Structural Vector Autoregression (SVAR)

Ulvi Niftullayev

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1 Introduction

Vector Autoregressive (VAR) models have become a widely utilized tool for analyzing macroeconomic dynamics and deriving monetary policy implications. However, unlike Structural Vector Autoregressive (SVAR) models, VAR models do not impose any theoretical or structural restrictions on the interactions between economic variables. In essence, they allow the data to drive the analysis without incorporating prior economic theory into the model's structure. This absence of restrictions can limit the interpretability of the results, especially when the aim is to understand causal relationships.

SVAR models address this limitation by incorporating economic theory through the imposition of restrictions on the behavior of variables, allowing for more meaningful economic interpretation. These restrictions are typically based on economic theory, thus facilitating the identification of shocks and their effects on the economy. In this short document, I will show the estimation of a SVAR model for the United States economy and discuss the policy implications that can be derived from the model.

2 Data

In this specific case, I will use three variables: the output gap (difference between actual and potential GDP), the inflation rate and the policy rate of the FED. The period for analysis is 2010 Q1 to 2024 Q2 (58 observations on quarterly frequency). The data was obtained from the Federal Reserve Bank of St. Louis website. Table 1 and figures 1-3 below show descriptive statistics and time series of the variables.

Table 1: Summary statistics for Output Gap, Inflation and Interest Rate

Variable	**Min.**	**1st Qu.**	**Median**	**Mean**	**3rd Qu.**	**Max.**
Output Gap	-9.2072	-3.1016	-1.2985	-1.5470	-0.0304	1.3422
Inflation	-0.0627	1.3960	1.9345	2.5798	3.2305	8.6356
Policy Rate	0.0700	0.0925	0.1850	1.1262	1.5400	5.3300

Figure 1: Output Gap

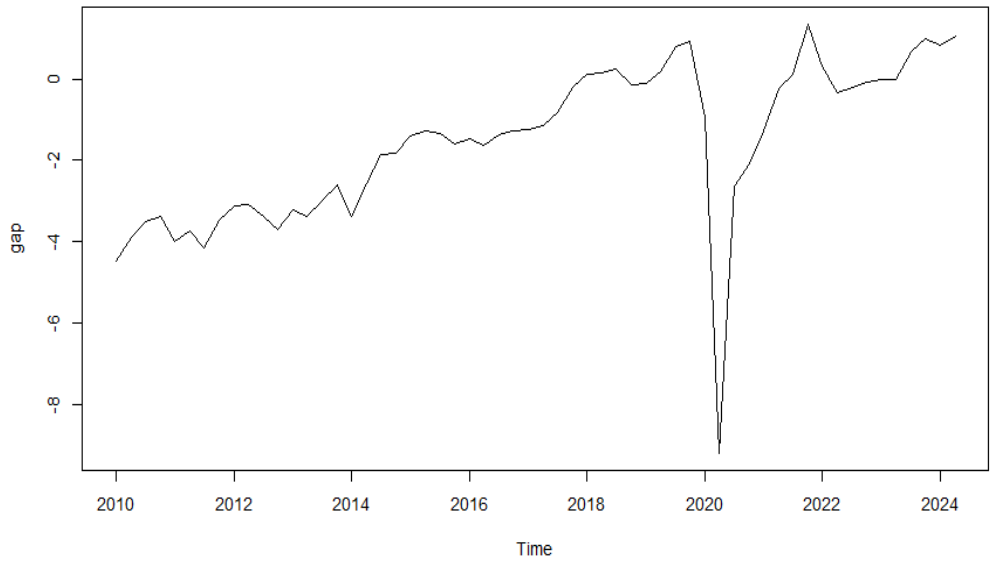


Figure 2: Inflation

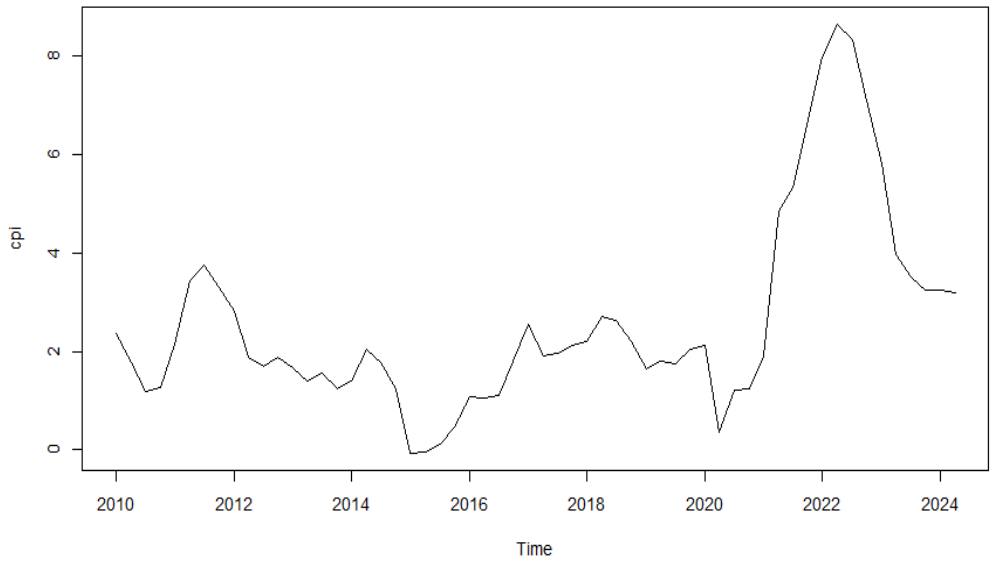
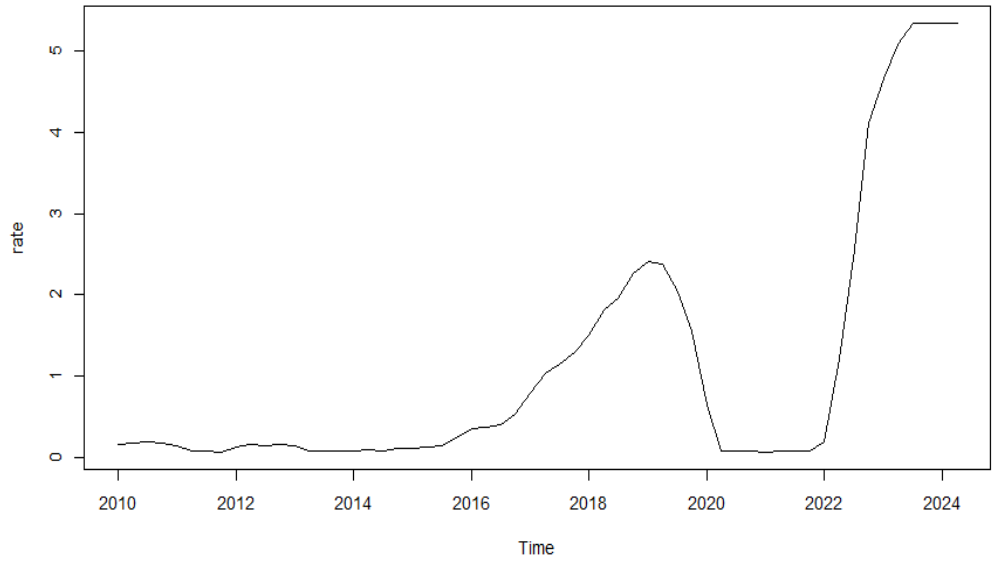


Figure 3: Policy Rate



3 Estimation

Before estimation, we must first impose sign restrictions on the data. The matrix below shows restrictions. The restrictions imposed are based on economic intuition. That is, the zero-sign restrictions assume that the output gap can affect inflation rate and policy rate contemporaneously (in the same period), inflation can only affect policy rate contemporaneously, while policy rate can affect neither at the same period.

$$A = \begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{pmatrix} \begin{pmatrix} \text{gap}_t \\ \text{inflation}_t \\ \text{rate}_t \end{pmatrix}$$

The estimation was performed on levels data, without transforming it into stationary form (as we are not performing forecasting). Based on the lag selection procedure in Table 2, all selection criteria chose the second lag to be the most optimal.

Table 2: Lag Selection

Criteria	**AIC(n)**	**HQ(n)**	**SC(n)**	**FPE(n)**
Lag Order	2	2	2	2

After selecting the best lag and estimating VAR, we estimate SVAR. We can now check Impulse Response Functions, which show how a shock in one variable triggers a response in another variable. We will check 3 IRFs. First, we will look at how a positive shock of the output gap (actual GDP exceeds potential) triggers inflation response. We will also check the response of policy rate to output gap. Finally, we will look at the shock of inflation and response of the policy rate.

As we can see, the theoretical assumptions put on restrictions align with empirical results. That is, a positive shock to the output gap increases inflation (see Fig.4). That must happen as when the GDP increases beyond its potential (whether caused by an increased demand or supply or both), the prices for goods and services are expected to rise. Figure 6 shows that the shock in inflation, in turn, raises the policy rates. This is logical as well, because increase in interest rate by the monetary institution is expected to raise the cost of borrowing and put downward pressure on inflation. Figure 5 shows that increase in output gap raises the policy rate, though here the effect is indirect, as the gap raises the inflation and that, in turn, causes the rate spike.

Figure 4: Output Gap Shock on Inflation

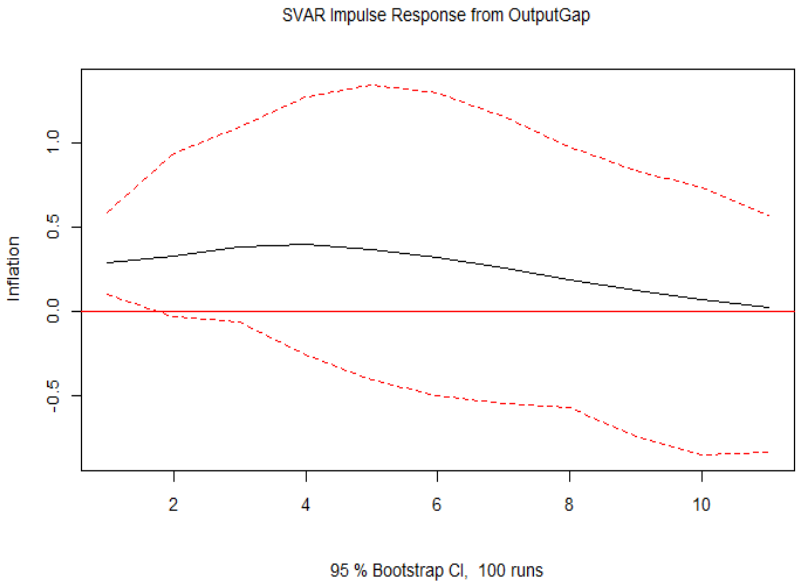


Figure 5: Output Gap shock on Policy Rate

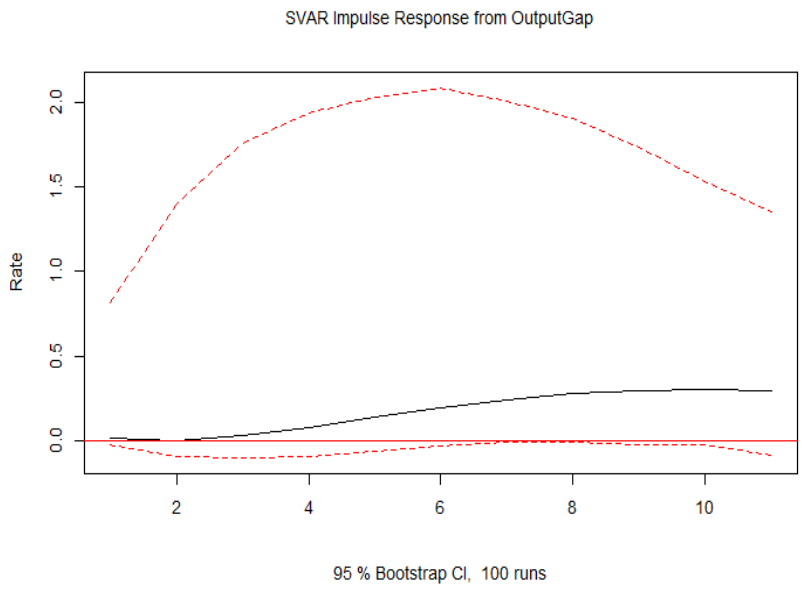


Figure 6: Inflation Shock on Policy Rate