the ICE shocks, whereas ICE does not react on impact to other shocks in the system. The assumption is valid since household investment leads output and ICE leads household investment, total hours worked and output.

Constrained impulse responses: Does household investment play in the transmission of confidence shocks? To answer this question we follow Bachmann and Sims (2012) and consider a hypothetical scenario where the response of household investment to an ICE shock is constrained to be exactly zero for all horizons. To frame the discussion, it is convenient to consider the companion matrix VAR(1) representation of the VAR(p) process.

$$Z_t = \Lambda Z_{t-1} + U_t, \tag{4}$$

where,

$$Z_t = \begin{bmatrix} Y_t \\ Y_{t-1} \\ . \\ . \\ . \\ Y_{t-p+1} \end{bmatrix}_{(kp \times 1)}, \quad \Lambda = \begin{bmatrix} A_0^{-1}A_1 & A_0^{-1}A_2 & \cdots & \cdots & A_0^{-1}A_p \\ I & 0 & 0 & \cdots & 0 \\ 0 & I & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & \cdots & \cdots & I & 0 \end{bmatrix}_{(kp \times kp)}, \quad \text{and} \quad U_t = \begin{bmatrix} u_t \\ u_{t-1} \\ . \\ . \\ . \\ u_{t-p+1} \end{bmatrix}_{(kp \times 1)}.$$

Let $A_0^{-1}(q)$ be the qth column of A_0^{-1}. The impulse response of variable i to structural shock q at horizon $h = 1, ..., H$ is:

$$\Phi_{i,q,h} = e_i \Lambda^{h-1} A_0^{-1}(q) \tag{5}$$

where, e_i is a selection vector of dimension $1 \times k$, with a one in the i^{th} place and zeros elsewhere. Since our objective is to hold fixed the response of household investment to confidence shocks in the system, we set $\Phi_{2,1,h} = 0$ at each forecast horizon, where the position indicators 2 and 1 denote for household investment and confidence shocks, respectively. We then create a hypothetical sequence of household investment shocks, $\varepsilon_{2,h}$, so that we can shut down the response of household investment at each forecast horizon. We can write this in the following matrix form:

$$A_0^{-1}(2,1) + A_0^{-1}(2,2)\varepsilon_{2,1} = 0 \tag{6}$$

which implies

$$\varepsilon_{2,1} = -\frac{A_0^{-1}(2,1)}{A_0^{-1}(2,2)}. \tag{7}$$

We then calculate the required household investment shocks for subsequent horizons as follows:

$$\varepsilon_{2,h} = -\frac{\Phi_{2,1,h} + \sum_{j=1}^{h-1} e_2 \Lambda^{h-j} A_0^{-1}(2)\varepsilon_{2,j}}{e_2 A_0^{-1}(2)}, \ h = 2, ..., H. \tag{8}$$

Now we use the above household investment shocks series to get the constrained or hypothetical impulse responses of the variables to ICE shocks. These are:

$$\tilde{\Phi}_{i,1,h} = \Phi_{i,1,h} + \sum_{j=1}^{h} e_i \Lambda^{h-j} A_0^{-1}(2)\varepsilon_{2,j}, \ i = 1, ..., k. \tag{9}$$

Figure 5 shows the impulse responses of ICE, household investment, total hours worked and output to an ICE shock. The blue solid lines and the red dashed lines in the figure show the actual and hypothetical impulse responses, respectively. Shutting down the response of household investment at all horizons has significant effects on the other variables in the VAR system. The response of output to confidence shocks without household investment is substantially attenuated and consistently lower than in the presence of the household investment channel at all horizons. The response of output to a one-standard-deviation ICE shock drops to nearly 0.2 percent from 1.4 percent at a 40 quarter horizon when we impose the constraint that the response of household investment is zero at all horizons. The response of total hours worked to ICE shocks is small on impact when the household investment effects are absent. It also subsequently drops at longer horizons without household investment. These results demonstrate that household investment plays a significant role in transmitting confidence shocks to the broader economy.

4.3 Corroborative evidence

As illustrated in (1) in the introduction, a plausible story underlying our finding that household investment plays a significant role in transmitting confidence shocks to economy goes as follows: a positive confidence shock leads to more spending in houses and durable goods (increasing demand for housing) and putting upward pressure on real house prices; then house builders and consumer durables firms react by investing (producing) more houses and durable goods (increasing supply of housing). The investment on private capital structure then boosts GDP.

We estimate a five-variable structural VAR with ICE, durable goods (consumption), durable goods (industrial production), hours worked and output. Figure 6 shows the results for the period 1985–2017. The direct responses of durable goods, durable goods (industrial production) hours worked and output, when the response of durable goods to ICE shocks is fixed, are lower than the indirect responses of durable goods, durable goods (industrial production) hours worked and output at all horizons.[13] Figure 7 shows that real house prices also increase after an ICE shock. Taken together, these findings provide corroborative evidence for the transmission of confidence shocks and the demand-driven channel described in (1) above.

4.4 Historical decomposition

We compute the historical decomposition to quantify the share of confidence shock in accounting for historically observed fluctuations in household investment, hours worked and output in the VAR system. Figure 8 shows the historical decomposition in VAR system with four variables, ICE, household investment, hours worked and output. Panel (a) shows that the ICE forecast error variance accounts for ICE shocks for the most of the sample period. Panel (b) displays the historical decomposition of ICE shocks and other fundamentals for the forecast error variance of household investment. The contribution of ICE shocks is substantially higher in the 1990–2002 period. Panel (c) and (d) show the historical decomposition for the forecast error variance of total hours worked and output, respectively. The confidence shocks has little effect for total hours worked forecast error variance. However, the confidence shocks play a significant role for output forecast error variance for most of the sample

[13] The difference between the production and consumption responses indirectly shows the inventories response.

period.

We examine the cross-correlation of household investment with output and hours worked conditional on consumer confidence shocks, obtained using a four-variable structural VAR with ICE, household investment, hours worked and output. Table 5 shows the cross correlation (i.e. $Corr(HI_t, X_{t+j}|ICE^{shocks})$ for $j = \pm 4, 3, 2, 1, 0$) results. The conditional correlation between household investment and output is strongly positive. Household investment leads output on conditional confidence shocks by two quarters. The result is consistent with unconditional cross correlations between the two variables. We also find that household investment leads total hours worked conditional on confidence shocks by two quarters.

5 Robustness checks

We conduct a variety of robustness checks. These checks consider additional variables in the VAR, sub-samples, and robustness of the transmission channel. Below we report a few salient robustness checks and have provide others in a detailed online appendix.

5.1 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 9. 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 10 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.[14]

We consider a VAR with six variables (ICE, household investment, business investment, govern-

[14]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.

ment expenditures, total hours worked, and output). We include government expenditures in the VAR as in Bachmann and Sims (2012). Figure 11 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 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, TFP, RPI, household investment, hours worked and output. Figures 12 and 13 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.

5.2 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 6 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 very low R^2 (i.e. 0.003). Since technology growth variables are not related to the confidence shocks, that indicates that the ICE shocks are not related to future movements in supply-side forces.

5.3 The role of labour market variables in 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, i.e., holding fixed the responses of household investment to consumer confidence shocks at all forecast horizons.

Figure 14 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, 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 15 shows the results. The actual and hypothetical response of output to ICE shocks are qualitatively same. It implies that hours worked do not transmit consumer confidence shocks to the broader economy in the way that household investment does.

5.4 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 16. 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 17 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.

6 Conclusion

The well known and robust leading indicator property of household investment (consumer durables plus residential investment) has been a challenging business cycle fact to explain. Since single-family homes are the main source of this property for residential investment, it suggests that household investment is likely affected by shifts in consumer confidence at a family decision-making unit level. So far there has been no attempt to connect consumer confidence as source of the leading indicator property. Our paper fills this gap. We use quarterly aggregate data since 1960 and measure consumer confidence from the University of Michigan Surveys of Consumers. We show that consumer confidence leads household investment by two quarters and housing starts by one quarter. Household investment rises persistently in a hump-shaped manner after positive consumer confidence shock. Both hours-worked and output also increase on impact and the effects are highly persistent, and so do real house prices. The confidence shocks account for over 40 percent of the variation in household investment over long horizons (40 quarters). These shocks account for a substantial variation in output nearly 75 percent of all GDP variation) and about 40 percent of the hours variation. We find that household investment plays a quantitatively important role in the transmission of confidence shocks to the economy. Moreover, confidence shocks do not appear to be related to movements in future total factor productivity and relative price of investment reflecting supply side developments. Our findings, therefore, suggest that demand side forces originating in consumers' social and psychological factors may be a fruitful direction for studying household investment dynamics and their relationship with the business cycle.

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7 Appendix

7.1 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

7.2 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?

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

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

8 Tables and Figures

Table 1: Cross-correlations: Household investment in t with business investment or output in $t+j$

Variable	Rel Std.	$j=-4$	-3	-2	-1	0	1	2	3	4
				Panel I: HP filtered data						
(a) 1947Q1–2017Q4										
Business Investment	1.419	-0.423	-0.322	-0.135	0.105	0.380	0.568	0.660	**0.671**	0.619
Output	4.057	-0.312	-0.156	0.079	0.340	0.584	**0.678**	0.659	0.564	0.447
(b) 1947Q1–1983Q4										
Business Investment	1.682	-0.597	-0.542	-0.352	-0.061	0.300	0.533	**0.633**	0.624	0.544
Output	4.130	-0.483	-0.339	-0.076	0.228	0.525	**0.613**	0.568	0.438	0.297
(c) 1984Q1–2017Q4										
Business Investment	1.018	-0.170	-0.023	0.130	0.280	0.437	0.542	0.611	0.651	**0.653**
Output	4.210	-0.011	0.146	0.329	0.510	0.676	**0.733**	0.722	0.669	0.599
				Panel II: Hamilton (2017)-filtered data						
(a) 1947Q1–2017Q4										
Business Investment	1.380	-0.180	-0.074	0.068	0.229	0.422	0.517	0.587	0.642	**0.650**
Output	4.090	0.042	0.199	0.353	0.517	0.670	0.725	**0.729**	0.713	0.672
(b) 1947Q1–1983Q4										
Business investment	1.387	-0.305	-0.212	-0.072	0.114	0.337	0.495	0.607	0.677	**0.695**
Output	3.524	-0.121	-0.003	0.154	0.331	0.516	0.597	**0.621**	0.614	0.569
(c) 1984Q1–2017Q4										
Business Investment	1.060	-0.059	0.033	0.150	0.268	0.401	0.464	0.503	0.564	**0.572**
Output	4.125	0.053	0.162	0.316	0.485	0.644	**0.689**	0.685	0.669	0.656

Notes: In Panel I, we take logs in levels and de-trend them with the HP-filter ($\lambda = 1600$). In Panel II, we take logs in levels and de-trend them with the Hamilton (2017) filter using and 8-quarter forecast horizon and four lags in the regression specification. The largest correlations indicating the leading property of household investment are shown in bold.

Table 2: Cross-correlations: Components of residential investment in t with output in $t + j$

	Rel Std.	$j = -4$	-3	-2	-1	0	1	2	3	4
(a) 1958Q1–2017Q4										
Single family	9.525	-0.228	-0.059	0.174	0.425	0.635	**0.731**	0.730	0.670	0.590
Multi family	12.438	0.220	0.313	0.399	0.457	**0.469**	0.417	0.327	0.218	0.117
Other structures	3.995	-0.079	0.048	0.163	0.313	0.509	**0.617**	0.593	0.532	0.469
(b) 1958Q1–1983Q4										
Single family	9.538	-0.389	-0.226	0.035	0.340	0.620	**0.705**	0.662	0.550	0.433
Multi family	12.328	-0.008	0.132	0.294	0.440	**0.523**	0.480	0.369	0.223	0.087
Other structures	3.810	-0.234	-0.101	0.028	0.216	0.476	**0.578**	0.466	0.328	0.218
(c) 1984Q1–2017Q4										
Single family	10.955	-0.037	0.110	0.309	0.505	0.647	**0.702**	0.688	0.634	0.563
Multi family	14.780	0.611	**0.617**	0.561	0.466	0.361	0.241	0.1451	0.069	0.025
Other structures	4.575	-0.143	-0.031	0.088	0.231	0.413	0.522	0.601	0.632	**0.647**

Notes: We take logs in levels and de-trend with the HP-filter ($\lambda = 1600$). The largest correlations are shown in bold.

Table 3: Cross-correlations: ICE in t with a variable in $t+j$

Variable	$j=-4$	-3	-2	-1	0	1	2	3	4
				Panel I: HP-filtered data					
Household investment	-0.101	-0.015	0.070	0.174	0.282	0.328	**0.330**	0.318	0.286
Housing starts	-0.002	0.069	0.147	0.234	0.288	**0.296**	0.282	0.250	0.203
Output	-0.271	-0.220	-0.125	-0.011	0.135	0.224	0.278	0.297	**0.314**
Hours worked	-0.227	-0.196	-0.142	-0.064	0.050	0.153	0.228	0.276	**0.303**
Business investment	-0.225	-0.209	-0.165	-0.095	0.014	0.116	0.200	0.264	**0.309**
				Panel II: Hamilton (2017)-filtered data					
Household investment	0.269	0.335	0.388	0.459	0.513	**0.516**	0.475	0.433	0.355
Housing starts	0.302	0.360	0.414	0.476	**0.503**	0.480	0.436	0.370	0.301
Output	0.187	0.251	0.326	0.423	0.536	0.602	0.634	**0.651**	0.627
Hours worked	0.062	0.094	0.141	0.210	0.297	0.366	0.402	**0.422**	0.407
Business investment	0.058	0.079	0.105	0.173	0.255	0.315	0.369	0.427	**0.433**

Note: The sample period is 1960Q1 to 2017Q4. In Panel (a), we take logs of the variables (except ICE) in levels and de-trend them with the HP-filter ($\lambda = 1600$). In Panel (b), we take logs of the variables (except ICE) in levels and de-trend them with the Hamilton-filter. The largest correlations are shown in bold.

Table 4: Granger-causality tests

Explained variables	Explanatory variables	Chi-squared	p-value	Granger-causality
Household investment	ICE	11.000	0.012	**ICE $\rightarrow$ Household investment**
ICE	Household investment	5.704	0.127	Household investment $\not\rightarrow$ ICE
Residential investment	ICE	11.474	0.003	**ICE $\rightarrow$ Residential investment**
ICE	Residential investment	3.603	0.165	Residential investment $\not\rightarrow$ ICE
Durable goods	ICE	22.416	0.000	**ICE $\rightarrow$ Durable goods**
ICE	Durable goods	3.065	0.216	Durable goods $\not\rightarrow$ ICE
Business investment	ICE	11.474	0.003	**ICE $\rightarrow$ Business investment**
ICE	Business investment	3.603	0.165	Business investment $\not\rightarrow$ ICE
Output	ICE	21.236	0.000	**ICE $\rightarrow$ Output**
ICE	Output	0.691	0.708	Output $\not\rightarrow$ ICE
Hours worked	ICE	15.057	0.001	**ICE $\rightarrow$ Hours worked**
ICE	Hours worked	3.482	0.175	Hours worked $\not\rightarrow$ ICE

Notes: We perform bi-variate VAR Granger-causality Wald tests (i.e ICE with household investment, residential investment, durable goods, business investment, output and hours worked). AIC is used for lag selection for each VAR regression. We take natural log for household investment, residential investment, durable goods, business investment, output and hours worked. A variable that Granger-causes another variable at 5% significance level is indicated in bold using a '$\rightarrow$' in the last column.

Table 5: Cross-correlations conditional on ICE shock

	$j=-4$	-3	-2	-1	0	1	2	3	4
$Corr(HI_t, Y_{t+j} \mid ICE^{shock})$	0.468	0.544	0.624	0.702	0.772	0.806	**0.811**	0.797	0.771
$Corr(HI_t, HW_{t+j} \mid ICE^{shock})$	0.224	0.263	0.309	0.360	0.408	0.439	**0.448**	0.440	0.417

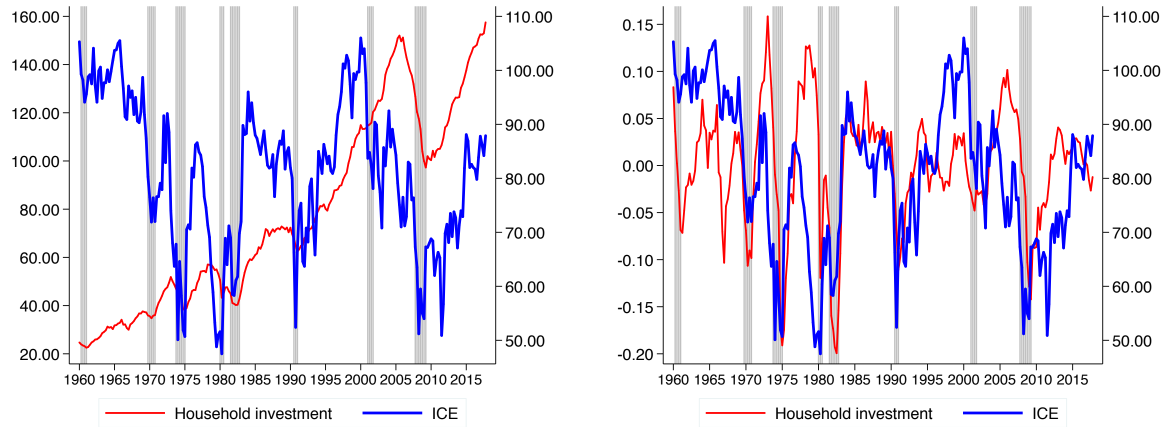
Notes: The table presents cross correlation between household investment in t with output and total hours worked in $t+j$ on conditional consumer confidence shocks in VAR system for the period 1961Q1 to 2017Q4. The largest correlations are shown in bold.

Table 6: 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). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

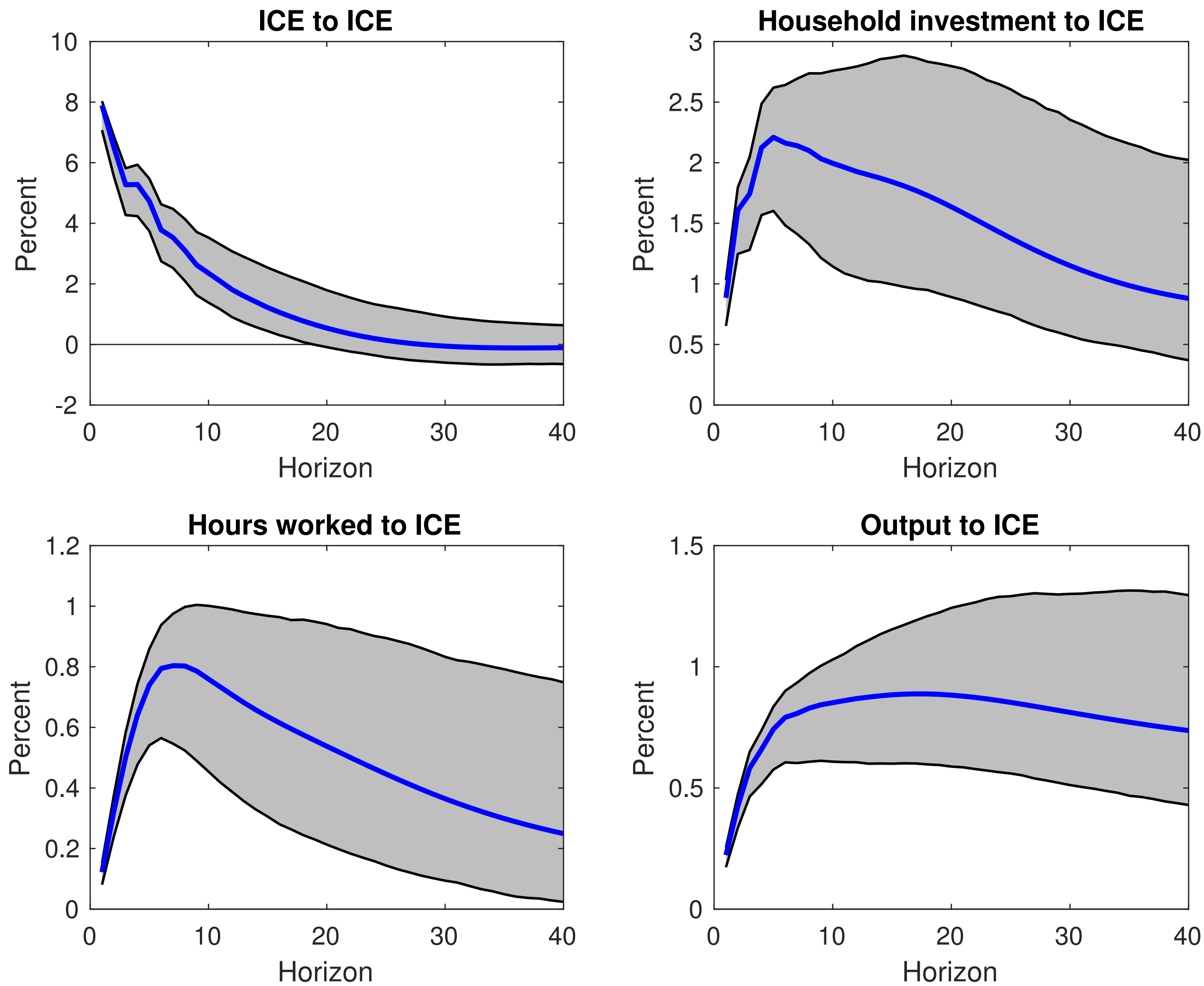
Figure 1: Consumer confidence and household investment



(a) Level **(b)** Cyclical

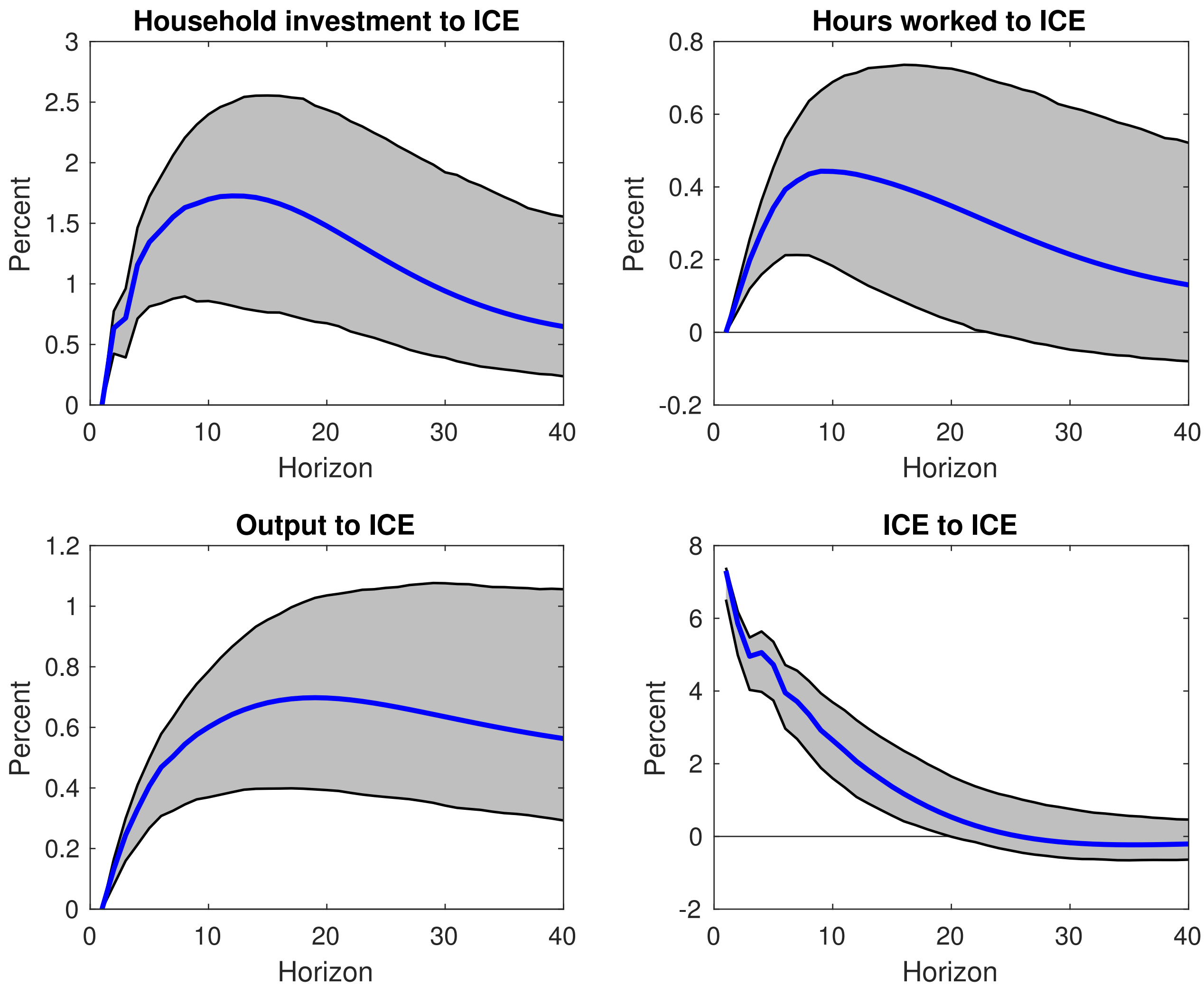
Notes: The NBER recession dates are in grey shading. In Panel (a), the data are in level. ICE and household investment are in right and left scales, respectively. The sample period is 1960Q1 to 2017Q4. In Panel (b), Household investment is logged and de-trended with the HP-filter ($\lambda = 1600$).

Figure 2: Responses to a one standard deviation consumer confidence shock (ICE ordered first)



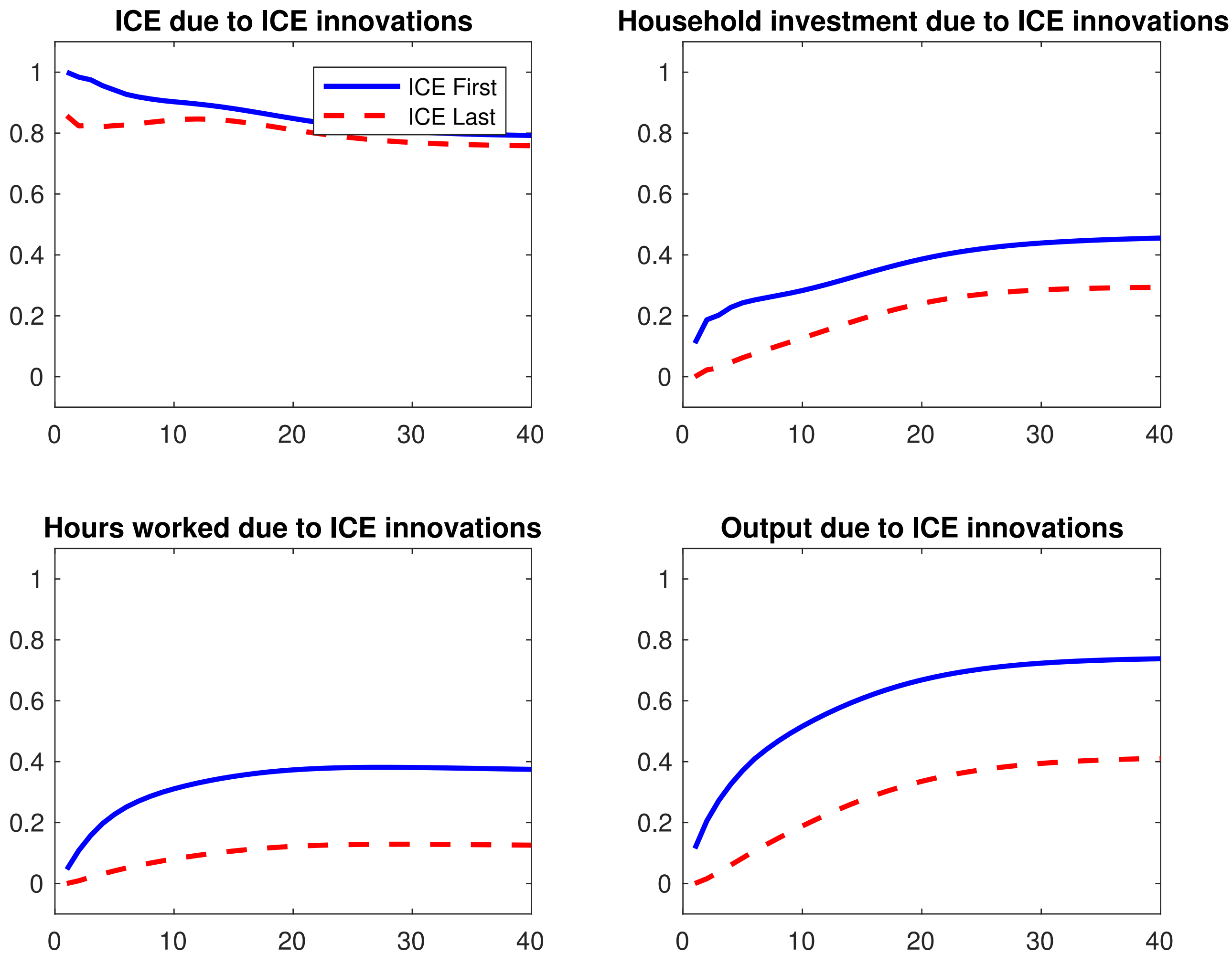
Notes: These are IRFs from a four-variable VAR with ICE, household investment, hours worked and output based on Cholesky identification. ICE is ordered first in the VAR. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

Figure 3: Responses to a one standard deviation consumer confidence shock (ICE ordered last)



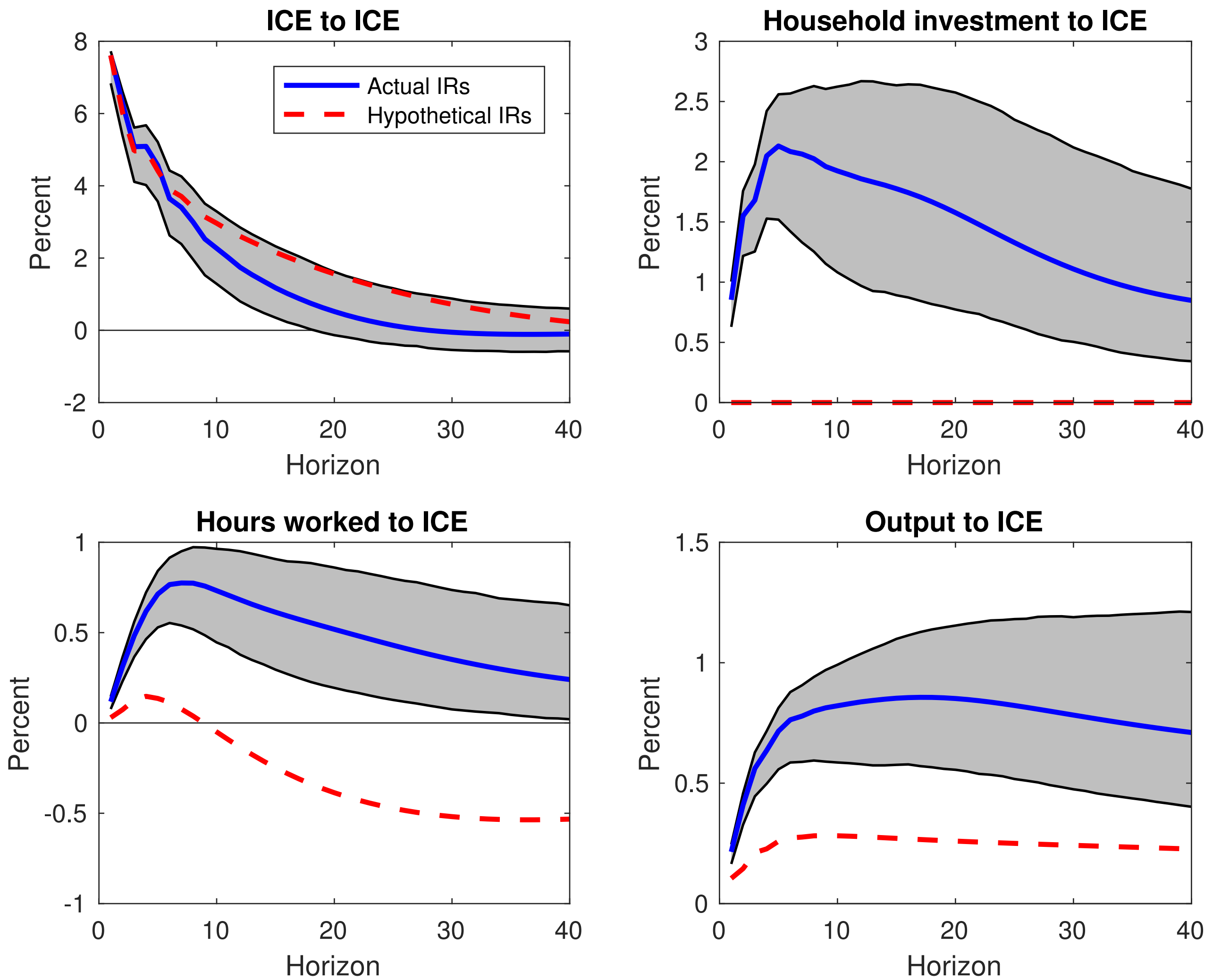
Notes: These are IRFs from a four-variable VAR with ICE, household investment, hours worked and output. ICE is ordered at last in the VAR. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s the bias-corrected bootstrap after bootstrap procedure. The sample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

Figure 4: Forecast error variance decomposition of confidence shocks



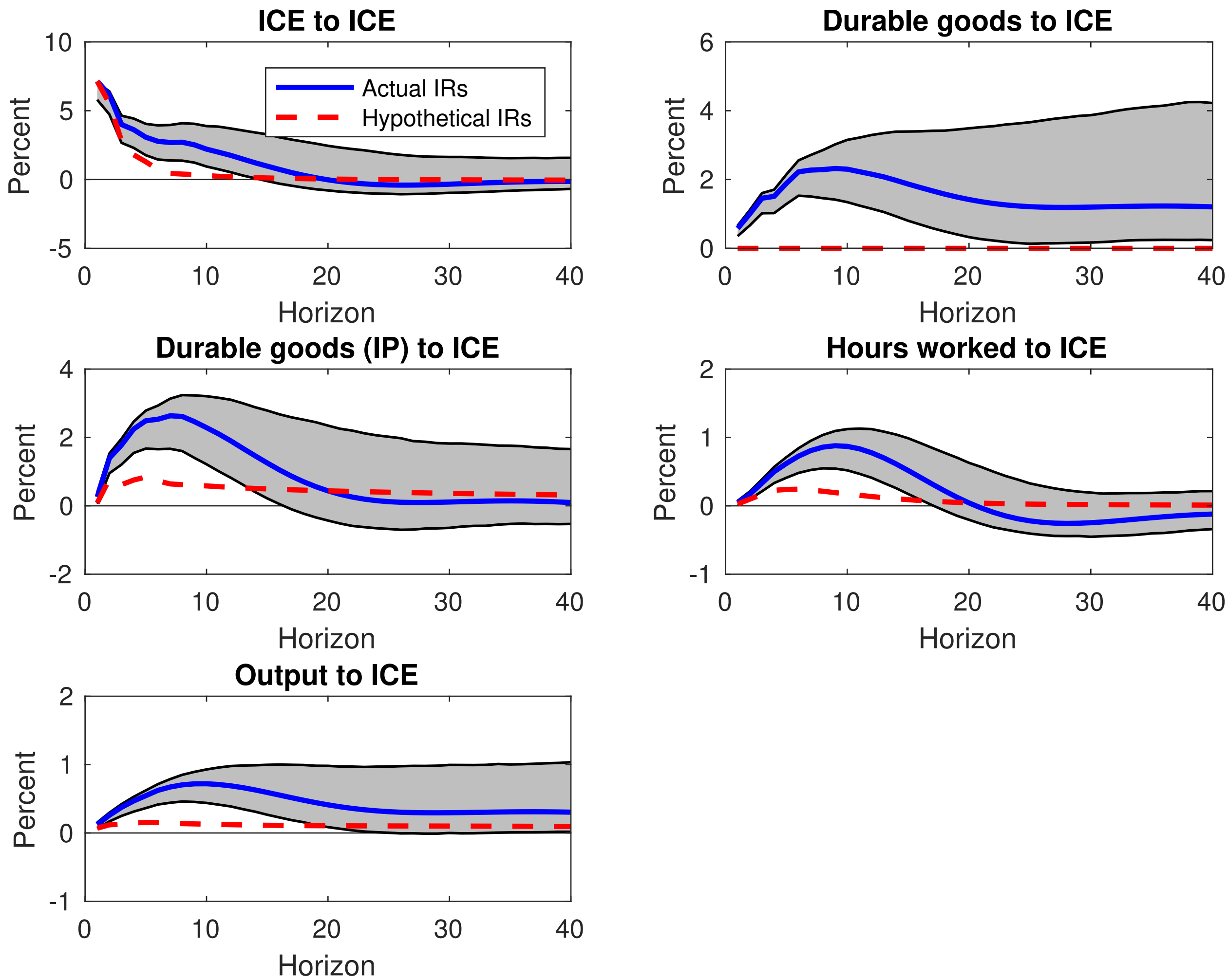
Notes: This figure plots variance decompositions from the four-variable VAR whose impulse responses are shown in Figure 2 and Figure 3 under both orderings. The sample period is 1960Q1 to 2017Q4.

Figure 5: Responses to one standard deviation consumer confidence shock: the role of household investment in the transmission channel



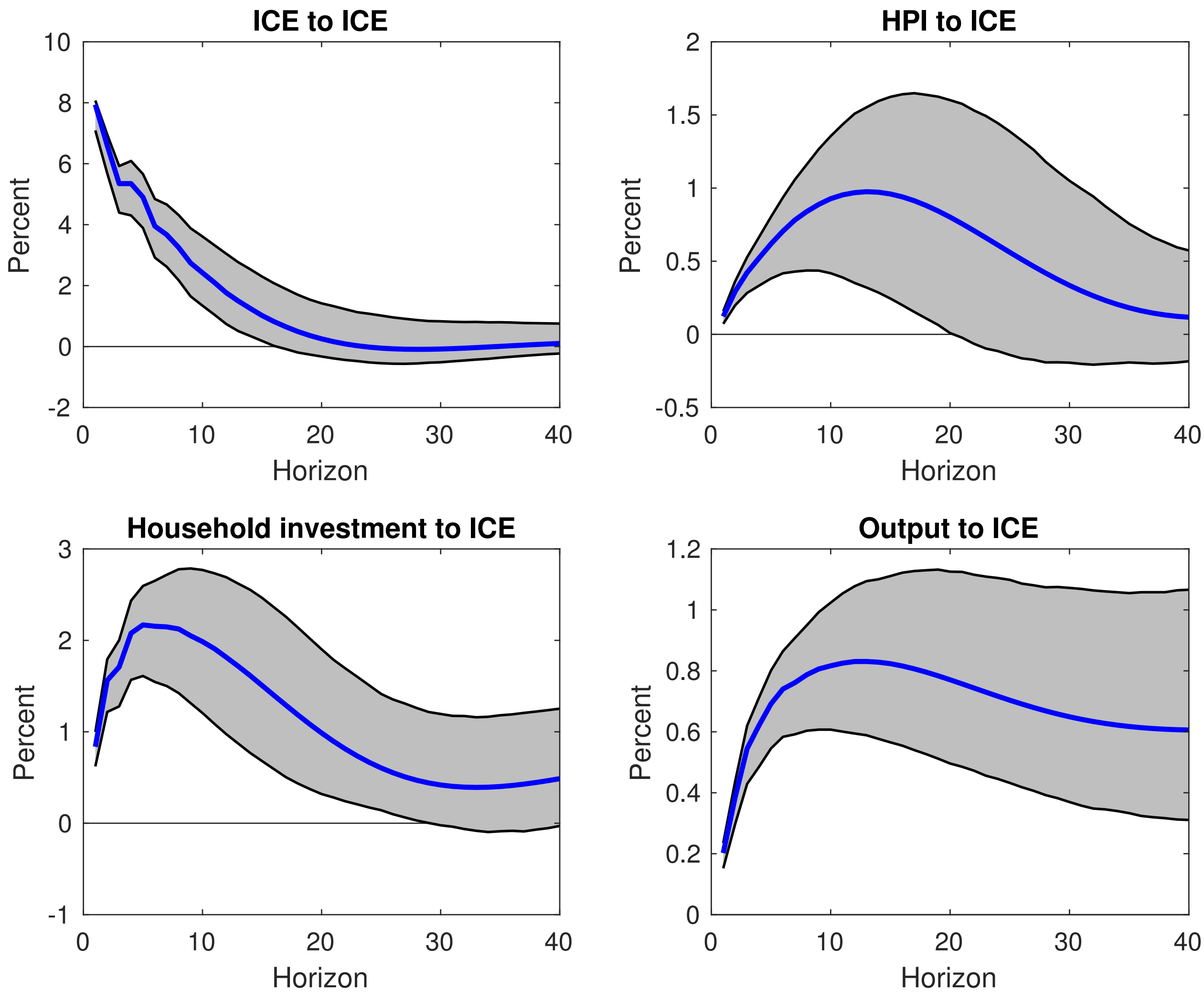
Notes: These are IRFs from a four-variable VAR with ICE, household investment, hours worked and output. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s the bias-corrected bootstrap after bootstrap procedure.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

Figure 6: Responses to a one standard deviation consumer confidence shock: durable goods



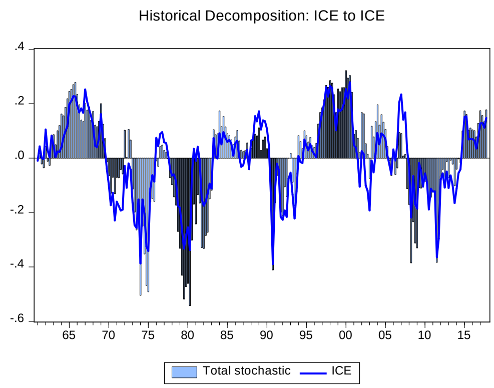
Notes: These are IRFs from a five-variable VAR with ICE, durable goods, durable goods industrial production, hours worked and output. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s the bias-corrected bootstrap after bootstrap procedure. The sample period is 1985Q1 to 2017Q4.

Figure 7: Responses to a one standard deviation consumer confidence shocks: Real house prices

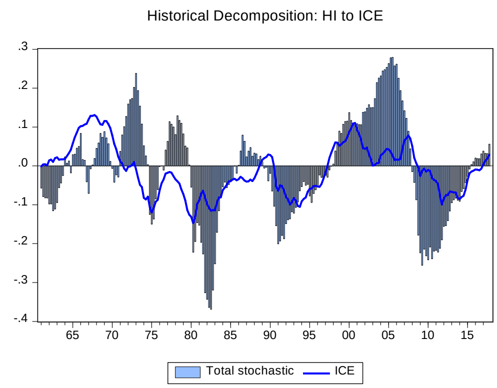


Notes: These are IRFs from a four-variable VAR with ICE, real home price index, household investment and output. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s the bias-corrected bootstrap after bootstrap procedure. The sample period is 1960Q1 to 2017Q4.

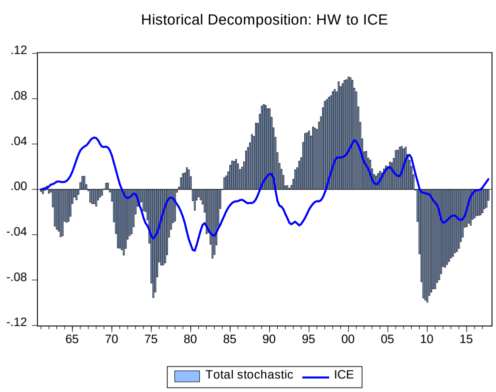
Figure 8: Historical forecast error decomposition of ICE shocks



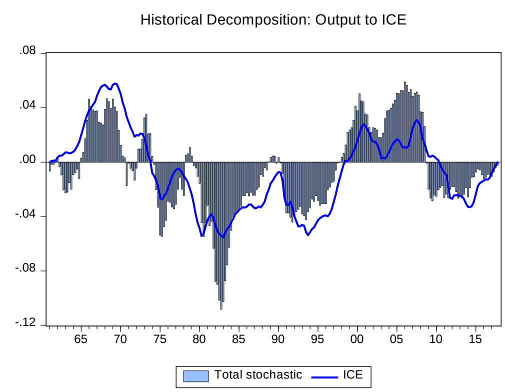
(a) ICE to ICE



(b) Household investment to ICE



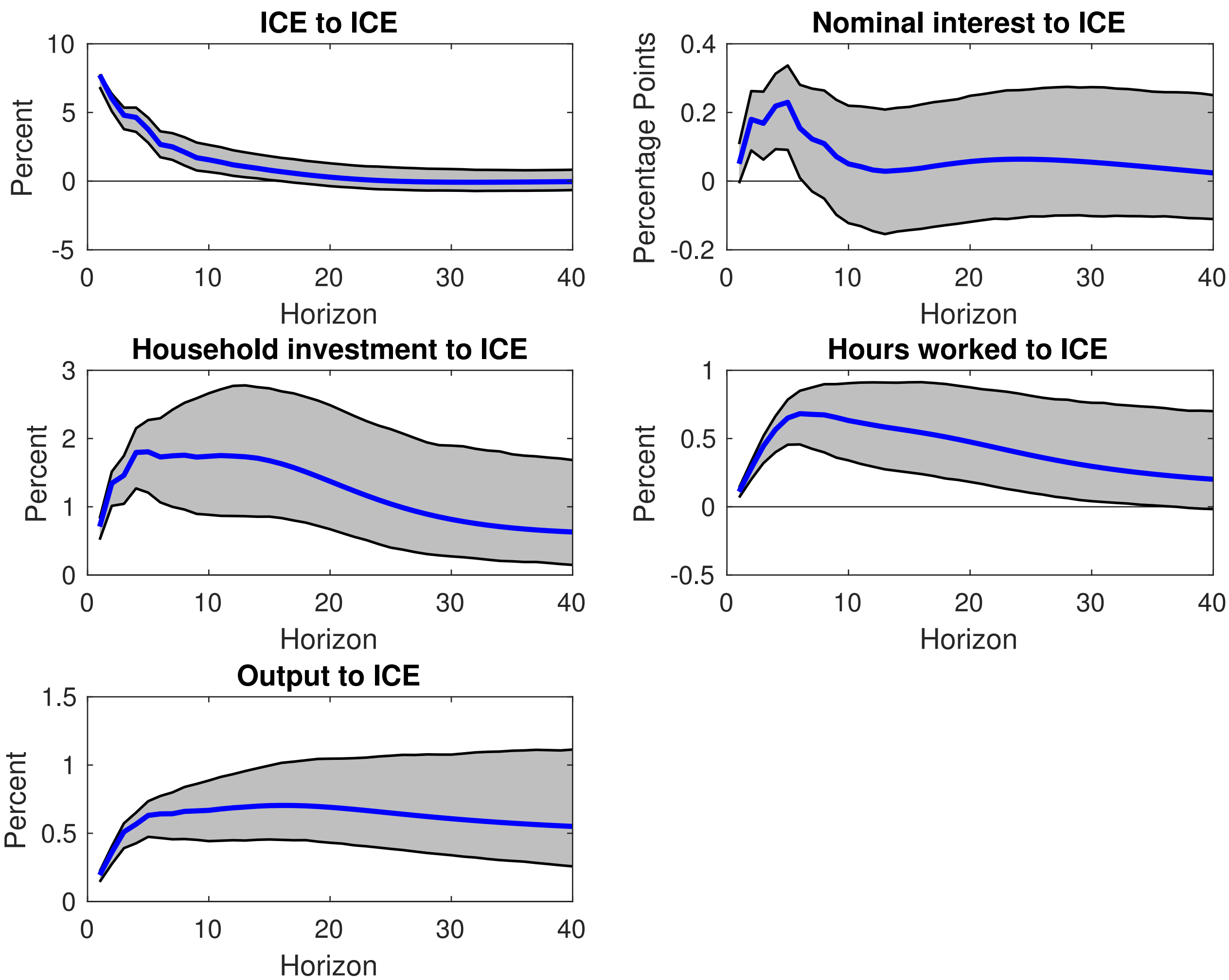
(c) Hours worked to ICE



(d) Output to ICE

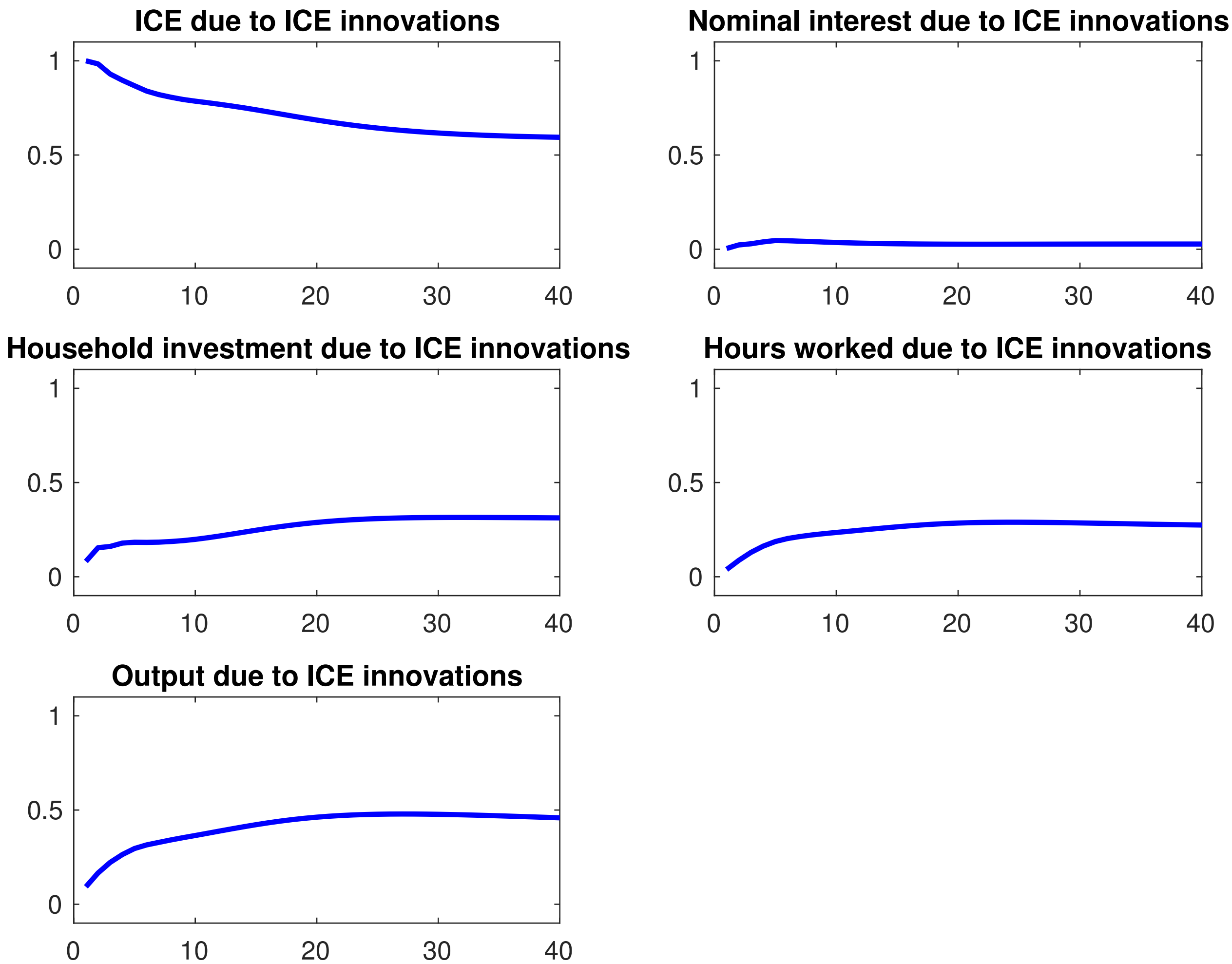
Notes: These are historical decomposition from a four-variable VAR with ICE, household investment, hours worked and output. The sample period is 1960Q1 to 2017Q4.

Figure 9: Robustness: Responses to a one standard deviation confidence shock (ICE ordered first)



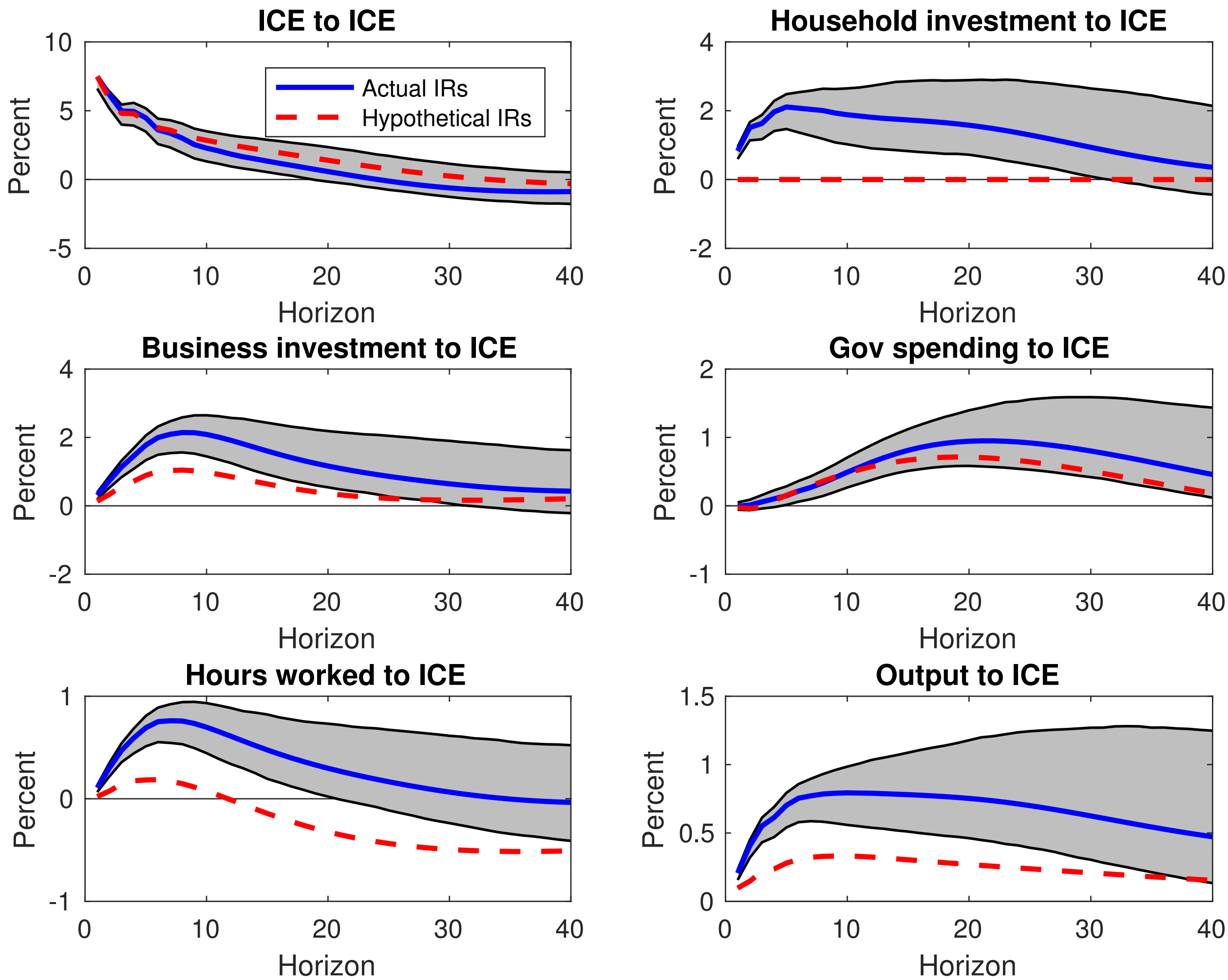
Notes: These are IRFs from a five-variable VAR with ordering ICE, nominal interest rate, household investment, hours worked and output. We take natural log for all variables except for nominal interest rate. The shaded areas are one-standard-error confidence bands based on Kilian (1998) bias-corrected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

Figure 10: Robustness: Forecast error variance decomposition of ICE shocks



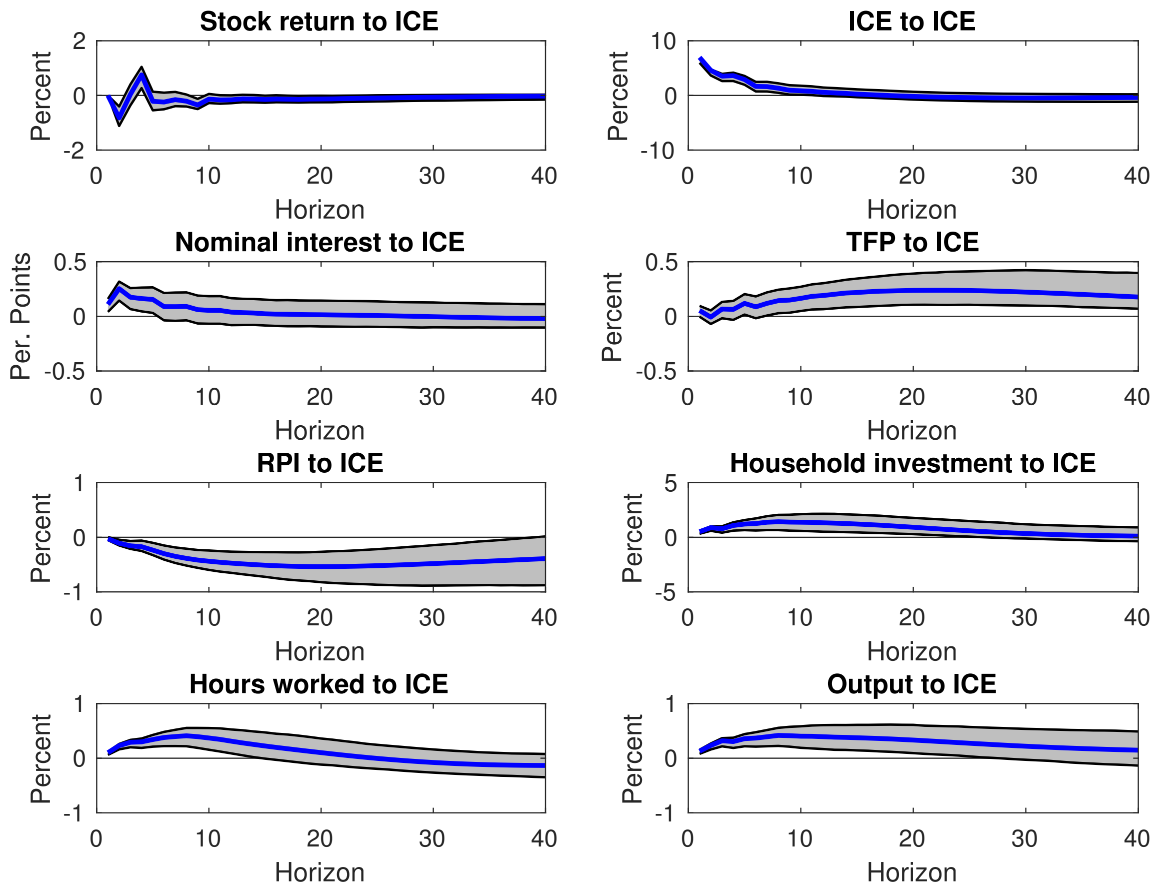
Notes: This figure plots variance decompositions from ICE shocks in the five-variable VAR system with ordering ICE, nominal interest rate, household investment, hours worked and output. We take natural log for all variables except for nominal interest rate. The sample period is 1960Q1 to 2017Q4.

Figure 11: Responses to a one standard deviation consumer confidence shock: Larger VAR



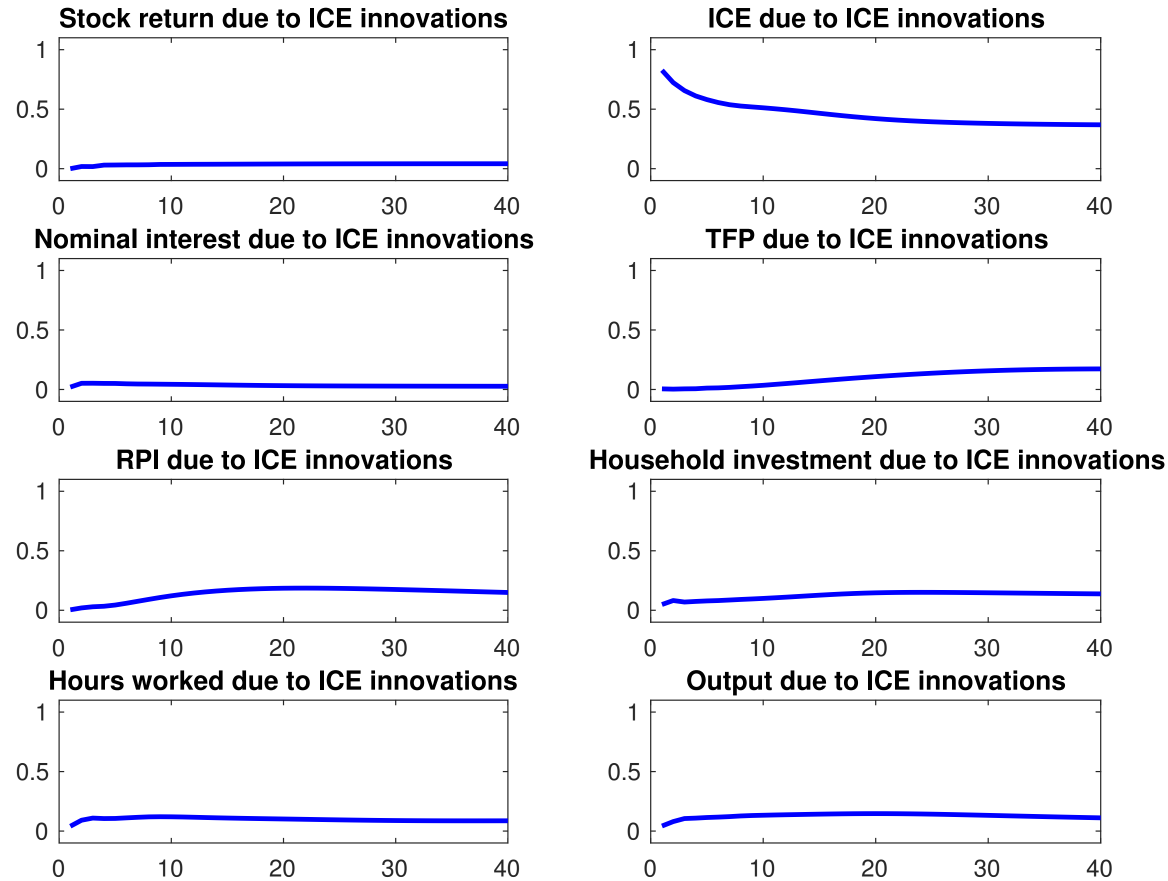
Notes: These are IRFs from a six-variable structural VAR with ICE, household investment, business investment, government expenditure, hours worked and output. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands constructed using Kilian (1998)'s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

Figure 12: Responses to a one standard deviation confidence shock



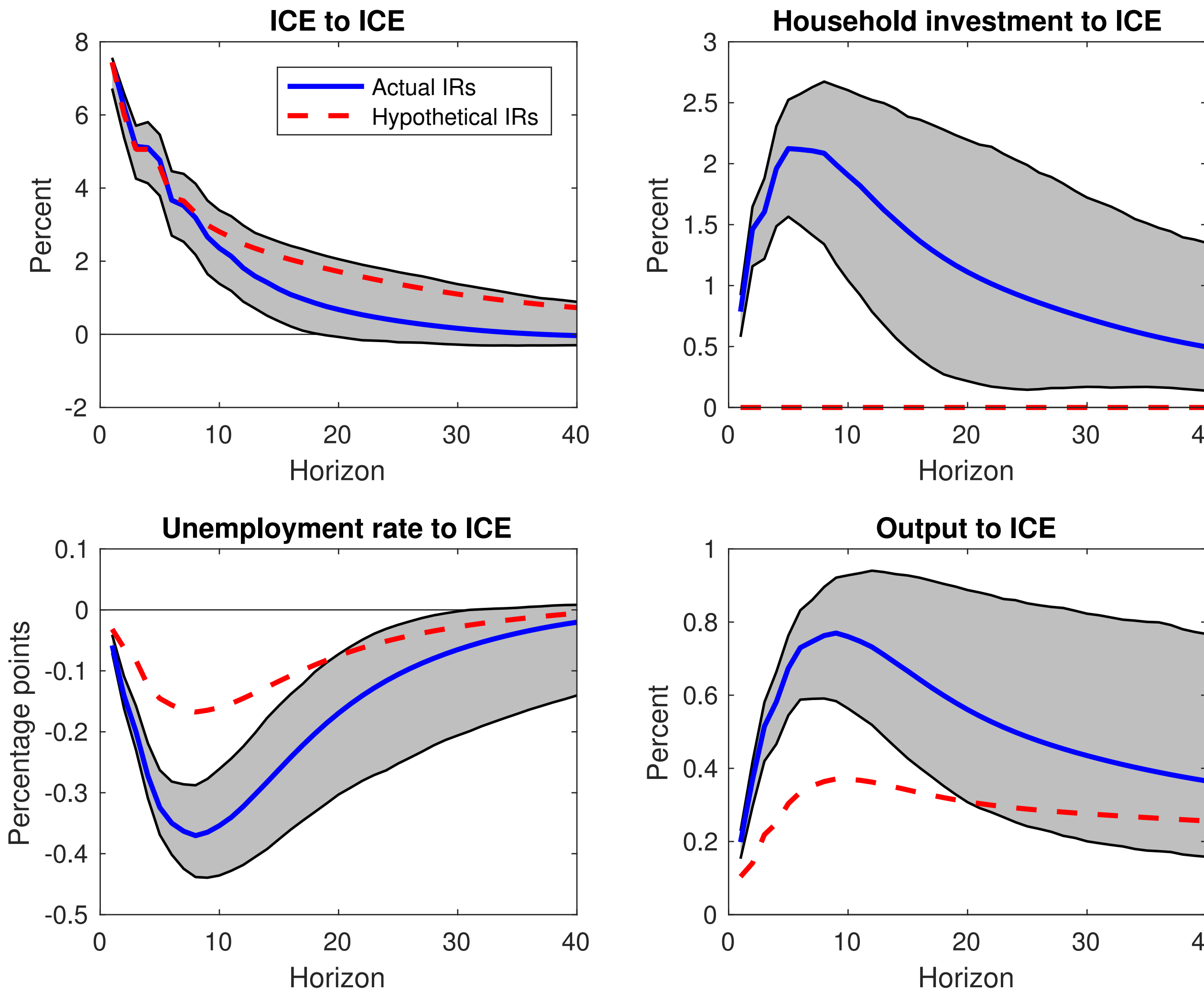
Notes: These are IRFs from an eight-variable VAR with ordering stock return, ICE, nominal interest rate, TFP, RPI, household investment, hours worked and output based on Cholesky identification. BCI is ordered first in the VAR. We take natural log for all variables except for nominal interest rate. The 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 13: Forecast error variance decomposition of confidence shock



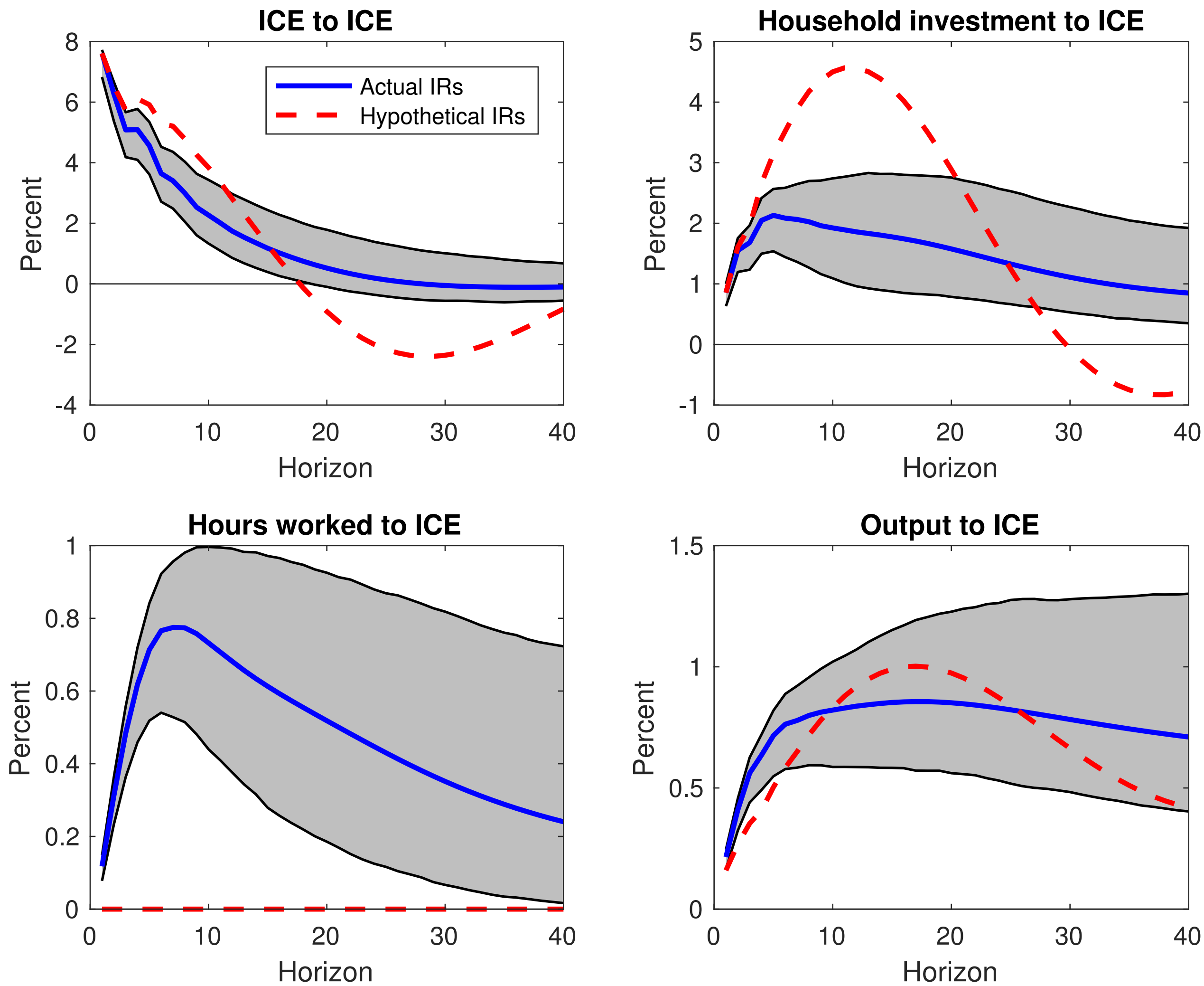
Notes: This figure plots variance decompositions from an eight-variable VAR with ordering stock return, ICE, nominal interest rate, TFP, RPI, household investment, hours worked and output, and their impulse responses are shown in Figure 12. We take natural log for all variables except for nominal interest rate. The sample period is 1960Q1 to 2017Q4.

Figure 14: Responses to a one standard deviation consumer confidence shock



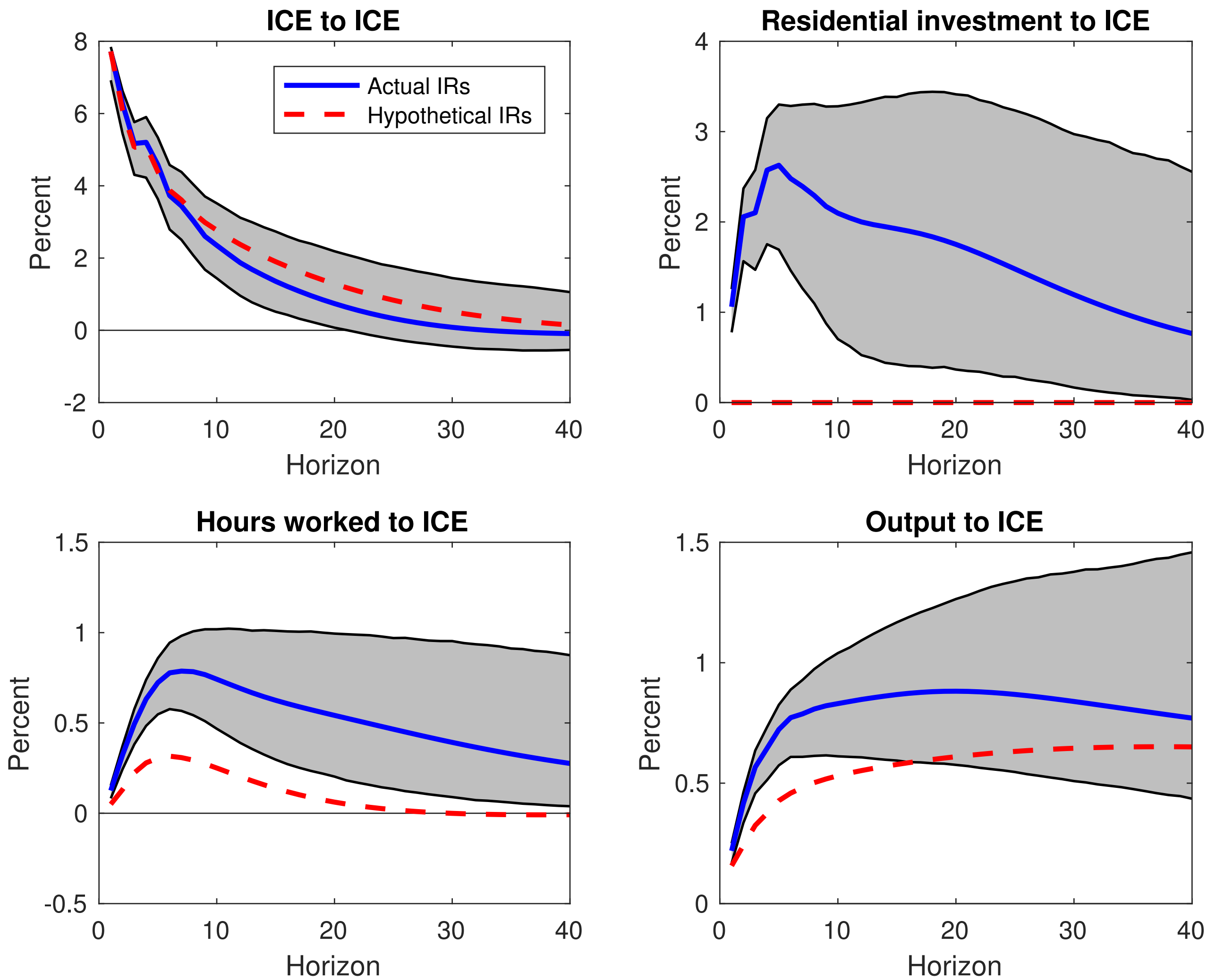
Notes: These are IRFs from a four-variable VAR with ICE (ordered first), household investment, unemployment rate and output. We take natural log for all variables except for unemployment rate. The solid lines are actual impulse responses. The grey shaded areas are one standard error confidence bands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

Figure 15: Responses to a one standard deviation consumer confidence shock, holding fixed hours worked responses to ICE shocks at all forecast horizons



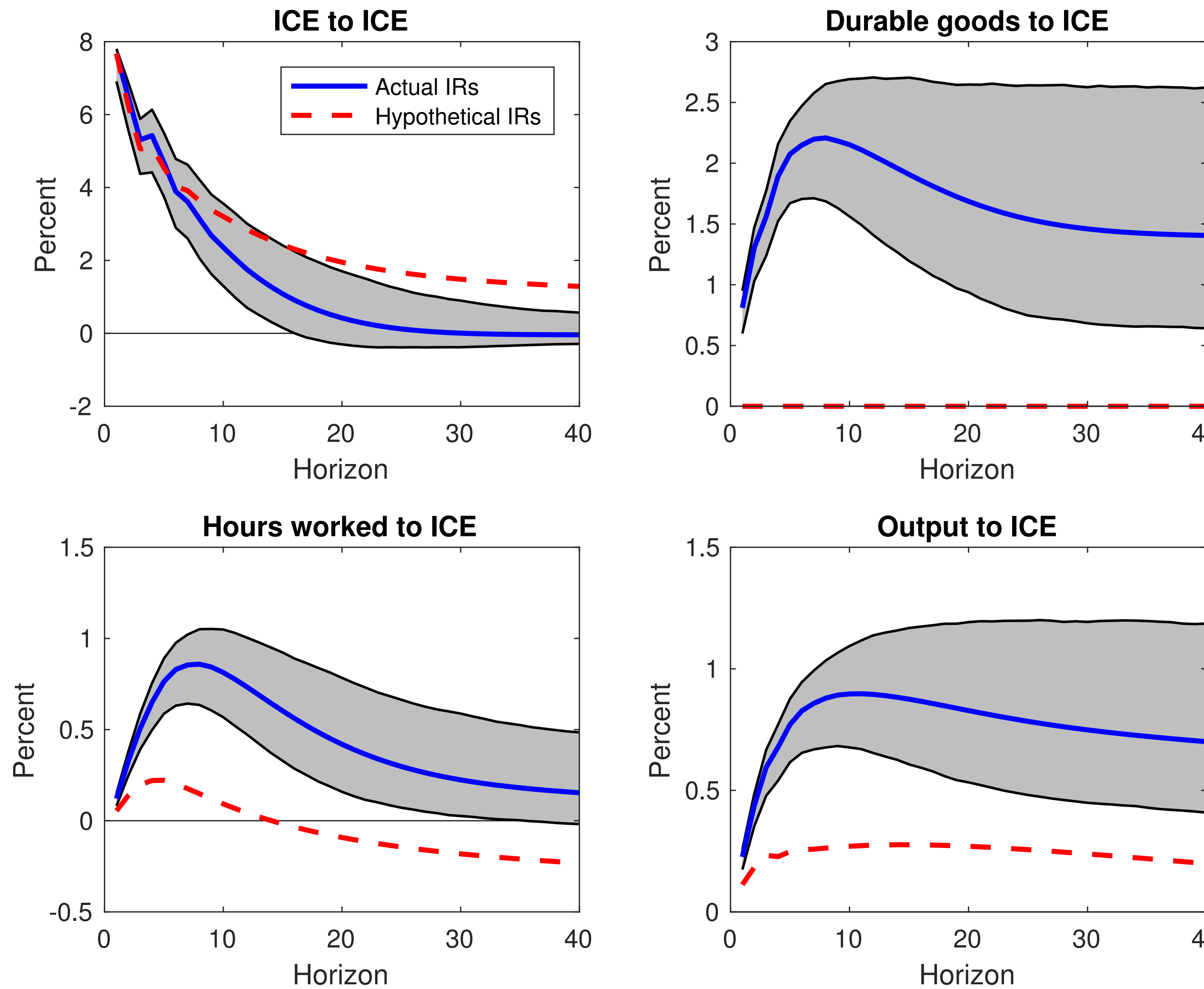
Notes: These are IRFs from a four-variable VAR with ICE (ordered first), household investment, hours worked and output. We shut down the direct responses of hours worked to confidence shocks at all forecast horizons. The solid lines are actual impulse responses. The grey shaded areas are one standard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

Figure 16: Responses to a one standard deviation consumer confidence shock: 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 17: 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.