News or Animal Spirits? Consumer Confidence and Economic Activity: Redux*

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Abstract

Barsky and Sims (2012, AER) demonstrated, via indirect inference, that confidence innovations can be viewed as noisy signals about medium-term economic growth. They highlighted that the connection between confidence and subsequent activity, such as consumption and output, is primarily driven by news shocks about the future. We expand upon their research in two significant ways. First, we incorporate the Great Recession and ZLB episodes, and second, we employ unique state-level data to offer insights into how to interpret the relationship between consumer confidence and economic activity. Our results confirm the main finding of Barsky and Sims (2012) that this relationship is predominantly driven by news about the future.

Keywords: Consumer confidence, news, animal spirits, Great Recession, state-level analysis

JEL codes: E12, E21, E31, E32, E71

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1 Introduction

Can consumer confidence predict future economic activity? Previous studies have posited that consumer confidence serves as an effective predictor of future economic activity.[1] However, it remains unclear whether this relationship is due to a causal effect of "animal spirits" on the economy or to information regarding future productivity that consumers receive. Proponents of the animal spirits view assert that changes in economic activity are caused by fluctuations in consumer beliefs (Blanchard 1993), while advocates of the information view contend that confidence measures contain information about the present and future state of the economy (Barsky and Sims 2012).

To gain a better understanding of the relationship between consumer confidence and economic activity, we expand upon the research conducted by Barsky and Sims (2012) in two significant ways. First, we extend the sample to include the Great Recession and the subsequent Zero-Lower-Bound (ZLB) episodes, during which animal spirits have a greater potential to influence economic activity (see Farmer 2012, Schmitt-Grohé and Uribe 2017, Heathcote and Perri 2018, and Dai, Weder, and Zhang 2020, among others) and re-evaluate the importance of news and animal spirits in explaining confidence innovations and economic activity. Second, we employ novel quarterly state-level data on consumer confidence, consumption, output, and inflation to exploit rich cross-sectional heterogeneity and better identify the relationship between confidence and economic activity by accounting for confounding factors common to each state.[2].

Our findings largely support Barsky and Sims (2012)'s conclusion that the relationship between consumer confidence and subsequent economic activity is mostly due to news about the future. However, the inclusion of the Great Recession and ZLB episodes suggests that animal spirit shocks play a somewhat more significant role in explaining confidence innovations and consumption than in Barsky and Sims (2012). Our state-level panel VAR models reveal dynamics in consumption, output, and inflation that are similar to the aggregate dynamics identified in Barsky and Sims

[1] See, for example, Carroll, Fuhrer, and Wilcox (1994), Matsusaka and Sbordone (1995), Ludvigson (2004), and Lahiri, Monokroussos, and Zhao (2016).

[2] Although there have been a few attempts to exploit cross-sectional heterogeneity in a measure of consumer confidence, their scope was rather limited to only a small subset of U.S. (or Canadian) regions (Garrett, Hernández-Murillo, and Owyang 2005; Dunn and Mirzaie 2006; Kwan and Cotsomitis 2006)

(2012). Notably, even after controlling for time-fixed effects (i.e., accounting for potential general equilibrium forces, such as monetary policy, federal fiscal policy, and common business cycles), consumption and output persistently respond to a consumer confidence shock, while inflation significantly declines. Our time series and cross-sectional extensions of Barsky and Sims (2012)'s exercise further support the interpretation that consumer confidence serves as a harbinger of future economic conditions.

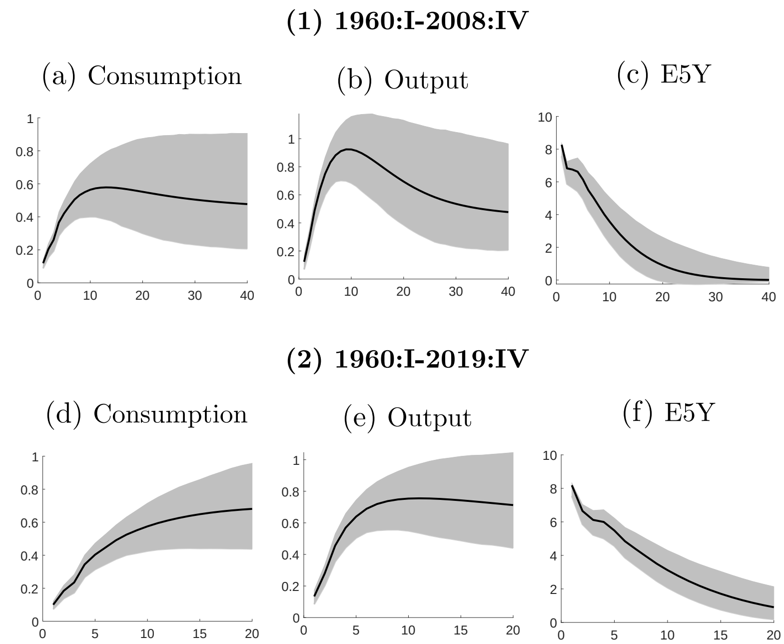
2 Reassessing Barsky and Sims (2012)

Barsky and Sims (2012), henceforth BS2012, using a sample from 1960:I to 2008:IV, show empirically that confidence innovations are associated with little immediate movement in economic activity but subsequent growth in consumption and income in a persistent manner. In BS2012, consumer confidence is measured using a survey measure called E5Y, which reflects respondents' expectations of economic conditions in the country as a whole over the next five years.[3] The authors estimate structural parameters of the standard New Keynesian dynamic stochastic general equilibrium (DSGE) model and find that the evidence supports the information interpretation of confidence.

In this section, we first replicate the main empirical findings of BS2012 using the original (but revised) data. Then, we extend their sample up to 2019:IV, including the Great Recession and ZLB episodes, during which animal spirits have a better chance to explain economic activity. By minimizing the distance between empirical impulse responses from the extended VAR model and those generated from simulations of the structural model, we revisit the role of news and animal spirit shocks in explaining consumer confidence and economic activity.

[3]The exact question is as follows: "Turning to economic conditions in the country as a whole, do you expect that over the next five years we will have mostly good times, or periods of widespread unemployment and depression, or what?" The variable E5Y is given by the percentage giving a favorable answer minus the percentage giving an unfavorable answer plus one hundred.

Figure 1: Impulse Responses to E5Y Innovation (Three Variable VAR, E5Y ordered first)



Notes: The panels depict the impulse responses for a three variable VAR with E5Y, consumption, and GDP. The top (bottom) panels are estimated using the data from 1960:I-2008:IV (1960:I-2019:IV). The VAR features 4 lags. E5Y is ordered first. The shaded areas report 68% confidence bands.

2.1 Replication with Barsky and Sims (2012) Sample

The top panels of Figure 1 display the impulse responses to a confidence innovation with E5Y ordered first.[4] A confidence innovation does not have an immediate effect on consumption and output but results in a steady increase in both variables. The variance decomposition analysis of consumption, income, and E5Y (depicted in Figure A2 with solid lines in the appendix A) indicates that E5Y innovations substantially explain the forecast error variance of income and consumption at long horizons (but not in the short term or on impact). E5Y innovations almost completely account for the forecast error variance of E5Y. Despite the data revisions since the original analysis, the replicated VAR results are in line with BS2012's findings: Innovations in confidence measures lead to significant, gradual, and permanent consumption and output responses.

We now proceed to the structural estimation exercise. Despite the robust relationship estab-

[4]These panels correspond to Figure 2 in BS2012, and the estimation employs E5Y, real consumption of goods and services, and real GDP, which were available as of April 12, 2022. Following BS2012, we report 68% confidence intervals. The impulse responses with E5Y being ordered last are presented in Figure A1 of the appendix A.

lished by previous VAR analyses between consumer confidence innovations and economic activity, it remains unclear whether this correlation implies causality. BS2012 addresses this issue by assuming that (i) confidence follows a univariate first-order autoregression, and (ii) the innovation in confidence is a linear combination of the underlying structural shocks in the economy. They provide a structural interpretation of the estimated impulse responses by decomposing confidence innovations into variations in structural shocks.

To shed light on the causal nature of this relationship, a standard DSGE model is enriched with informational components such as news, animal spirits, and confidence, and its parameters are estimated through an impulse response function matching. Specifically, the log of neutral technology, a_t, is modeled to follow a random walk with drift, where the drift term g_t follows a stationary AR(1) process. A shock to the expected growth rate is treated as a "news shock" following Beaudry and Portier (2006). While agents observe the level of technology, a_t, period by period, they do not observe the growth rate. Instead, they observe its noisy signal. A shock to this noisy signal is regarded as an animal spirit shock. This shock generates errors in expectations about the growth rate for the forward-looking agents but does not alter actual technology. Agents form expectations on this unobserved growth rate, $g_{t|t} \equiv \mathbb{E}_t[g_t]$, by solving a signal extraction problem.

Confidence $E5Y_t$ is assumed to follow a univariate first-order autoregressive process, and its innovation, u_t, is assumed to depend on the underlying structural shocks in the economy:

$$u_t = \zeta_1(a_t - a_{t-1} - g_{t-1|t-1}) + \zeta_2(g_{t|t} - \rho_g g_{t-1|t-1}) + \zeta_3 \varepsilon_{c,t} \tag{1}$$

where $\epsilon_{c,t}$ is an i.i.d. standard Gaussian measurement error in the confidence data. Thus, parameters ζ_1, ζ_2, and ζ_3 respectively capture the impact of structural news, animal spirits, and noise shocks to innovation to confidence. A detailed model description is provided in the appendix B.

The parameters of the model are estimated through indirect inference, and we analyze the extent to which each structural shock accounts for the variation in the innovations in confidence and economic activity. To estimate the parameters, BS2012 first estimate an expanded five-

Table 1: Variance Decomposition: Confidence, Consumption, and Output

	(1) 1960:I-2008:IV					(2) 1960:I-2019:IV				
	h=1	h=4	h=8	h=16	h=20	h=1	h=4	h=8	h=16	h=20
News										
E5Y	0.52	0.69	0.72	0.74	0.74	0.09	0.33	0.46	0.53	0.54
C	0.17	0.38	0.50	0.59	0.61	0.04	0.42	0.67	0.80	0.83
Y	0.01	0.26	0.45	0.58	0.60	0.00	0.21	0.56	0.77	0.81
Animal Spirits										
E5Y	0.23	0.09	0.06	0.05	0.05	0.53	0.31	0.23	0.18	0.18
C	0.08	0.01	0.00	0.00	0.00	0.21	0.05	0.01	0.00	0.00
Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Technology										
E5Y	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
C	0.73	0.60	0.49	0.41	0.40	0.74	0.52	0.31	0.19	0.17
Y	0.82	0.72	0.54	0.42	0.40	0.24	0.53	0.36	0.21	0.18
Noise										
E5Y	0.25	0.23	0.22	0.21	0.21	0.37	0.35	0.31	0.28	0.28

variable VAR model, including two additional variables, consumer price inflation and the real interest rate, and then use the impulse response functions (IRFs) of the VAR estimated with aggregate data to estimate the model's parameters by minimizing the distance between empirical and model IRFs. In the appendix A, Figure A3 presents the IRFs of a five-variable system.[5]

The variance decomposition of confidence (E5Y), consumption, and output at various horizons in the model using the estimated parameter values based on the original sample period is presented in Table 1 (left columns). Tables A1 and A2 in the appendix B report the fixed and estimated parameters used in the estimation process, respectively. Despite data revisions since the original analysis, the results are consistent with BS2012's findings: on impact, news shocks account for 52 percent of the variance in measured confidence, whereas animal spirits and noise shocks account for the remaining variance in confidence innovation. For consumption and output, news shocks explain only a small fraction of the variations on impact (17% and 1% for consumption and output, respectively), but they account for a growing share of the forecast error variance of these variables at longer horizons (61% and 60% for consumption and output at $h = 20$). The innovation in

[5]The authors' replication kit, available at https://www.aeaweb.org/articles?id=10.1257/aer.102.4.1343, is used for structural estimation.

the current level of technology explains 40% of the variance in consumption and output in longer horizons. Animal spirit shocks, on the other hand, explain almost no variation in economic activity, except for explaining 8% of the variation in consumption on impact.

2.2 Replication with the Extended Sample

In this section, we extend the original sample period until 2019:IV and re-examine the role of consumer confidence in explaining fluctuations in economic activity. Specifically, we investigate whether the inclusion of the post-recession period changes the relative importance of news shocks and animal spirit shocks in driving fluctuations in confidence and economic aggregates.

To begin our analysis, we present impulse responses to a confidence innovation using the extended sample in Figure 1 (bottom panels). The responses of consumption and output to this shock are similar to those observed in the original sample. Despite a lack of immediate response, both variables experience slow-building responses to permanent levels over time. We note that our findings are also consistent with the five-variable VAR model of the original study, as confirmed by Figure A3 (bottom panels) in the appendix A, which shows a persistent decline in inflation and rising real interest rates following a consumer confidence shock.

Next, we report the model-implied variance decomposition of confidence, consumption, and output at various forecasting horizons ($t = 1, 4, 8, 16, 20$) in Table 1 (right columns), using the estimated parameters. We find that, on impact, animal spirit shocks explain a larger proportion of the confidence innovation than in the original sample (53% vs 23%). Moreover, even at longer horizons, animal spirit shocks continue to have a substantial importance in confidence variation (18% vs 5% at $h = 20$). However, animal spirit shocks still explain only a minor proportion of the forecast-error variances of consumption and output at all horizons, except for consumption in the short run (21% at $h = 1$). In contrast, news shocks continue to account for a substantial amount of variation in economic activity, followed by technology shocks. Our analysis shows that, despite the use of an extended sample spanning the Great Recession and ZLB episodes, variations in economic activity are still largely explained by news about future economic prospects, confirming the main findings in BS2012.

3 State-level Extension of Barsky and Sims (2012)

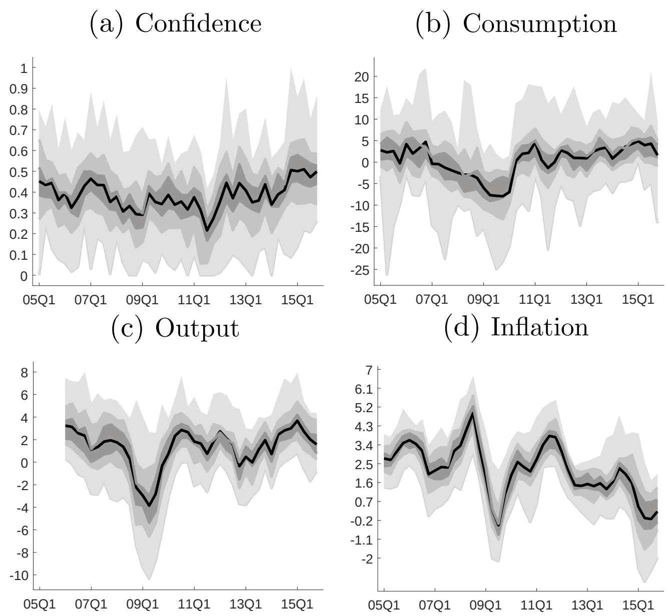
To sharpen the identification of the consumer confidence-economic activity relationship, we utilize a four-variable panel VAR model employing novel state-level data. The panel structure enables the inclusion of both state- and time-fixed effects, which is analogous to a difference-in-differences approach commonly employed in applied microeconomic research. To be more precise, our analysis improves identification compared to typical dynamic macroeconomic settings such as BS2012 by controlling for various confounding factors, notably general equilibrium forces that affect both consumer confidence and economic activity (e.g., monetary policy, federal fiscal policy, etc.). This is the first attempt, to the best of our knowledge, to disentangle the complex dynamic relationship between consumer confidence and the macroeconomy using genuine state-level data and a panel VAR model that controls for general equilibrium effects.[6]

Unfortunately, due to data availability, the state-level analysis is limited to the period between 2005:I and 2015:IV. Nonetheless, our analysis encompasses the Great Recession and the ZLB episodes, during which widespread pessimism about the economy prevailed (Farmer 2012; Lahiri, Monokroussos, and Zhao 2016; L'Huillier and Yoo 2017), thereby providing the best opportunity to examine the nature of consumer confidence and its macroeconomic implications. Section C.1 in the online appendix provides more extensive details on the state-level data, while Section C.2 describes our panel VAR model estimation. Here, we focus on the primary findings from the state-level analysis.

Figure 2 depicts the evolution of state-level consumer confidence, consumer spending growth, output (GSP) growth, and annual inflation during the sample period (2005:I to 2015:IV). We report

[6]Recently, Biolsi and Du (2020) used state-level consumer confidence data to investigate a similar question. However, their state-level consumer confidence data was imputed from the aggregate data using an age profile of each state. Moreover, their analysis did not include state-level consumption or inflation, which is crucial in differentiating between the news and animal spirit interpretation of consumer confidence.

Figure 2: Evolution of key state-level variables



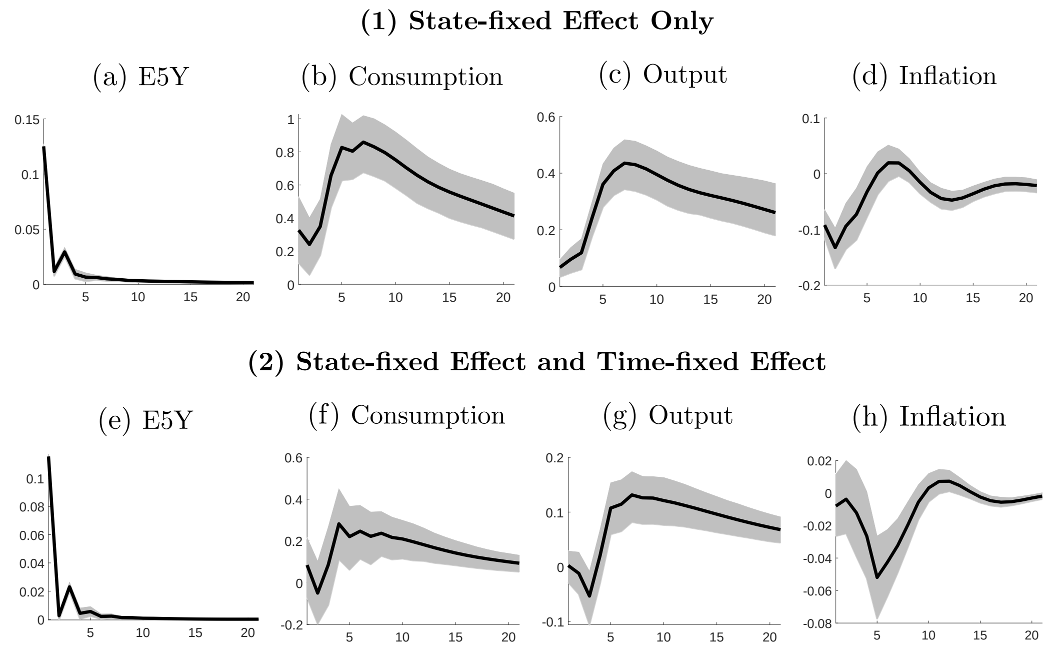
Notes: The panels depict the evolution of key state-level variables: consumer confidence, consumption growth, output growth, and inflation with their 5th, 20th, 35th, 50th, 65th, 80th, and 95th percentiles.

cross-state values corresponding to the 5th, 20th, 35th, 50th, 65th, 80th, and 95th percentiles to demonstrate cross-sectional heterogeneity in the behavior of these variables. Although a decline in consumer confidence characterizes the Great Recession, accompanied by a significant decrease in consumption, output, and inflation, substantial cross-sectional heterogeneity is evident in each variable, with the heterogeneity in consumer confidence appearing particularly strong. We exploit this heterogeneity to deepen our comprehension of the link between consumer confidence and economic activity.

The top panel of Figure 3 displays the results of estimating the panel VARs of 30 U.S. states from 2005:I to 2015:IV. This panel is comparable to Figure 7 in BS2012, excluding the real interest rate, as it is collinear with the inflation rate at the state level.[7] Despite the short-lived nature of consumer confidence shocks at the state level, the responses of consumption and output persist. The impact effect is minor, but the effect increases over time and remains positive even after five

[7] We note that the trivariate VAR model yields responses of consumption and output to consumer confidence shocks that are nearly identical to those in the four-variable model.

Figure 3: Impulse Responses to E5Y Innovation (Panel VAR, E5Y ordered first)



Notes: The panels depict the impulse responses for a four-variable panel VAR with E5Y, consumption, GDP, and inflation. The top (bottom) panels are estimated using state fixed-effect (state-fixed effect and time-fixed effect). The models are estimated using the data from 2005:I-2015:IV. The panel VAR features 4 lags. The shaded areas report 68% confidence bands.

years. This feature of the impulse response functions appears to be consistent with the dynamics implied by the news shock interpretation of consumer confidence shocks in BS2012.

The response of state-level inflation is particularly informative in determining the nature of consumer confidence. According to Barsky (2015), the sign of the inflation response to consumer confidence shocks can help determine whether they are a demand shock that aligns with the animal spirit interpretation (Lorenzoni 2009) or a supply shock that aligns with the news interpretation (BS2012, via the role of future real marginal costs in the determination of current inflation). Moreover, recent studies on news shocks employing alternative identifying assumptions commonly find a decline in inflation (see, for example, Fisher and Huh 2016; Fève and Guay 2019; Klein and Linnemann 2021). As in the aggregate VAR model, state-level inflation exhibits a significant and persistent decline after a positive consumer confidence shock, which is challenging to reconcile with the animal spirit interpretation.

However, the absence of additional control variables at the national level could confound the estimation results with general equilibrium effects, such as monetary policy, common business cycle fluctuations, and federal fiscal policy. To address this issue, we extend the panel VAR model by introducing time-fixed effects to control for any time-varying confounding factors common to each state. While one can include such confounding factors as an exogenous variable in the VAR system (i.e., VARX model), the relatively low degree of freedom in our data limits the scope of these variables.

The bottom panel of Figure 3 presents the partial equilibrium effect of consumer confidence shocks at the state level. As expected, the magnitude of consumption and output responses becomes smaller but the responses remain persistent. Importantly, we still observe a significant decline in inflation, which supports the news interpretation of consumer confidence. We conduct a battery of sensitivity tests to verify whether our primary findings presented in Figure 3, are robust to changes in the specification, such as using alternative measures of state-level consumption or consumer confidence and reversing the ordering of variables in the VAR system. The results of these tests, which are presented in Section C.3 in the online appendix, confirm qualitatively similar outcomes to Figure 3, lending further support to the news interpretation of consumer confidence in BS2012.

4 Conclusion

To clarify the interpretation of consumer confidence and its impact on economic fluctuations, we have re-examined the findings of BS2012. Our study incorporates two unique events, namely the Great Recession and the ZLB period, which were not taken into account in the original research. Despite these additions, the main conclusion of BS2012 regarding the dominance of news shocks, rather than animal spirit shocks, in driving the relationship between confidence and subsequent economic activity remains valid. To the extent that our study's use of state-level data improves the identification of this connection, our findings provide a novel perspective on the ongoing dispute surrounding the nature of consumer confidence.

References

Abdallah, C. S. and W. D. Lastrapes (2013). Evidence on the relationship between housing and consumption in the united states: a state-level analysis. *Journal of Money, Credit and Banking 45*(4), 559–590.

Alvarez, J. and M. Arellano (2003). The time series and cross-section asymptotics of dynamic panel data estimators. *Econometrica 71*(4), 1121–1159.

Barsky, R. B., S. Basu, and K. Lee (2015). Whither news shocks? *NBER Macroeconomics Annual 29*(1), 225–264.

Barsky, R. B. and E. Sims (2012). Information, animal spirits, and the meaning of innovations in consumer confidence. *American Economic Review 102*(2), 1343–1377.

Beaudry, P. and F. Portier (2006). Stock prices, news and economic fluctuations. *American Economic Review 96*(4), 1293–1307.

Benhabib, J. and M. M. Spiegel (2019). Sentiments and economic activity: Evidence from us states. *Economic Journal 129*(618), 715–733.

Biolsi, C. and B. Du (2020). Do shocks to animal spirits cause output fluctuations? *Southern Economic Journal 87*(1), 331–368.

Blanchard, O. (1993). Consumption and the recession of 1990-1991. *American Economic Review 83*(2), 270–274.

Carroll, C. D., J. C. Fuhrer, and D. W. Wilcox (1994). Does consumer sentiment forecast household spending? if so, why? *American Economic Review 84*(5), 1397–1408.

Case, K. E., J. M. Quigley, and R. J. Shiller (2005). Comparing wealth effects: the stock market versus the housing market. *Advances in Macroeconomics 5*(1).

Dai, W., M. Weder, and B. Zhang (2020). Animal spirits, financial markets, and aggregate instability. *Journal of Money, Credit and Banking 52*(8), 2053–2083.

Dunn, L. F. and I. A. Mirzaie (2006). Turns in consumer confidence: An information advantage linked to manufacturing. *Economic Inquiry 44*(2), 343–351.

Farmer, R. E. (2012). Confidence, crashes and animal spirits. *Economic Journal 122*(559), 155–172.

Fève, P. and A. Guay (2019). Sentiments in svars. *Economic Journal 129*(618), 877–896.

Fisher, L. A. and H.-s. Huh (2016). On the econometric modelling of consumer sentiment shocks in svars. *Empirical Economics 51*, 1033–1051.

Garrett, T. A., R. Hernández-Murillo, and M. T. Owyang (2005). Does consumer sentiment predict regional consumption. *Federal Reserve Bank of St. Louis Review 87*(2), 123–135.

Hamilton, J. D. (2020). *Time Series Analysis*. Princeton University Press.

Hazell, J., J. Herreno, E. Nakamura, and J. Steinsson (2022). The slope of the phillips curve: evidence from us states. *Quarterly Journal of Economics 137*(3), 1299–1344.

Heathcote, J. and F. Perri (2018). Wealth and volatility. *Review of Economic Studies 85*(4), 2173–2213.

Holtz-Eakin, D., W. Newey, and H. S. Rosen (1988). Estimating vector autoregressions with panel data. *Econometrica*, 1371–1395.

Judson, R. A. and A. L. Owen (1999). Estimating dynamic panel data models: a guide for macroeconomists. *Economics Letters 65*(1), 9–15.

Klein, M. and L. Linnemann (2021). Real exchange rate and international spillover effects of us technology shocks. *Journal of International Economics 129*, 103414.

Kwan, A. C. and J. A. Cotsomitis (2006). The usefulness of consumer confidence in forecasting household spending in canada: A national and regional analysis. *Economic Inquiry 44*(1), 185–197.

Lahiri, K., G. Monokroussos, and Y. Zhao (2016). Forecasting consumption: The role of consumer confidence in real time with many predictors. *Journal of Applied Econometrics 31*(7), 1254–1275.

L'Huillier, J.-P. and D. Yoo (2017). Bad news in the Great Depression, the Great Recession, and other U.S. recessions: A comparative study. *Journal of Economic Dynamics and Control 81*, 79–98.

Lorenzoni, G. (2009). A theory of demand shocks. *American Economic Review 99*(5), 2050–84.

Ludvigson, S. C. (2004). Consumer confidence and consumer spending. *Journal of Economic Perspectives 18*(2), 29–50.

Matsusaka, J. G. and A. M. Sbordone (1995). Consumer confidence and economic fluctuations. *Economic Inquiry 33*(2), 296–318.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica*, 1417–1426.

Pesaran, M. H. and R. Smith (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics 68*(1), 79–113.

Phillips, P. C. and H. R. Moon (1999). Linear regression limit theory for nonstationary panel data. *Econometrica 67*(5), 1057–1111.

Schmitt-Grohé, S. and M. Uribe (2017). Liquidity traps and jobless recoveries. *American Economic Journal: Macroeconomics 9*(1), 165–204.

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Online Appendix For:

"News or Animal Spirits? Consumer Confidence and Economic Activity: Redux"

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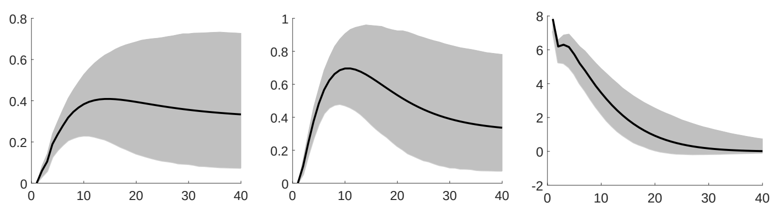
A Additional Figures

Figure A1: Impulse Responses to E5Y Innovation (Three Variable VAR, E5Y ordered last)

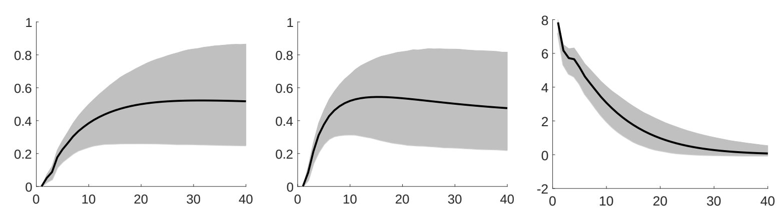
(1) 1960:I-2008:IV

(a) Consumption (b) Output (c) E5Y



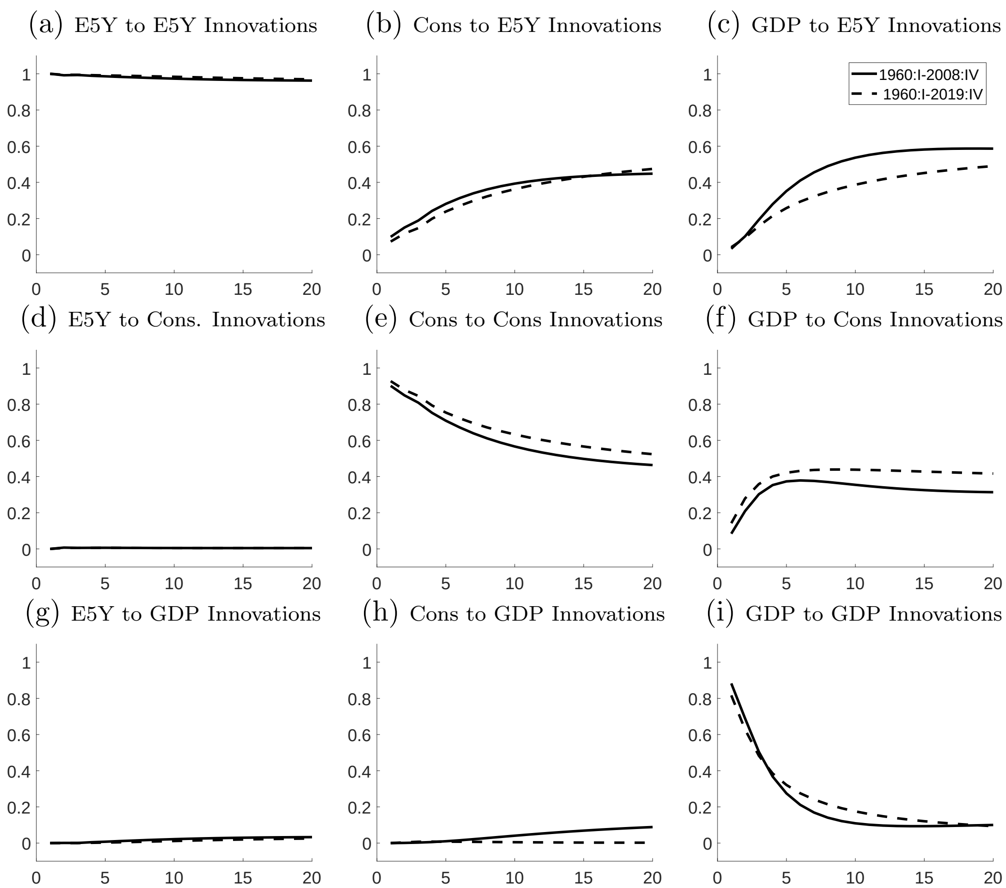
(2) 1960:I-2019:IV

(d) Consumption (e) Output (f) E5Y



Notes: The panels depict the impulse responses for a three-variable VAR with E5Y, consumption, and GDP. The top (bottom) panels are estimated using the data from 1960:I-2008:IV (1960:I-2019:IV). The VAR features 4 lags. E5Y is ordered last. The shaded areas report 68% confidence bands.

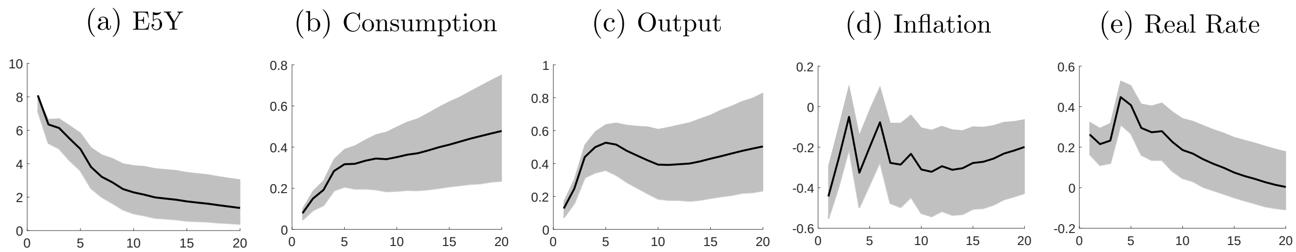
Figure A2: Variance Decomposition (Three Variable VAR, E5Y ordered first)



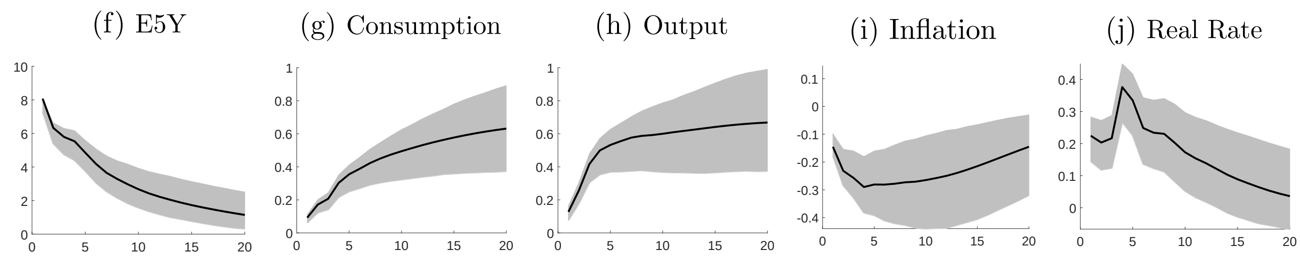
Notes: Panels (a), (d), and (g) report the contribution of innovations to the variation in E5Y, consumption, and GDP to E5Y; Panels (b), (e), and (h) report the contribution of innovations to E5Y, consumption, and GDP to the consumption variation; Panels (c), (f), and (i) report the contribution of innovations to E5Y, consumption, and GDP to the output variation. Solid lines are with respect to the sample from 1960:I to 2008:IV and dashed lines are for the sample from 1960:I to 2019:IV.

Figure A3: Impulse Responses to E5Y Innovation (Larger VAR)

(1) 1960:I-2008:IV



(2) 1960:I-2019:IV



Notes: The panels depict the impulse responses for a five-variable VAR with E5Y, consumption, and GDP, inflation, and the real rate. The top (bottom) panels are estimated using the data from 1960:I-2008:IV (1960:I-2019:IV). The VAR features 4 lags. E5Y is ordered first. The shaded areas report 68% confidence bands.

B A New Keynesian DSGE Model

This section reproduces the model description in BS2012 (Appendix 2). The final good is a Dixit-Stiglitz aggregate of a continuum of intermediate goods, produced by monopolistic competitive firms, with Calvo price rigidity. The model also features habit formation and adjustment costs. In addition to the usual frictions, the model also includes news shocks about future productivity growth, and agents only observe a noisy signal about it. From the informational perspective, the model features news, animal spirits, and pure noise.

Information and productivity: The log of neutral technology, a_t, follows a random walk with drift:

$$a_t = a_{t-1} + g_{t-1} + \varepsilon_{a,t} \tag{2}$$

where $\varepsilon_{a,t}$ is the conventional surprise technology shock.

The drift term g_t follows a stationary AR(1) process:

$$g_t = (1 - \rho_g)g^* + \rho_g g_{t-1} + \varepsilon_{g_a,t} \tag{3}$$

where g^* is an unconditional mean of the process, and $\varepsilon_{g_a,t}$ is a shock to the expected growth rate, which can be classified as "news shocks" in Beaudry and Portier (2006).

Agents observe the level of technology, a_t, period by period, but do not observe the drift term g_t. Instead, they observe a noisy signal about it:

$$s_t = g_t + \varepsilon_{s,t} \tag{4}$$

where $\varepsilon_{s,t}$ is an i.i.d. Gaussian shock with zero mean and unit variance. We consider this shock, as the animal spirit shock as it generates errors in expectations about the growth rate for the forward-looking agents.

We further assume that confidence follows a univariate first-order autoregressive process:

$$E5Y_t = (1 - \rho_e)E5Y^* + \rho_e E5Y_{t-1} + u_t \tag{5}$$

where u_t is the innovation in confidence. We assume that u_t depends on the underlying structural shocks in the economy:

$$u_t = \zeta_1(a_t - a_{t-1} - g_{t-1|t-1}) + \zeta_2(g_{t|t} - \rho_g g_{t-1|t-1}) + \zeta_3 \varepsilon_{c,t} \tag{6}$$

where $\epsilon_{c,t}$ is an i.i.d. Gaussian process with zero mean and unit variance, which is considered to be the measurement error in the confidence data. Looking at the decomposition of the innovation in confidence, note that $g_{t-1|t-1}$ and $g_{t|t}$ respectively denote agents' expectation about the growth rate time t conditional on information t, $g_{t|t} \equiv \mathbb{E}_t[g_t]$ and agents' expectation about the growth rate time $t-1$ conditional on information $t-1$, $g_{t-1|t-1} \equiv \mathbb{E}_{t-1}[g_{t-1}]$.

Households: Households choose consumption (C_t), labor supply (N_t), and real holdings of riskless one-period bonds (B_t) to maximize lifetime utility:

$$\max_{\{C_T, N_T, B_T\}} \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \left(\ln(C_t - \kappa C_{t-1}) - \frac{N_t^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \right) \tag{7}$$

subject to

$$C_t + B_t = w_t N_t - T_t + (1 + r_{t-1})B_{t-1} + \Pi_t \tag{8}$$

where β is a discount factor, κ indexes the degree of habit persistence in consumption, and η is the Frisch labor supply elasticity; w_t is the real wage, r_t is the real interest rate, T_t is lump sum taxes/transfers, and Π_t denotes profits. The solution to this maximization problem is the familiar

Euler equation and intra-temporal labor supply condition:

$$\Lambda_t = \frac{1}{C_t - \kappa C_{t-1}} - \mathbb{E}_t\left[\frac{\beta\kappa}{C_{t+1} - \kappa C_t}\right] \tag{9}$$

$$\Lambda_t = \beta(1 + r_t)\Lambda_{t+1} \tag{10}$$

$$N_t^{\frac{1}{\eta}} = \Lambda_t w_t \tag{11}$$

where Λ_t denotes the marginal utility of consumption at time t.

Firms: There are final goods producers, intermediate goods producers, and capital producers. Competitive final goods producers demand intermediate goods given the price of intermediate goods:

$$\max_{Y_t(j)} P_t Y_t - \int_0^1 P_t(i) Y_t(i) \tag{12}$$

subject to

$$Y_t = \left[\int_0^1 P_t(j)^{1-\xi}\right]^{\frac{1}{1-\xi}} \tag{13}$$

which yields the demand function for each intermediate good as follows:

$$Y_t(j) = \left[\frac{P_t(j)}{P_t}\right]^{-\xi} Y_t \tag{14}$$

Intermediate goods firms, indexed by j along the unit interval, demand labor and capital given wage and the rental rate of capital:

$$\max_{N_t(j), K_t(j)} Y_t(j) - W_t N_t(j) - R_t K_t(j) \tag{15}$$

subject to

$$Y_t(j) = A_t K_{t-1}(j)^{\alpha} N_t(j)^{1-\alpha} \tag{16}$$

which yields labor and capital demand curves as follows

$$W_t = MC_t(j)(1-\alpha)A_t K_t(j)^{\alpha} N_t(j)^{-\alpha} \tag{17}$$

$$R_t = MC_t(j)\alpha A_t K_t(j)^{\alpha-1} N_t(j)^{1-\alpha} \tag{18}$$

Moreover, intermediate goods producers reset their price each period with constant probability $(1-\theta)$. The pricing decision of an intermediate goods producer is given by

$$\max_{P_t(j)} \sum_{i=0}^{\infty} (\theta\beta)^i \mathbb{E}_t \left(\frac{\Lambda_{t+i}}{\Lambda_t} \frac{1}{P_{t+i}} (P_t(j) Y_{t+i}(j) - TC_{t+i}(Y_{t+i}(j))) \right) \tag{19}$$

subject to

$$Y_t(j) = A_t K_t(j)^{\alpha} N_t(j)^{\alpha} \tag{20}$$

which yields optimal reset price which will be common across all firms updating in any period:

$$P_t^* = (1+\mu) \frac{\mathbb{E}_t \left(\sum_{i=0}^{\infty} (\theta\beta)^i \frac{\Lambda_{t+i}}{\Lambda_t} MC_{t+i} Y_{t+i} \right)}{\mathbb{E}_t \left(\sum_{i=0}^{\infty} (\theta\beta)^i \frac{\Lambda_{t+i}}{\Lambda_t} Y_{t+i} \right)} \tag{21}$$

A continuum of capital producers along the unit interval produces new capital while maximizing their profit. Specifically, they solve the following problem:

$$\max_{I_t, K_t} Q_t Y_t^K(\nu) - I_t(\nu) - R_t^K K_t(\nu) \tag{22}$$

subject to

$$Y_t^K(\nu) = \phi\left(\frac{I_t(\nu)}{K_t(\nu)}\right)K_t(\nu) \tag{23}$$

which yields the following first-order conditions:

$$Q_t\phi'\left(\frac{I_t(\nu)}{K_t(\nu)}\right) = 1 \tag{24}$$

$$Q_t\left(\phi\left(\frac{I_t(\nu)}{K_t(\nu)}\right) - \frac{I_t(\nu)}{K_t(\nu)}\phi'(\frac{I_t(\nu)}{K_t(\nu)}\right) = R_t^k \tag{25}$$

Government: The government is assumed to consume a stochastic share of output each period. Specifically, we assume the government share of the output follows a stationary AR(1):

$$ln(\frac{G}{Y})_t = (1-\rho_g)ln(\frac{G}{Y}) + \rho_g ln(\frac{G}{Y})_{t-1} + \epsilon_{G,t} \tag{26}$$

The government finances its purchases with lump-sum taxes on households, T_t, and it also operates monetary policy according to a Taylor-type policy rule

$$i_t = \rho_i i_{t-1} + (1-\rho_i)\phi_\pi(\pi_t - \pi^*) + (1-\rho_i)\phi_y(\Delta Y_t - \Delta Y^*) + \epsilon_{i,t} \tag{27}$$

Aggregation: The aggregate resource constraint is

$$Y_t = C_t + I_t + G_t \tag{28}$$

The aggregate capital stock accumulates according to

$$K_t = \phi\left(\frac{I_t}{K_t}\right)K_t + (1-\delta)K_{t-1} \tag{29}$$

B.1 Structural Estimation

The following parameters are fixed in the estimation procedure as shown in Table A1. The discount factor is set to 0.99. The capital share of income is set to 0.36. The depreciation rate is fixed at 0.03. The steady-state growth rate is set to 0.0033.[8] The steady-state share of government spending to final output is fixed at 0.2. The persistence and standard deviation of government spending shocks are set to 0.95 and 0.0025, respectively.

Table A1: Fixed Parameter

	Parameter	Value
β	Discount factor	0.99
α	Capital share	0.36
δ	Capital depreciation rate	0.03
g^*	Steady state growth rate	0.0033
$\left(\frac{G}{Y}\right)^*$	Government spending share	0.20
ρ_G	Govt spend shock persistence	0.95
σ_G	Govt spending shock size	0.0025

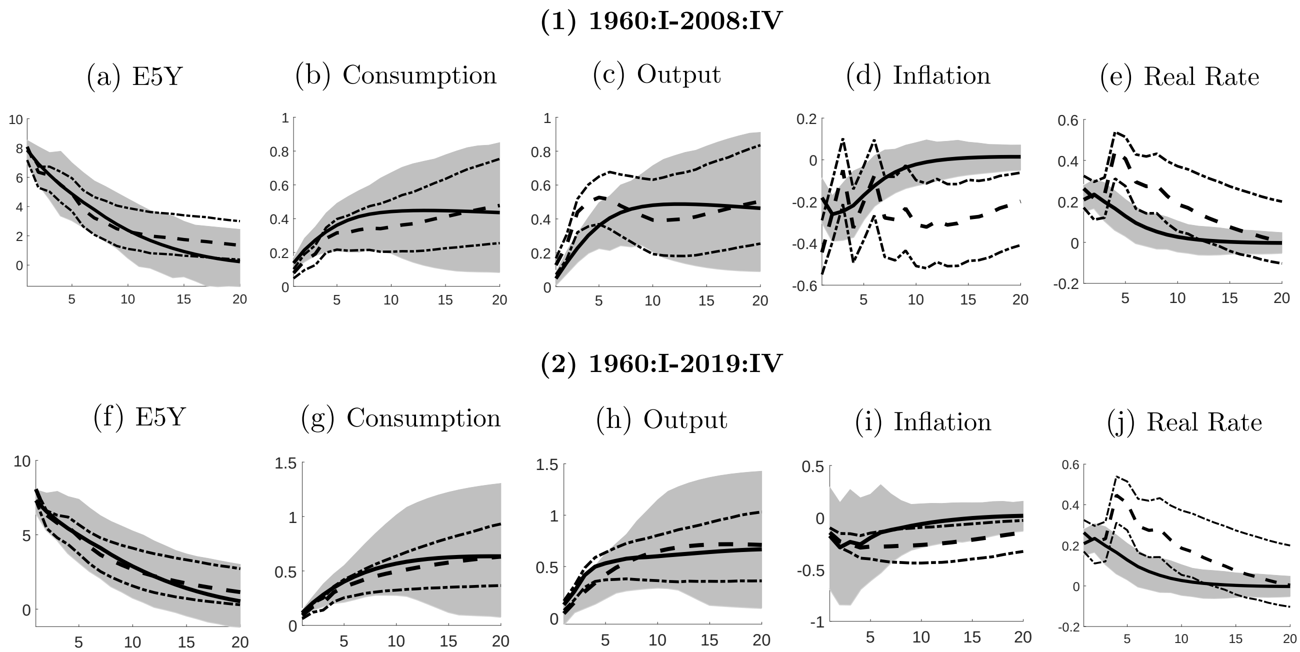
Notes: The table reports parameters fixed in the estimation procedure.

The remaining parameters of the model are chosen to match the model's impulse responses to the empirically-estimated impulse responses as closely as possible. The resulting impulse responses are shown in Figure A4 (solid lines). The parameter estimates are reported in Table A2. We report the parameter estimates and standard errors.

We first consider the estimation with the original sample period (1960:I-2005:IV). The first four parameters in Table A2 are concerned with the confidence equations in (5) and (6). The first three of them measure the importance of the innovation in perceived current technology (ζ_1), of the innovation in the perceived growth rate (ζ_2), and of the noise or the measurement error (ζ_3). Given that agents do not perfectly observe g_t, neither do they fully observe the realized structural shocks. Thus, the coefficients ζ_1 and ζ_2 are associated with the perceived current technology and the growth rate, not the actual realization of them. The parameter ρ_e governs the persistence of confidence.

[8] We set g^* to 0.0022 in our estimation with the extended sample.

Figure A4: Impulse Responses to Confidence (E5Y) from Estimated Model



Notes: The dashed lines are identical to the responses shown in Figure A3. The dotted lines 68% confidence bands. The solid lines are the average estimated response from simulations of the model at the estimated parameter values. The shaded areas correspond to the 2.5 and 97.5 percentiles of the simulated responses. The units are points for confidence and percentage points for the other variables.

As evidenced by Figure A4, confidence is estimated to be fairly persistent ($\rho_e = 0.90$). The coefficient on the expected growth rate innovation is much larger than the coefficients on the innovation in current technology and noise. However, we cannot directly measure the importance of each shock explaining the confidence fluctuations just by looking at these coefficients. First, the innovation variance of the expected growth rate is much smaller than the other two disturbances that affect confidence. Second, agents' expectations $g_{t|t}$ and $g_{t-1|t-1}$ are also affected by the shock disturbances. Thus, in order to properly measure the importance of these shocks quantitatively, we need to resort to the variance decomposition of confidence and other variables at various horizons in the model using the estimated parameter values (see Table 1 in Section 2).

The parameters $\rho_{g_a}, \sigma_{\varepsilon_{g_a}}, \sigma_{\varepsilon_a}, \sigma_{\varepsilon_s}$ govern the stochastic process for technology (first three) and information (σ_{ε_s}). The size of the current technology shock is about three times larger than that of news shocks (0.43 versus 0.17). News shocks are also estimated to be relatively persistent at 0.74. With σ_{ε_s} estimated at 0.11, agents do not immediately recognize the evolution of current

Table A2: Estimated Parameter Values

Parameter	(I) 1960:I-2008:IV Estimate	(I) 1960:I-2008:IV S.E	(II) 1960:I-2019:IV Estimate	(II) 1960:I-2019:IV S.E
Confidence Innovations				
ζ_1	1.01	0.34	1.47	0.19
ζ_2	32.76	4.92	11.43	1.94
ζ_3	3.79	1.98	4.24	1.60
ρ_e	0.90	0.36	0.92	0.30
Technology Shocks				
ρ_{g_a}	0.74	0.25	0.86	0.08
$\sigma_{\varepsilon_{ga}}$	0.17	0.04	0.18	0.02
σ_{ε_a}	0.43	0.13	0.42	0.07
σ_{ε_s}	0.11	0.04	0.44	0.06
Monetary Policy				
ϕ_π	1.30	0.25	1.40	0.09
ϕ_y	0.94	0.19	0.81	0.11
ρ_i	0.66	0.08	0.59	0.06
σ_{ε_i}	0.21	0.05	1.93	0.22
Other Parameters				
κ	0.35	0.05	0.76	0.10
γ	0.33	0.06	0.21	0.04
η	1.32	0.37	0.55	0.05
$\xi/\xi-1$	1.10	0.19	1.10	0.10
θ	0.68	0.18	0.54	0.10

technology and growth shocks and slowly adjust their expectations.

The parameters governing the monetary policy are estimated as follows: the central bank exhibits a hawkish policy reaction to inflation $\phi_\pi = 1.30$ and also responds aggressively to deviations of output growth from trend $\phi_y = 0.94$. The estimated standard deviation of monetary policy shocks is 0.21. Overall, the estimated set of parameters is in line with the ones in BS2012 (Table 2).

Regarding the estimation result with the extended sample, most of the parameter estimates are close to the ones with the original sample. A few exceptions are a strong habit formation in consumption (0.76 vs 0.35), a large standard deviation of monetary policy shock (1.93 vs 0.21), and a small degree of Frisch labor supply elasticity (0.55 vs 1.32). We also find that ζ_2 is estimated to be much smaller with the extended sample (11.43 vs 32.76).

C State-level VAR Analysis

C.1 Panel VARs: Data

This section presents the primary quarterly data that we utilize for our state-level extension of BS2012 in the United States. The state-level consumer confidence index is the first essential variable, which we derive from the University of Michigan's Index of Consumer Sentiment (ICS) survey. Since the 1960s, the ICS has been widely employed as a measure of consumer confidence at the national level. Recently, the survey has also been available at the state level, and we use this data to capture the differences in the evolution of consumer confidence across states during the Great Recession and ZLB episodes.

The ICS survey comprises questions on respondents' confidence in the current national business conditions and their expectations for future business conditions. Among the various questions on consumer confidence, we focus on the 'E5Y' variable, which is commonly used in the literature on consumer confidence (e.g., Ludvigson 2004; Barsky and Sims 2012; Benhabib and Spiegel 2019).

E5Y pertains to the response to the question: "Looking ahead, which would you say is more likely that in the country as a whole, we will have continuous good times during the next five years or so, or that we will have periods of widespread unemployment or depression, or what?" Responses are rated on a scale from 1 (indicating good times) to 5 (suggesting bad times). We attach particular significance to this question as it seeks to capture expectations over a relatively extended horizon and is specific regarding the relevant time frame. We use the data from 2005:I through 2015:IV, which is accessible for 49 states out of 51 (including Washington D.C.) states, excluding Alaska and Hawaii.

Our second primary variable is a consumption proxy, as we cannot obtain direct measures of state-level consumption on a quarterly basis. Instead, we utilize the ratio of sales tax revenues to sales tax rates, as proposed by Case, Quigley, and Shiller (2005) and Abdallah and Lastrapes (2013). We obtain state sales tax revenues (including general and gross receipts, motor fuels, tobacco products, and alcoholic beverages) from the Census Bureau's database of state government collections. We exclude five states (Alaska, Delaware, Montana, New Hampshire, and Oregon) that do not impose sales tax. To account for seasonality in the constructed proxy, we seasonally adjust the data and deflate nominal values.

As a robustness check, we interpolate annual personal consumption expenditures (PCE) data from the Bureau of Economic Analysis (BEA) to a quarterly frequency to assess consumption's response to consumer confidence shocks. However, the persistence of consumption's response is also important in interpreting the structural implications of consumer confidence and its macroeconomic effects. As interpolation may impose a mechanical pattern on the IRFs, we use a consumption proxy constructed from sales tax revenues in the baseline analysis.

Our third primary variable is Gross State Product (GSP), which measures state-level real output and is obtained from the Bureau of Economic Analysis database. GSP data are available for all U.S. states throughout the sample period.

Finally, quarterly inflation serves as our fourth variable and was recently made available at the state level by Hazell, Herreno, Nakamura, and Steinsson (2022). They derived this dataset from the U.S. Bureau of Labor Statistics' micro-price data and used it to construct new state-level price indexes. Their methodology involved a simplified version of the approach employed by the BLS in constructing the Consumer Price Index (CPI). However, their method differs somewhat from that of the BLS, as it does not rely on imputing missing values using data from other regions. The time-series coverage spans from 1978:I to 2018:IV but is limited to a sampling area of 34 states.

C.2 Panel VARs: Model

This section outlines the methodology employed to estimate the panel VAR model in Section 3, which is an extension of the VAR model of the U.S. economy proposed by BS2012 to the state level. By pooling data across states, we achieve greater efficiency in model estimation, while simultaneously accommodating cross-sectional heterogeneity that is time-invariant.

Consider the following reduced-form VAR system with four endogenous variables:

$$Y_{i,t} = A(L)Y_{i,t-1} + \lambda_i + e_{i,t}, e_{i,t} \sim N(0, \Sigma_i) \tag{30}$$

where $Y_{i,t} = \begin{bmatrix} s_{i,t} \\ c_{i,t} \\ y_{i,t} \\ \pi_{i,t} \end{bmatrix}$, $A(L) = \begin{bmatrix} A_{i,11} & A_{i,12} & A_{i,13} & A_{i,14} \\ A_{i,21} & A_{i,22} & A_{i,23} & A_{i,24} \\ A_{i,31} & A_{i,32} & A_{i,33} & A_{i,34} \\ A_{i,41} & A_{i,42} & A_{i,43} & A_{i,44} \end{bmatrix}$, $e_{i,t} = \begin{bmatrix} e_{i,1,t} \\ e_{i,2,t} \\ e_{i,3,t} \\ e_{i,4,t} \end{bmatrix}$, $t = 1, ..., T$ indexes time, $i = 1, ..., N$ indexes state, and λ_i is state-fixed effects. In the four-variable model, $s_{i,t}$ is a consumer confidence index, $c_{i,t}$ is the log of real consumer spending, $y_{i,t}$ is the log of real GSP, and $\pi_{i,t}$ is the inflation rate. We assume that reduced-form residuals $e_{i,t}$ follow an i.i.d normal distribution, and they are linear combinations of the underlying structural shocks.

We provide a detailed discussion of the treatment of non-stationarity in the panel model estimation, as it is a critical issue that can lead to different estimation results and implications (see, for example, Barsky, Basu, and Lee 2015). The consumer confidence index is stationary by design, and its stationarity cannot be rejected at a conventional significance level. Consequently, it is always included in the system in levels. The inflation variable is stationary, so it is also included in levels. In contrast, the consumption and output variables are non-stationary and are classified as I(1) variables.

To ensure that we do not eliminate interesting medium to long-term dynamics among the variables, we estimate the VARs with these variables entered in levels. This approach is consistent with the cointegration of unknown forms and produces reliable estimates of impulse responses (Hamilton 2020). Additionally, Phillips and Moon (1999) showed that the OLS estimator for non-stationary regressors is consistent and asymptotically normal when N and T are large, as in our case.

The use of this level specification ensures that our results can be directly compared with those in Barsky and Sims (2012), who also estimated their VAR model in levels. Our identification strategy employs a Cholesky decomposition with a lower triangular matrix restriction and the same ordering as Equation (30). Under this setup, variables that appear later in the ordering affect variables that appear earlier only with a lag. This identification approach builds on the ample evidence that consumer confidence developments often lead business cycles and contain forward-looking information (e.g., Carroll, Fuhrer, and Wilcox 1994; Matsusaka and Sbordone 1995; Ludvigson 2004), and it is identical to Barsky and Sims (2012). Other than state-fixed effects, the system can be rewritten in its structural vector moving average form:

$$\begin{bmatrix} s_{i,t} \\ c_{i,t} \\ y_{i,y} \\ \pi_{i,t} \end{bmatrix} = \begin{bmatrix} C_{i,11} & C_{i,12} & C_{i,13} & C_{i,14} \\ C_{i,21} & C_{i,22} & C_{i,23} & C_{i,24} \\ C_{i,31} & C_{i,32} & C_{i,33} & C_{i,34} \\ C_{i,41} & C_{i,42} & C_{i,43} & C_{i,44} \end{bmatrix} \begin{bmatrix} \epsilon_{i,1,t} \\ \epsilon_{i,2,t} \\ \epsilon_{i,3,t} \\ \epsilon_{i,4,t} \end{bmatrix}, \tag{31}$$

where $\epsilon_{i,t}$ are structural innovations. Zero contemporaneous restrictions using the Cholesky decomposition defined above corresponds to $C_{i,12}(0) = C_{i,13}(0) = C_{i,14}(0) = C_{i,23}(0) = C_{i,24}(0) = C_{i,34}(0) = 0$ in Equation (31).

Following Holtz-Eakin, Newey, and Rosen (1988), we abstract from heterogeneous dynamic effects of consumer confidence shocks by assuming that the cross-sectional units share the same underlying data-generating process. State-fixed effects are an important component of our panel VAR model, which enables us to control for time-invariant state-level heterogeneity that may affect the dynamics of endogenous variables, such as the geographical location, industry share, and demographic structure of each state.[9]

It is worth noting that the size of our panel VAR model's cross-sectional (N) and time (T) dimensions is almost identical. If $T \gg N$, the mean-group estimator proposed by Pesaran and Smith (1995) can be used to account for the heterogeneous dynamic effects of consumer confidence shocks. The mean-group estimator makes use of many time-series observations available for each state and provides an important alternative to the fixed-effect estimator while preserving the cross-

[9]Indeed, the state's industry share or demographic structure does vary over time, but only gradually. Given the quarterly frequency of our analysis, the state-fixed effects largely control for any persistent cross-state heterogeneity.

sectional information of the data. When T is large, the average of the responses estimated unit by unit is consistent with the mean response. Conversely, if $N \gg T$, the ordinary least squares (OLS) estimator should be avoided because the joint inclusion of lagged dependent variables and unit-fixed effects can induce a substantial bias (Nickell 1981).

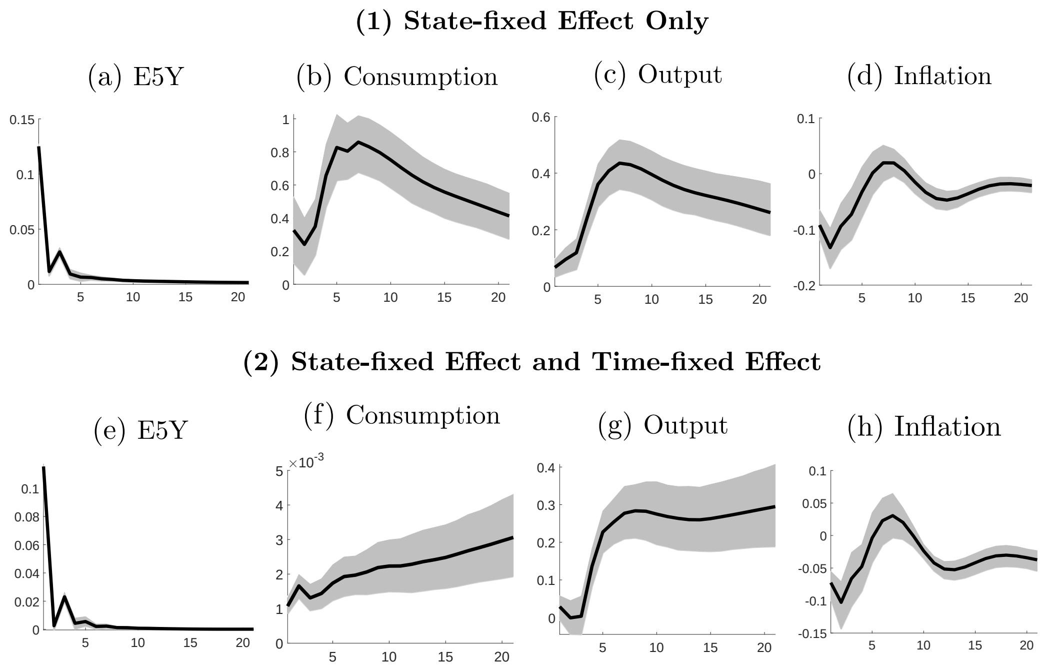
However, in settings where both N and T are large, such as ours, the Nickell bias from OLS tends to zero as T increases (Alvarez and Arellano 2003). Therefore, we estimate the model using OLS, following Judson and Owen (1999)'s suggestion. The baseline panel VAR model spans a period from 2005:I to 2015:IV, covering 30 states (Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, and Wisconsin), in which all key variables are consistently available. In accordance with Barsky and Sims (2012), we estimate the model using four lags, which are relatively conservative compared with the statistics provided by the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Following Barsky and Sims (2012), we report a 68% confidence interval for the impulse response functions, computed using 200 Monte Carlo simulations.

C.3 Panel VARs: Robustness Checks

This section provides robustness checks for the key finding of the state-level analysis presented in Figure 3. First, despite the availability at a quarterly frequency, our measure of consumer expenditure does not fully correspond to consumption in the official national income account statistic, which might affect the interpretation of our findings. Since state-level consumption data are available at an annual frequency, we interpolate them (i) linearly or (ii) using Denton's method. Regardless of the interpolation methods, Figure A5 and A6 confirm that our main finding is not driven by a particular consumption proxy. The consumption response becomes somewhat smaller but more persistent when official PCE data from the BEA are used.

Second, to obtain more conservative estimates on the effect of consumer confidence shocks,

Figure A5: Impulse Responses to E5Y Innovation (Panel VAR, linear interpolation)



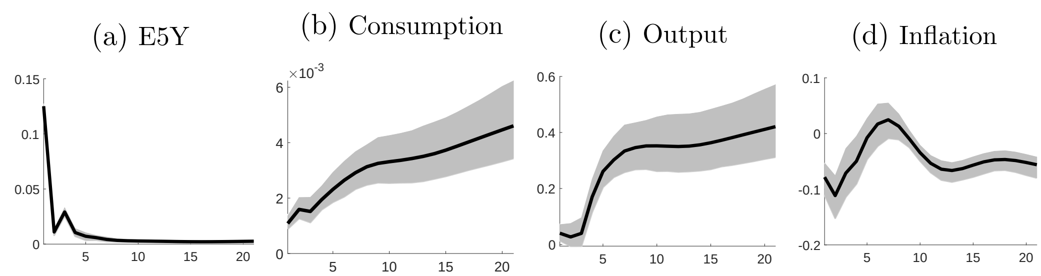
Notes: The panels depict the impulse responses for a four-variable panel VAR with E5Y, consumption, GDP, and inflation. The top (bottom) panels are estimated using state fixed-effect (state-fixed effect and time-fixed effect). The models are estimated using the data from 2005:I-2015:IV. The panel VAR features 4 lags. The shaded areas report 68% confidence bands.

we orthogonalize innovations in consumer confidence with respect to consumption, output, and inflation. Figure A7 presents the results with the Cholesky ordering where the consumer confidence variable is placed last. Even after such an orthogonalization, which rules out any impact response, shocks to consumer confidence are followed by similar responses of consumption, output, and inflation.

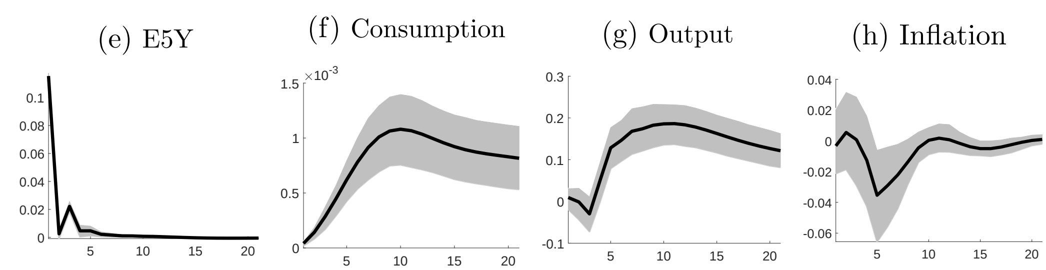
Third, we investigate whether using alternative measures of consumer confidence affects the response of consumption and output documented in the baseline model. First, instead of the question concerning five years ahead, we use the same forward-looking question but limit it to the short-run horizon (12 months ahead). Second, we substitute the Index of Consumer Sentiment (ICS), which is an average of survey responses to both forward and backward-looking questions, in place of the purely forward-looking survey questions. Figure A8 and A9 present impulse responses to confidence innovations with two alternative measures of consumer confidence. There is little qualitative difference arising from using alternative measures.

Figure A6: Impulse Responses to E5Y Innovation (Panel VAR, Denton-method)

(1) State-fixed Effect Only

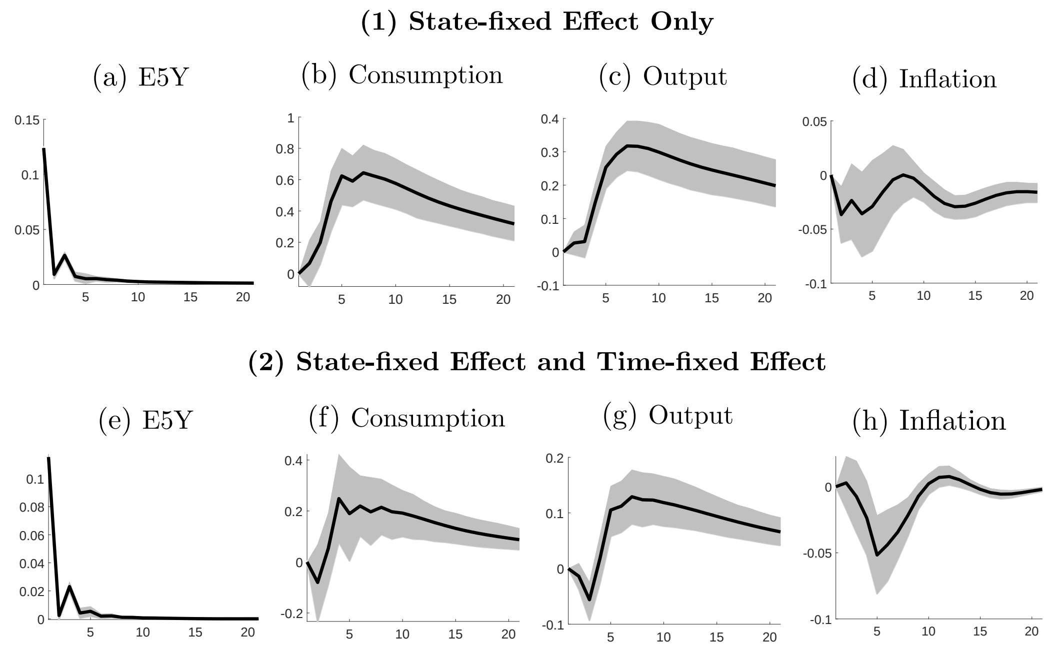


(2) State-fixed Effect and Time-fixed Effect



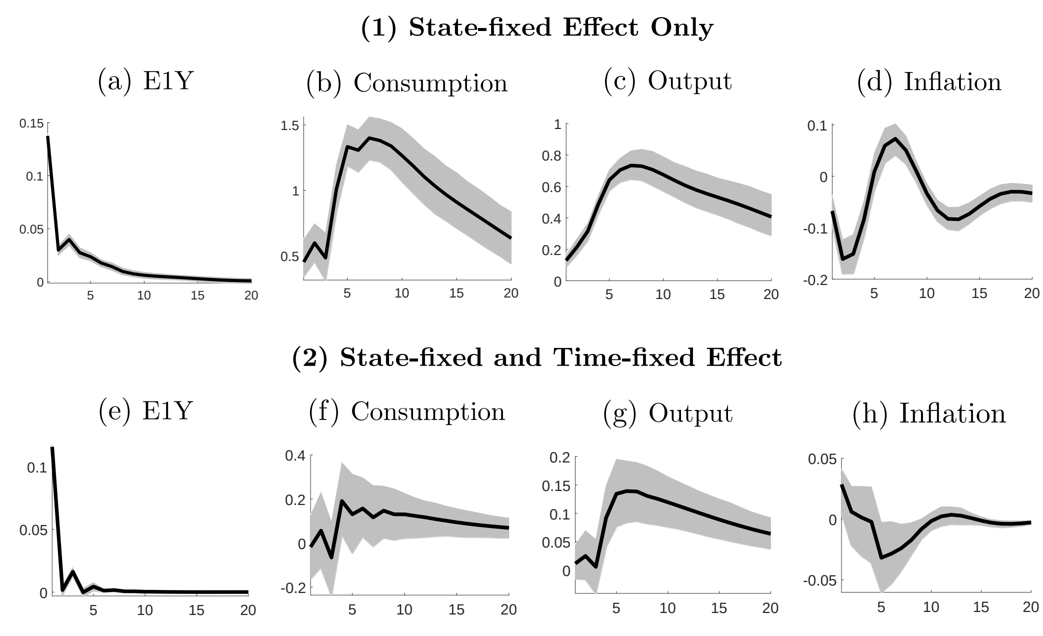
Notes: The panels depict the impulse responses for a four-variable panel VAR with E5Y, consumption, GDP, and inflation. The top (bottom) panels are estimated using state fixed-effect (state-fixed effect and time-fixed effect). The models are estimated using the data from 2005:I-2015:IV. The panel VAR features 4 lags. The shaded areas report 68% confidence bands.

Figure A7: Impulse Responses to E5Y Innovation (Panel VAR, E5Y ordered last)



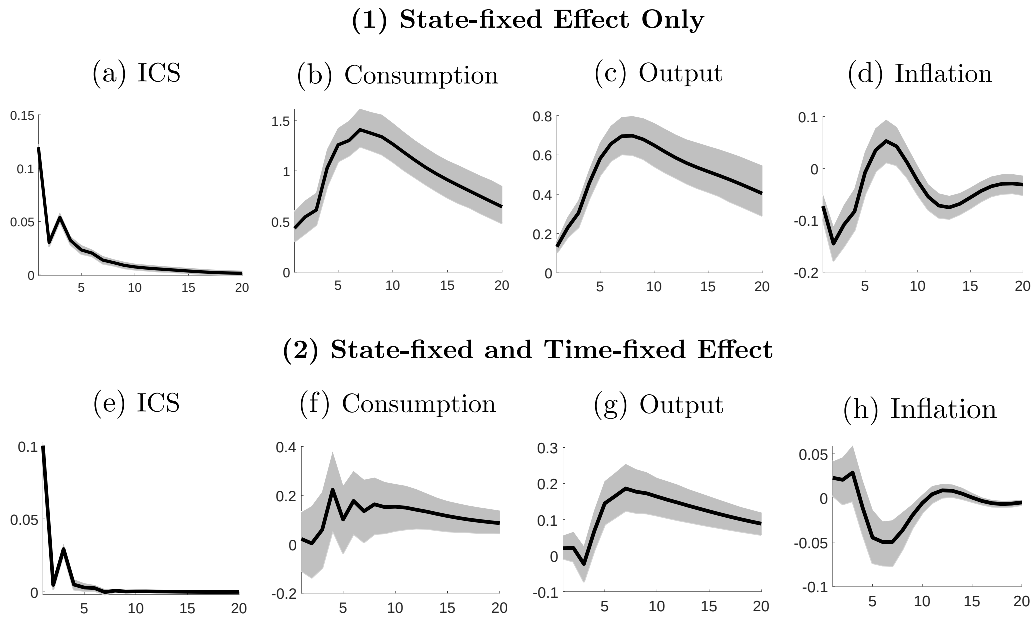
Notes: The panels depict the impulse responses for a four-variable panel VAR with E5Y, consumption, GDP, and inflation. The top (bottom) panels are estimated using state fixed-effect (state-fixed effect and time-fixed effect). The models are estimated using the data from 2005:I-2015:IV. The panel VAR features 4 lags. E5Y is ordered first. The shaded areas report 68% confidence bands.

Figure A8: Impulse Responses to E1Y Innovation (Panel VAR, E1Y ordered first)



Notes: The panels depict the impulse responses for a four-variable panel VAR with E1Y, consumption, GDP, and inflation. The top (bottom) panels are estimated using state fixed-effect (state-fixed effect and time-fixed effect). The models are estimated using the data from 2005:I-2015:IV. The panel VAR features 4 lags. The shaded areas report 68% confidence bands.

Figure A9: Impulse Responses to ICS Innovation (Panel VAR, ICS ordered first)



Notes: The panels depict the impulse responses for a four-variable panel VAR with ICS, consumption, GDP, and inflation. The top (bottom) panels are estimated using state fixed-effect (state-fixed effect and time-fixed effect). The models are estimated using the data from 2005:I-2015:IV. The panel VAR features 4 lags. The shaded areas report 68% confidence bands.