

Question 4.

The Reserve Bank of Australia is tasked with managing price inflation and (un)employment levels: “the Bank sets monetary policy to keep inflation in the economy to 2–3 per cent and employment at the maximum level that is consistent with maintaining low and stable inflation.”

A VAR model is to be specified to model three quarterly time series, with sample from 1966q3 to 2024q4:

`Inf_CPI` : inflation rate of the Consumer Price Index

`D_Unemp` : first difference of the unemployment rate

`Inf_Oil` : inflation rate of global oil price index

VAR models with lag orders $p = 1, 2, 3, 4$ are estimated, with AIC and p -values of residual autocorrelation tests tabulated below.

p	AIC	Auto.pval
1	969.9	0.396
2	966.8	0.302
3	964.8	0.286
4	971.6	0.157

- (a) What is the appropriate lag order for the VAR based on these statistics? Explain.

A VAR(3) is appropriate because this lag order minimises the AIC and the null hypothesis of no autocorrelation is not rejected by the autocorrelation test ($p = 0.286 > 0.05$).

The time series are included in the VAR in the order `Inf_Oil`, `D_Unemp`, `Inf_CPI`. The Choleski factorisation of the conditional variance matrix of the VAR estimated to be

	<code>Inf_Oil</code>	<code>D_Unemp</code>	<code>Inf_CPI</code>
<code>Inf_Oil</code>	14.481	-0.096	0.060
<code>D_Unemp</code>	0.000	0.246	-0.044
<code>Inf_CPI</code>	0.000	0.000	0.173

- (b) Suppose we are interested in the forecast effects of an orthogonalised impulse to oil price inflation. What is the size of the impulse to oil price inflation? Are there any non-zero contemporaneous impulses to other time series in the VAR? If so, what would the impulse(s) be?

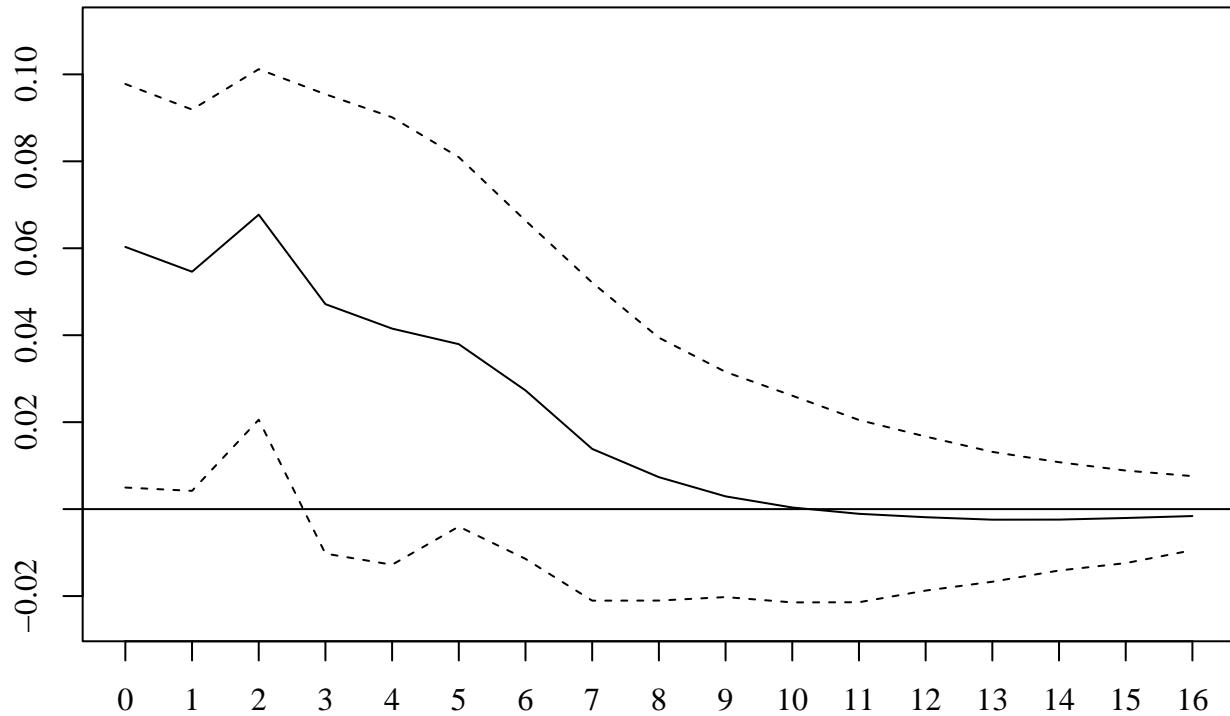
These impulses are taken from the first row of the C matrix above. These are 14.481 impulse to oil price inflation, -0.096 to unemployment and 0.060 to CPI inflation.

- (c) Suppose we are interested in the forecast effects of an orthogonalised impulse to CPI inflation. What is the size of the impulse to CPI inflation? Are there any non-zero contemporaneous impulses to other time series in the VAR? If so, what would the impulse(s) be?

These impulses are taken from the third row of the C matrix above. These are 0.173 impulse to CPI inflation, and zero contemporaneous impulses to the other two time series.

The VAR is used to compute the impulse response function of CPI inflation to the orthogonalised oil price inflation impulse discussed in part (b). A plot of this impulse response function is shown below.

Response of CPI Inflation to orthogonalised impulse to Oil Price Inflation



(d) What conclusions can you draw from this plot?

The contemporaneous response of CPI Inflation to the positive oil price shock is positive and significant. The impulse responses for the next two quarters are also positive and significant. The impulse responses at longer horizons remain positive but insignificant out to 8 quarters, becoming close to zero thereafter. Overall the conclusion would be that a positive oil price shock results in increased CPI inflation forecasts for at least two quarters (6 months) into the future. (Economically an unsurprising conclusion, perhaps the only surprise being the significance is only for two quarters.)

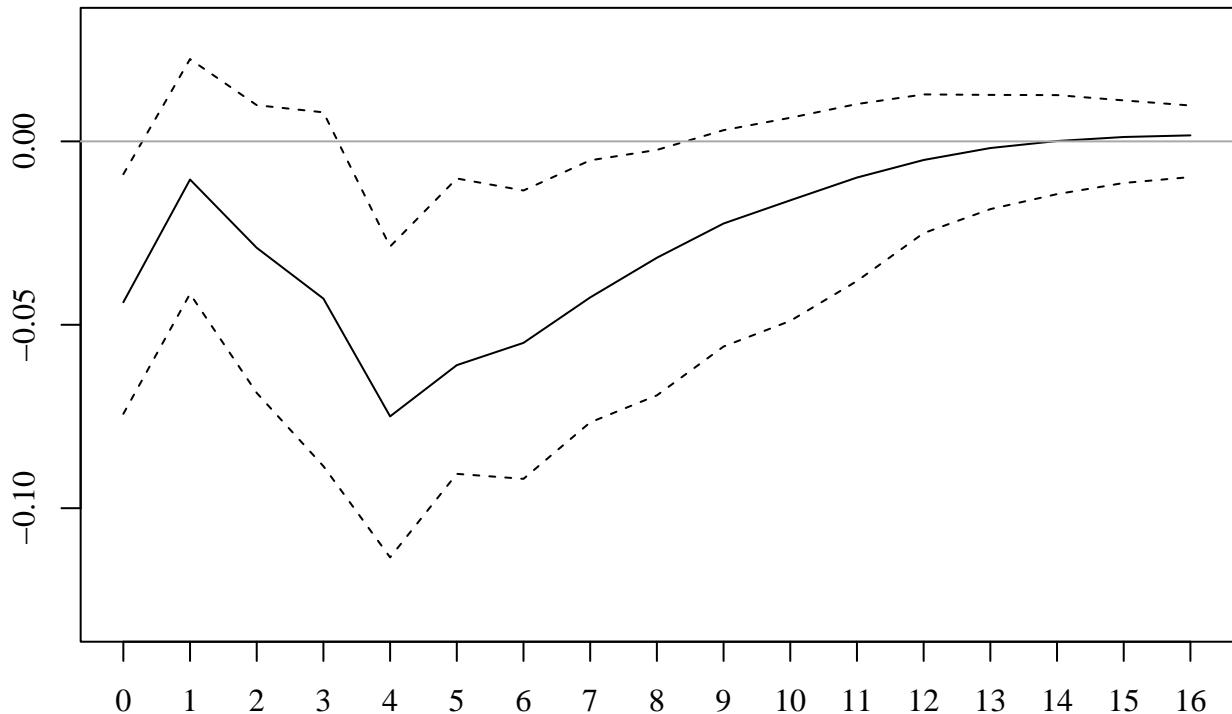
The “Phillips Curve” theory in macroeconomics proposes a *negative* relationship between inflation and employment. Consider an orthogonalised impulse to D_{Unemp} using the same Choleski factorisation.

- (e) For this impulse to D_{Unemp} , what are the values of the impulses to each of the three time series?

The impulse to D_{Unemp} is defined by the second row of the C matrix, so the corresponding impulses to each time series are 0.246 to D_{Unemp} , -0.044 to Inf_{CPI} and 0 to Inf_{Oil} .

The impulse response function of Inf_{CPI} to this impulse to D_{Unemp} is shown below.

Response of CPI Inflation to orthogonalised impulse to Unemployment



- (f) Does this impulse response function provide any evidence for the “Phillips Curve” theory?

The contemporaneous impulse to `D_Unemp` is negative, as may be suggested by the Phillips curve, but it is not significant here since the 95% confidence interval at horizon 0 includes zero.

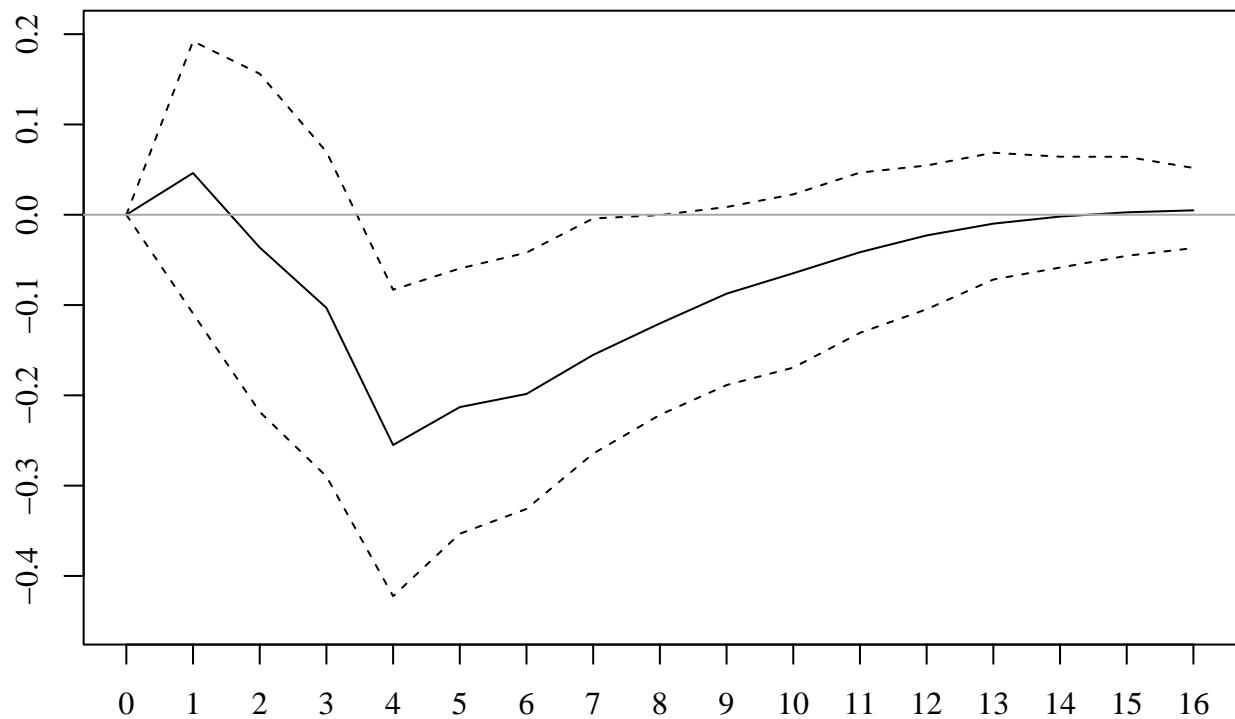
The full impulse response function is mostly negative, at least until around horizon 12 (3 years) where it has reached essentially zero. At horizons 4–7 the impulse response function is negative and significant. This does provide some evidence for the Phillips Curve theory, at least statistically in the sense that a positive unemployment impulse leads to lower inflation forecasts 1-2 years in the future (i.e. the theory, if true, appears to take some time to take effect.)

- (g) Suppose we want to re-define the impulse computations so that a `D_Unemp` impulse no longer implies a contemporaneous impulse to `Inf_CPI`. Instead a `Inf_CPI` impulse should imply a non-zero contemporaneous impulse to `D_Unemp`. What steps would you take to implement this?

This requires a re-ordering of the variables in the VAR. Currently `D_Unemp` appears before `Inf_CPI`, and these should be reversed. Without further information about `Inf_Oil`, it is fine to leave it as first in the ordering.

Here is the *non-orthogonalised* response function for Inf_CPI to a *non-orthogonalised* impulse to D_Unemp

Response of CPI Inflation to *non-orthogonalised* impulse to Unemployment



- (h) What values are implied for the impulses to the three time series in the model by this *non-orthogonalised* impulse to D_Unemp?

The impulses are respectively 0, +1, 0 to Inf_Oil, D_Unemp and Inf_CPI.

- (i) What similarities and differences are there between this impulse response function and that for part (f)?

This non-orthogonalised impulse response starts at exactly 0, since that is imposed by this type of impulse. The orthogonalised impulse response does not start at zero in this case, since `Inf_CPI` was placed after `D_Unemp` in the variable ordering in the VAR.

The two impulse response functions have the same shape, but different scales. This is because the impulses to `D_Unemp` have different magnitudes: +1 for the non-orthogonalised, and +0.246 for the orthogonalised impulse.

- (j) Is there evidence for Granger causality from `D_Unemp` to `Inf_CPI` in these results?

The non-orthogonalised impulse response of `Inf_CPI` to the `D_Unemp` impulse is significant at horizons 4–6, implying that inflation forecasts would be revised in response to changes to unemployment. This provides evidence of Granger causality from `D_Unemp` to `Inf_CPI` in this model.