Xiong, Rui; Liao, Wenting; Gupta, Rangan

Book

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Rui Xiong
Renmin University of China
Wenting Liao
Renmin University of China
Centre for Econometrics & Applied Research
Rangan Gupta
University of Pretoria

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Department of Economics
University of Pretoria
0002, Pretoria
South Africa
Tel: +27 12 420 2413

Reassessing the Macroeconomic Effects of Aggregate Skewness: A Time-Varying Perspective

Rui Xiong*

Wenting Liao†

Rangan Gupta ‡

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Abstract

This paper studies the time-varying effects of the aggregate skewness on the macro economy. First we replicate the results in Iseringhausen, Petrella and Theodoridis (2023). However, instead of using the recursive identification in their paper, we construct an instrumental variable (IV) and identify the structural skewness shock by the IV. Then we extend the study to a time-varying context. We find that a negative skewness shock will decrease the GDP growth, increase the unemployment, and decrease the labor productivity. These effects vary over time significantly and become stronger during recessions.

1 Introduction

Iseringhausen, Petrella and Theodoridis (2023) develop an aggregate expected skewness factor from 210 macro fundamental time series to describe the asymmetric macroeconomic fluctuations. Then they show that the revisions in their expected skewness factor act as concretionary business cycle shocks, which will decrease the output, consumption and investment. When estimating the macroeconomic effects of the skewness, they construct a VAR model and use the recursive restriction with the aggregate skewness ordered first.

*School of Finance, Renmin University of China, Beijing, China. Email: xiongrui_ruc@ruc.edu.cn.

†School of Finance, Renmin University of China, Beijing, China. Email: liaowenting@ruc.edu.cn. Corresponding author.

‡Department of Economics, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa. Email address: rangan.gupta@up.ac.za

This study widely replicate their VAR model to reassess the dynamic macroeconomic effects of the new aggregate skewness factor from two aspects. First, instead of using the recursive restriction, we use the external instrumental variable approach to identify the skewness shock. Second, we explore the time-varying effects of the aggregate skewness by estimating a time-varying-parameter structural VAR model with stochastic volatility (TVP-SVAR-SV).

The rest of this study is organized as follows. Section 2 describes the data used in the paper. Section 3 shows the widely replication with the external IV method. Section 4 assesses the time-varying dynamic effects of the skewness factor. Section 5 concludes the paper.

2 Data

In our first replication, we use the same data as in Iseringhausen, Petrella and Theodoridis (2023). Specially, we include the quarterly skewness factor, real GDP, real investment, real consumption, hours, unemployment rate, labor share, policy rate, inflation, labor productivity, and TFP.[1] The sample period is form 1960Q1 to 2019Q4.

In our time-varying extension, we use monthly data instead of the quarterly data to have more observations. Besides, we delate some variables since a time-varying VAR of all previous variables is very hard to be estimated. Thus, the variables used in this exercise are industrial production, unemployment, inflation, federal fund rate, and the stock return. The sample period is from January 1961 to April 2023.

3 Replication with IV method

In this section, we replicate the VAR model investigating the macroeconomic effects in Iseringhausen, Petrella and Theodoridis (2023). However, instead of implying the recursive short-run zero restrictions, we apply the external instrumental variable method (Stock and Watson (2012) and Mertens and Ravn (2013)), which is more popular and less restrictive.

3.1 Instrumental Variable

The instrumental variable should only be related to the structural skewness shock but not to any other shocks. While the skewness factor in Iseringhausen, Petrella and Theodoridis (2023) contains information of other structural shocks, we estimate a VAR model with the skewness factor and its related variables, and then collect the residuals of the skewness equation to extract the IV (see Stock and Watson (2012) and Peersman (2022)). We take the control variables in the Robustness checks section of Iseringhausen, Petrella and Theodoridis (2023) as the variables in our VAR model. Specially, the variables in our model are

[1]The skewness factor can be downloaded from the Review of Economics and Statistics Dataverse. The authors also provide the monthly version of their skewness factor.

macro uncertainty, financial uncertainty, Geopolitical Risk Index, ebp, and the skewness factor. These variables measure total volatilities from different perspectives which may affect the skewness factor. We estimate the VAR and collect the residual of the equation of the skewness factor as our IV. Figure 1 shows the proposed skewness factor in Iseringhausen, Petrella and Theodoridis (2023) and Figure 2 shows the IV used in our following replication. Comparing with the skewness factor, the IV is more volatile. Besides, their behaviors during recessions are quite different. The skewness factor usually starts to decrease several quarters before the recessions, and keeps decreasing during the whole recession. While, during recessions, the IV only decrease at the beginning period and rebounds soon. This implies that the decreasing of the skewness factor is dominated by the increasing of the totaly uncertainty during recessions. If we focus on the tail risk, it only increase at the beginning of the recessions, and will mitigate during the rest of the recessions.

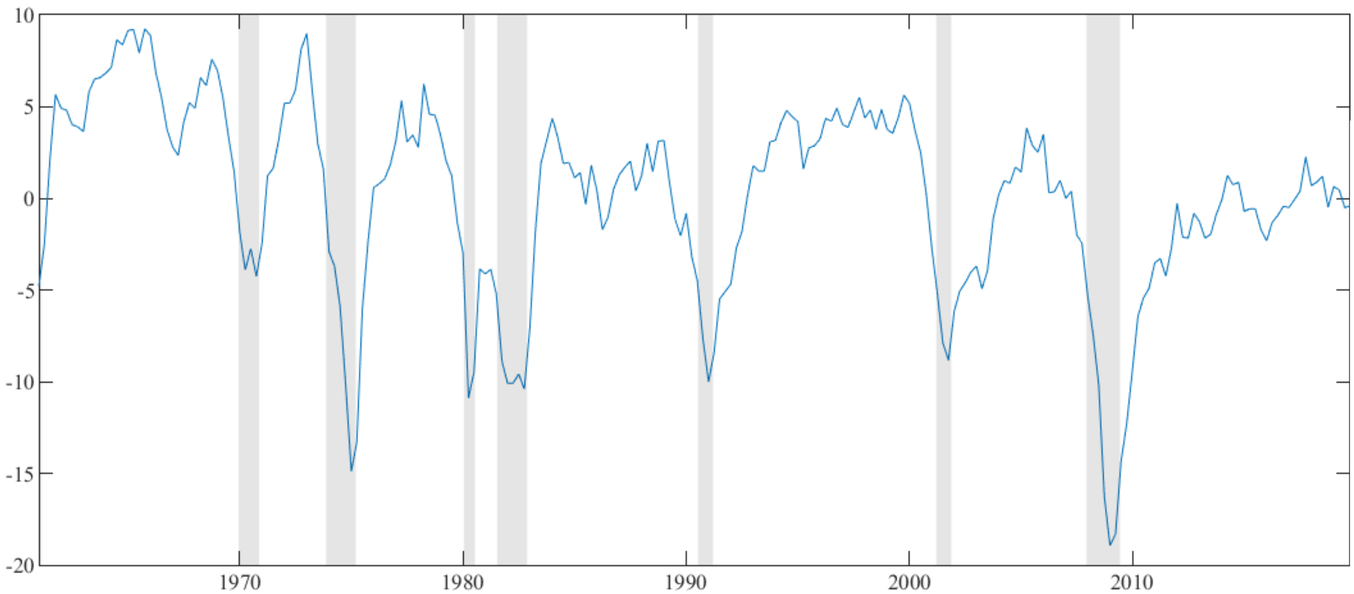

Figure 1: The quarterly skewness factor

Note: This figure shows the quarterly aggregate skewness factor in Iseringhausen, Petrella and Theodoridis (2023). The shaded areas are the NBER recessions.

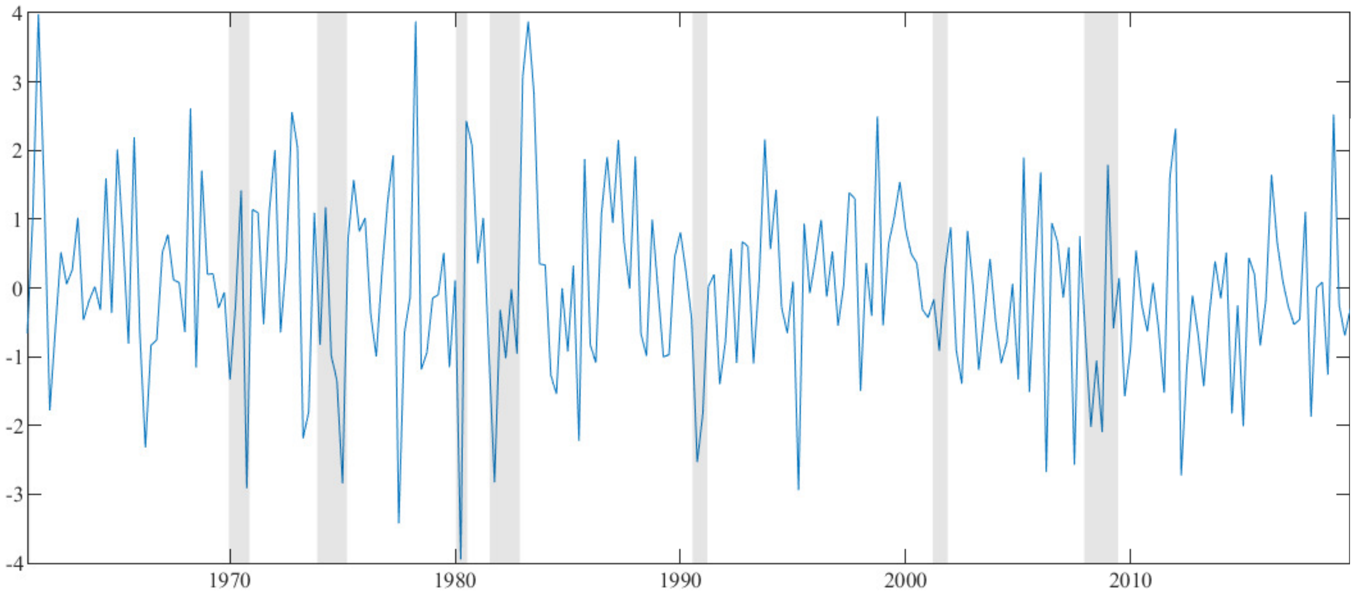

Figure 2: The quarterly IV

Note: This figure shows the constructed quarterly IV. The shaded areas are the NBER recessions.

3.2 Replication Results

With the instrument in hand, we estimate the same VAR model in Iseringhausen, Petrella and Theodoridis (2023). The variables in the model are quarterly skewness factor, real GDP, real investment, real consumption, hours, unemployment rate, labor share, policy rate, inflation, labor productivity, and TFP. The lag is 2. Figure 3 shows the impulse response functions of macro variables to a negative skewness shock. Our results successfully replicate Figrue 2, the impulse response functions of the baseline model, in Iseringhausen, Petrella and Theodoridis (2023). The GDP decreases upon impact and continues to decrease for about 3 quarters, and then rebound gradually to its original level. The pattern for the investment is similar. The consumption also decreases after the impact, and it continues to decrease a bit longer than the investment, then it gradually recoveries. The unemployment increases upon impact and after about 5 quarters, it starts to decrease. The response of the inflation is not significant upon impact, but then becomes significantly negative after several quarters. Overall, the skewness shock acts as the business cycle anatomy in Angeletos, Collard and Dellas (2020).

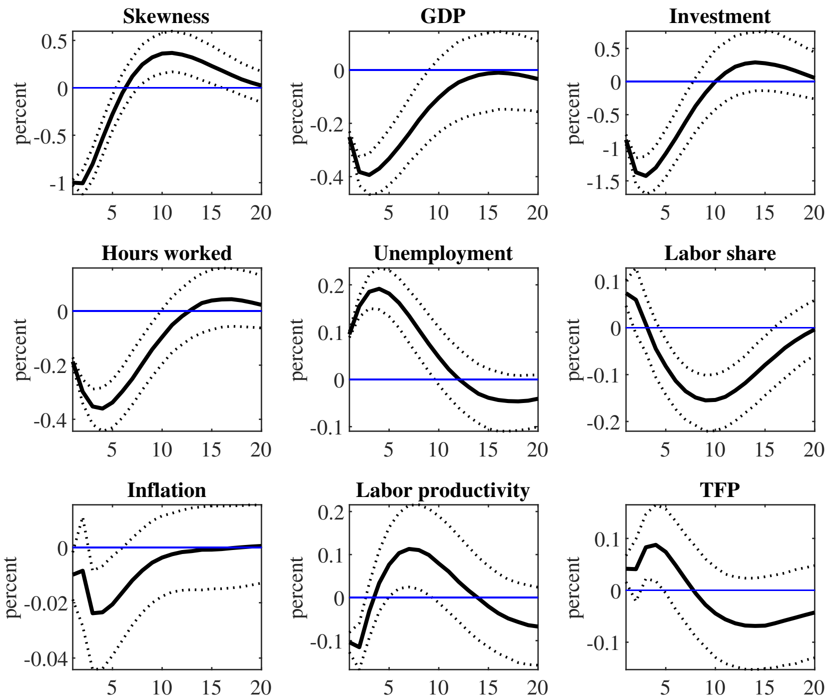

Figure 3: IRFs of the quarterly variables

Note: This figure shows the IRFs of the quarterly macro variables to a negative skewness shock with 90% confidence intervals.

4 Time-varying extension

Given such a long sample period, in this section, we study the time-varying macroeconomic effects of the skewness factor proposed by Iseringhausen, Petrella and Theodoridis (2023).

4.1 TVP-SVAR-IV-SV Model

Following Primiceri (2005), Del Negro and Primiceri (2015), and Liao, Ma and Zhang (2023), we conduct the following TVP-VAR-SV model:

$$y_t = c_t + \varphi_t(L)y_{t-1} + \eta_t,\ \ \eta_t \sim N(0, \Sigma_{\eta,t}) \tag{1}$$

where y_t is an $N \times 1$ vector of macroeconomic variables, c_t time-varying intercepts, and $\varphi_t(L)$ a conformable matrix of lag polynomials of finite order p with time-varying coefficients. The stochastic volatility $\Sigma_{\eta,t}$ can be decomposed as

$$\Sigma_{\eta,t} = A_t^{-1} D_t D_t' A_t^{-1\prime}, \tag{2}$$

and thus,

$$\eta_t = A_t^{-1} D_t \nu_t,\ \nu_t \sim i.i.dN(0, I_N), \tag{3}$$

where A_t is a lower triangular matrix with ones on the diagonal and D_t is a diagonal matrix of the standard deviations of the reduced-from shocks. We stack the lower part of A_t into a vector denoted as α_t, and the diagonal elements of D_t into a vector denoted as d_t. We further stack the elements of the coefficients c_t and $\varphi_t(L)$ into a vector denoted as β_t. We assume all the three vectors to follow random walk processes:

$$\beta_t = \beta_{t-1} + u_t,\ u_t \sim i.i.dN(0, Q), \tag{4}$$
$$\alpha_t = \alpha_{t-1} + \xi_t,\ \xi_t \sim i.i.dN(0, S), \tag{5}$$
$$logd_t = logd_{t-1} + \zeta_t,\ \zeta_t \sim i.i.dN(0, W), \tag{6}$$

and the shocks follows joint normal distribution with the following variance covariance matrix:

$$\text{Var}\left(\begin{bmatrix} \nu_t \\ u_t \\ \xi_t \\ \zeta_t \end{bmatrix}\right) = \begin{pmatrix} I_N & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{pmatrix}. \tag{7}$$

In the SVAR, the reduced-from shock η_t is the linear combination of the structural shock ε_t:

$$\eta_t = B_t \varepsilon_t. \tag{8}$$

Since we are only interested the effect of one single shock, we only have to identify the first column of the impact matrix denoted as B_{1t}. According to Liao, Ma and Zhang (2023) and Lunsford (2015), this can be done by regressing the reduced-form shock on the external IV, g_t, and assuming the regression coefficients to be time-varying:

$$\eta_t = \beta_{IV,t} g_t + v_t,\ v_t \sim N(0, (\Sigma_{\eta,t})^{1/2} \Sigma_{IV} (\Sigma_{\eta,t})^{1/2'}) \tag{9}$$
$$\beta_{IV,t} = \beta_{IV,t-1} + \theta_t,\ \theta_t \sim N(0, Q_{IV}). \tag{10}$$

Then the initial impacts of the interested structural shock can be backed out by:

$$B_{1t}\sigma_{\varepsilon 1,t} = \beta_{IV,t} \left[\beta'_{IV,t} \Sigma_{\eta,t}^{-1} \beta_{IV,t}\right]^{-\frac{1}{2}}, \tag{11}$$

where we normalize the standard deviation of the structural shock $\sigma_{\varepsilon 1,t}$ to be a constant over time.

4.2 Empirical Results

In the time-varying extension, we use monthly data for two reasons. First, the above time-varying model has a lot of coefficients to be estimated. The second reason is that we can check whether the macroeconomic effects are robust for data of a different frequency.

4.2.1 Monthly IV

We still use the same method in section 3.1 to construct the monthly IV. Figure 4 shows the monthly skewness factor from Iseringhausen, Petrella and Theodoridis (2023), and Figure 5 shows the constructed IV.

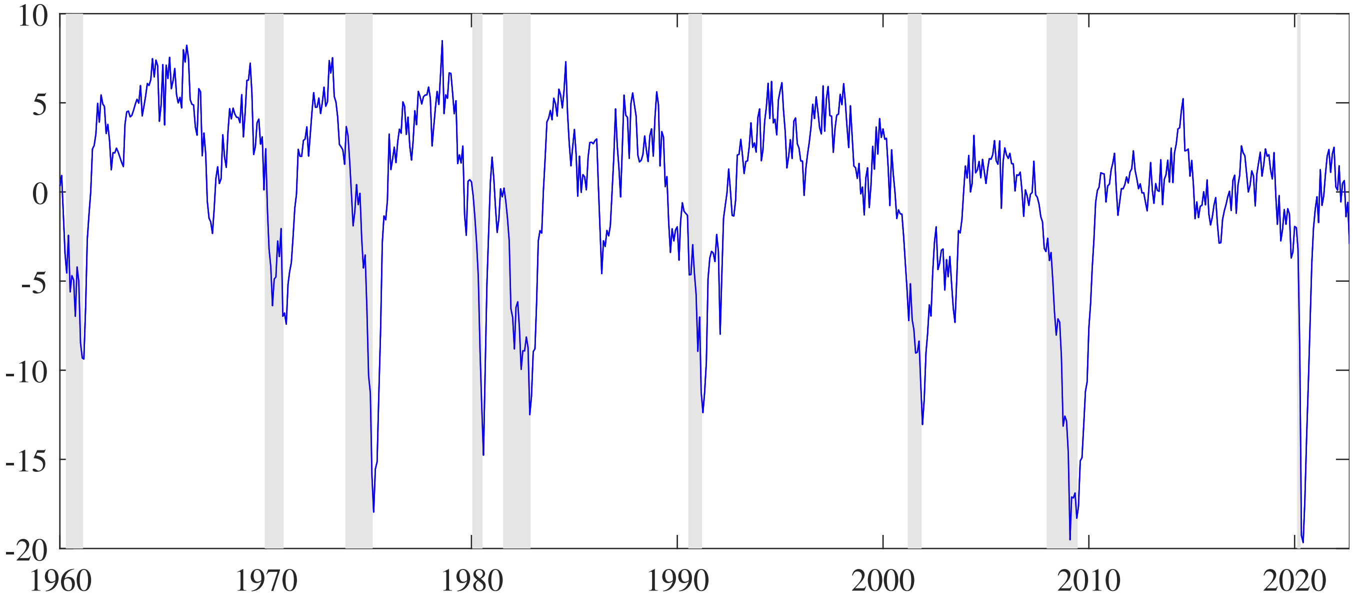

Figure 4: The monthly skewness factor

Note: This figure shows the monthly aggregate skewness factor in Iseringhausen, Petrella and Theodoridis (2023). The shaded areas are the NBER recessions.

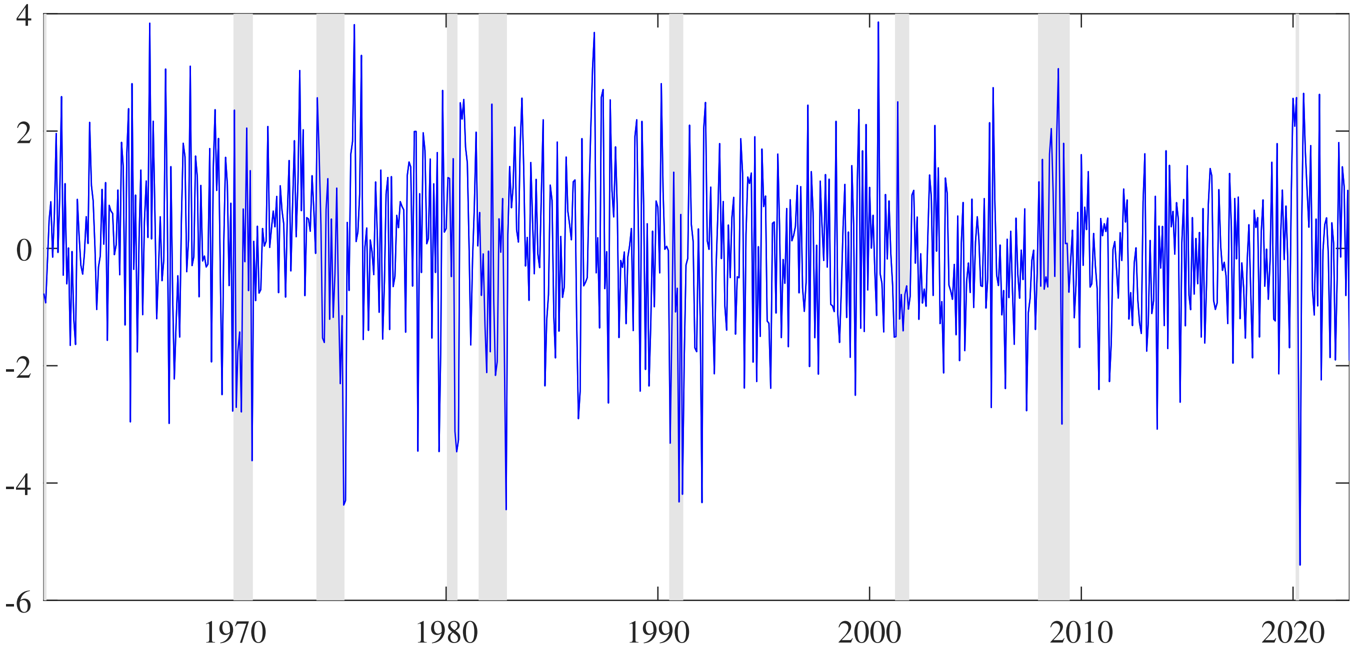

Figure 5: The month IV

Note: This figure shows the constructed monthly IV. The shaded areas are the NBER recessions.

4.2.2 A constant model

Before we estimate our TVP-VAR-SV model, we estimate a constant-parameter VAR model with two lags for initial analysis.The variables in our model are industrial production, unemployment, inflation, ffr, and the stock return. The sample period is from 1961.1 to 2023.4.[2]

Figure 6 shows the IRFs of the macro variables to a negative skewness shock. Comparing with the IRFs estimated with the quarterly data (Figure 3), we find that the effects of the skewness shock on the output are similar. The industrial production decrease upon impact, and then increases gradually to its original level. The effects on the unemployment are also similar. The negative skewness shock increases the employment immediately. For the monthly data, the effects of the first several months are not significant. The effects on the inflation is also different. For the monthly data, a negative skewness shock increases the inflation immediately after about 2 months,and after about 8 months the effects becomes significantly negative. While, for quarterly data, the effect is not significant upon impact and becomes significantly negative after about two quarters, which ignore the initial positive impact on the inflation. The effects on the interest rate are similar that a negative skewness shock tends to decrease the interest rate. Since the frequency of the monthly data is higher

[2]This is a baseline model, thus the variables in the model and the lag of the model is exactly the same as those in the time-varying model. The results of the constant model can also be viewed as the average effects of the time-varying model.

than the quarterly data, which enable us to investigates the effects of the skewness shock on the financial market. The last panel of Figure 6 shows that a negative skewness shock decreases the stock return immediately, and this effect disappears after about 2 months.

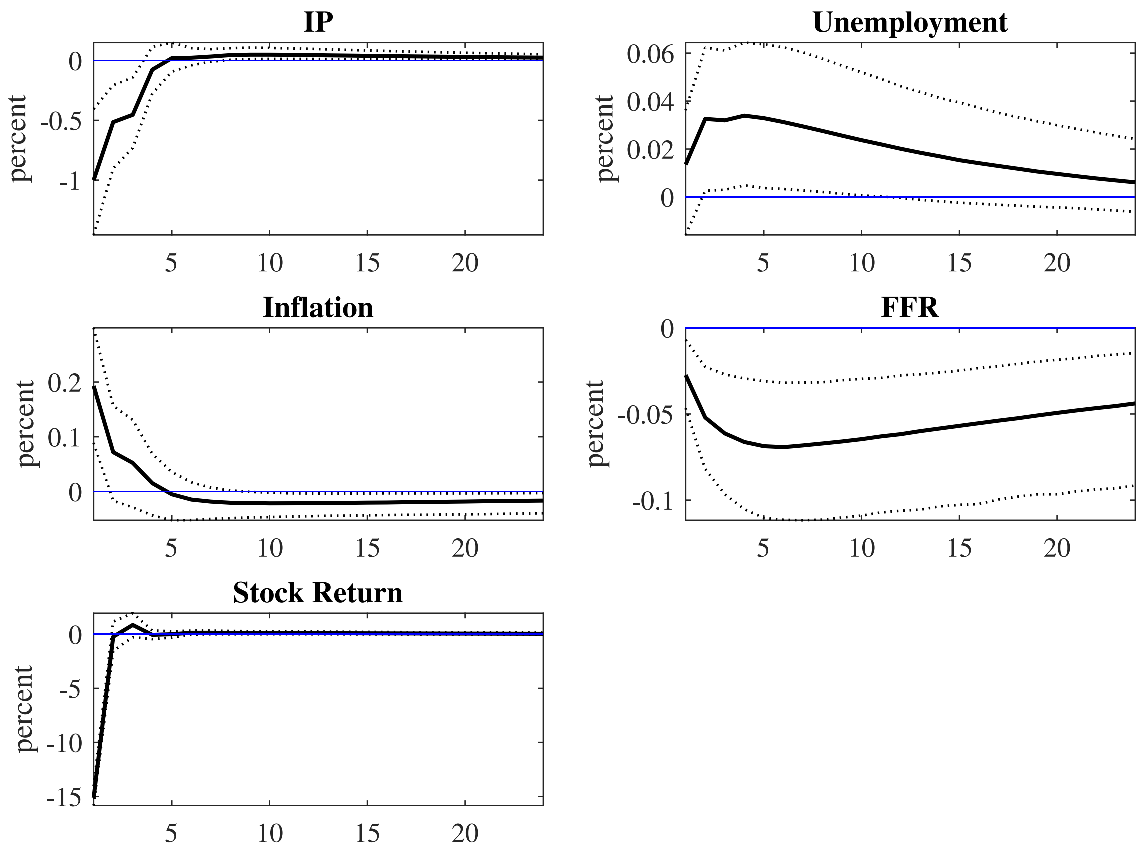

Figure 6: IRFs of the monthly variables

Note: This figure shows the IRFs of the monthly macro variables to a negative skewness shock with 90% confidence intervals.

4.2.3 Time-varying Responses

Given the good result of the constant parameter model, we extend the analysis to the time-varying-parameter context. We estimate the time-varying model in Section 4.1 using a Bayesian Gibbs-sampling estimation algorithm following Liao, Ma and Zhang (2023). The priors and hyperparameters are choose by the algorithm in Amir-Ahmadi, Matthes and Wang (2020). We estimate the model with 50000 draws and discard the first 20000 draws, and we use the autocorrelation of the draws to check the convergence of the algorithm.

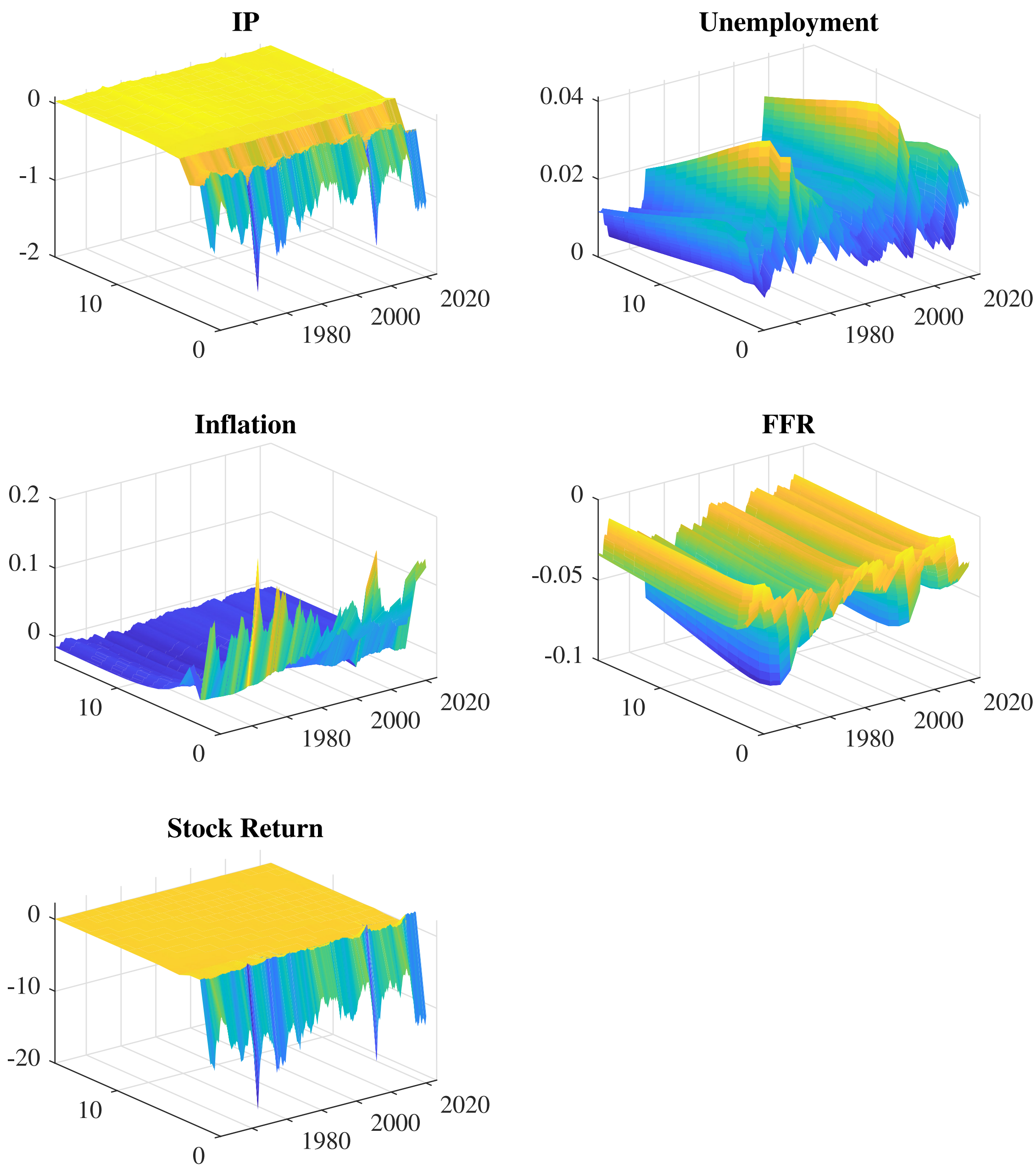

Figure 7: IRFs of the time-varying model

Note: These figure shows the IRFs of time-varying model.

Figure 7 shows the results of the IRFs from the time-varying model. The patterns for the 5 variable at different time periods are similar as their responses in the constant model (Figure 6). However, the initial impacts and strength of the effects vary over time. Specially, during recessions, the initial impacts are stronger.

5 Conclusion

This paper first widely replicates Iseringhausen, Petrella and Theodoridis (2023) with the same quarterly data but the external IV identification, and confirms their results. Then, using monthly data,this paper further investigates the time-varying effects of the skewness on macroeconomic variables. The results show that the patterns of the responses are similar to those in the constant model. However, the magnitudes are varying over time, especially, during recessions, the effects are stronger. This further shows that the results in Iseringhausen, Petrella and Theodoridis (2023) are robust to data of different frequency and model specifications.

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