VAR

level

Difference

Disadvantages

1) Parameters of SVAR have no economic meaning and this pose problem for interpretation

Ex.

5 variable, annual date 1960 - ~~15~~

take 4 lags

5 equation.

$21 \times 5 = 105$ parameter

D.f. MF = $55 - \underline{105} = -50$

$h - k = 0$

This is called Limited Information.

6 Over-parameterization makes the task of interpretation tedious.

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This problem is called over-parameterization.

SVAR → We have to impose a parameter that can have economic meaning. It deals with theory and partly deals with over-parameterization.

→ Reducing the variables will lead to another problem called → Limited Information

RVAR	Level	— SVAR	— FA-S-VAR
	Diff.	— FAVAR	

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Bernike (2003, 2005) - for FAVAR

Dynamism → over parameterization

↳ Limited Information

Limited Information leads to FAVAR.

SAVAR

Lag operator, vector of errors

$$A(L)\, y_t = e_t$$

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots - \cdots + A_p y_{t-p} + e_t$$

$A_1 = A_2 = \cdots = A_p$ are all called Reduced Form parameters

* Where is the Structural parameter and what is the relationship b/w Str. Parameters and Reduced form parameter

The S-parameter or S-VAR look this way

matrix

$$\lambda_1 y_t = \lambda_2 y_{t-1} + \lambda_3 y_{t-2} + \ldots - \ldots + \lambda_p y_{t-p} + \beta e_t$$

variable

Covariance matrix

$$e_t \sim N(0, \sigma^2)$$

This is the structural model in this contemperenous matrix because it is measuring the impact in the current period

$$\begin{array}{cc} & \begin{array}{ccc} m_3 & i & y \end{array} \\ \begin{array}{c} m_3 \\ i \\ y \end{array} & \beta = \begin{bmatrix} \sigma^2 & Cov(m_3, i) & Cov(m_3, y) \\ Cov(i, m_3) & \sigma^2 & Cov(i, y) \\ Cov(y, m_3) & Cov(y, i) & \sigma^2 \end{bmatrix} \end{array}$$

Divide both sides by λ_1 then after that we will have

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots - \ldots + A_p y_{t-p} + u_t$$

structural parameters

where $A_1 = \lambda_1^{-1} \lambda_2 = \dfrac{\lambda_2}{\lambda_1}$

$A_2 = \lambda_1^{-1} \lambda_3$

$\vdots$

$A_p = \lambda_1^{-1} \lambda_p$

SVAR is related to only non-systematic component

$$A_p = \Lambda^{-1} \Lambda_p$$

Reduced Form shock $\rightarrow$ $u_t = \Lambda_1^{-1} B e_t$

non-systematic component is represented by Impulse

$A_1 = \lambda^{-1} \lambda_1$ and others are Systematic component

If we have to study the non-systematic we have to study u_t

Covar. matrix

$u \cancel{A}_1 = B \, e_t$ — vector of structural shock

vector of reduced form shock

contamperenous matrix that will be 3 X 3 A matrix

$$A_1 = \begin{array}{c|ccc} & ms & i & y \\ \hline ms & A_{11} & A_{12} & A_{13} \\ i & A_{21} & A_{22} & A_{23} \\ y & A_{31} & A_{32} & A_{33} \end{array}$$

Contemperenous matrix

<u>Now, the restrictions will be imposed</u>. separately

1. A_1 model if we restrict if we restrict

$B = I_n$ (Identity matrix)

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2. B model if A

$\Lambda_1 \cancel{A} = I_n$

3. Λ_1 B model.

For 3 variables we should

have $2k^2 - \frac{k(k-1)}{2}$

K = no. of variables.

This is for

λB model. (3^{rd} model)

For the first two models to be exactly identified

we have to have

$\frac{k(k-1)}{2}$ exactly identified.

λ_1 model = $\frac{3(3-1)}{2} = \frac{3 \cdot \cancel{2}}{\cancel{2}} = 3$ restriction

$\lambda B = (2 \cdot (9)) - \frac{3(3-1)}{2} = 18 - \frac{3 \cdot \cancel{2}}{\cancel{2}} = 15$

$\lambda_1 B = 15$ restriction.

WAYS TO GET RESTRICTIONS

1. Recursive way (Sims 1980) — Only contemperenous is applicable in Recursive method.

2. Wold Restriction.

3. Restriction based on Eco-nomic theory - Theory drives the short-run, Long-run.

4. Sign Restriction

5. Restrictions based on Heteroskedasticity

6. Restriction based on DSGE

Periods of Restriction

1. Contemperonous

2. Short- run

3. Long- run

4. Short run and Long- run

Gali (1992)

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SIMS (1980)

Recursive Restriction or Identification

response

contemperous

$A u_t = B.\ e_t$

Reduced form VAR

$u^t = A^{-1} B e^t$

$u^t = 1\ B\ e_t$

$e_t = \underbrace{A u_t B^{-1}}$

structural shocks

Reduced form shock.

$A y_t = A_1 y_{t-1} + \cdots\cdots$

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} u^{m_3} \\ u^{i} \\ u^{y} \end{pmatrix}$$

$$= \begin{array}{c|ccc} & m_3 & i & y \\ \hline m_3 & \sigma^2_{m_3} & Cov(m_3, i) & Cov(m_3, y) \\ i & Cov(i, m_3) & \sigma^2_i & Cov(i, y) \\ y & Cov(y, m_3) & Cov(y\ i) & e^2_y \end{array} \begin{pmatrix} e_{m_3} \\ e_i \\ e_y \end{pmatrix}$$

Identity matrix

Recursive Identification

a) A- model if $B = I_k$, $\frac{K(K-1)}{2}$

$K = 3, so = 3$

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

So, only need to make 3 restrictions and this can be made in the form of lower triangular matrix and upper triangular matrix

structural shock

reduced shock

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} e^{m_3} \\ e^{i} \\ e^{y} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} u^{m_3} \\ u^{i} \\ u^{y} \end{pmatrix}$$

Parameter

$$e^{m_3} = a_{11} u^{m_3}$$

$$e^{i} = a_{21} u^{m_3} + a_{22} u^{i}$$

$$e^{y} = a_{31} u^{m_3} + a_{32} u^{i} + a_{33} u^{y}$$

This is an exactly identified model

The parameters can be substituted

IRF $w_t = A_1 u_{t-1} + A_p u_{t-p} + \cdots$

(A- model)

$M_{3,t} = a_{11} u^{m_3}$

$i = a_{21} u^{m_3} + a_{22} u^{i}$

$y = a_{31} u^{m_3} + a_{32} u^{i} + a_{33} u^{y}$

The coefficients will be 0 because it will respond with a lag.

because the matrix is an contemperon

M_3 will respond to its own shock contemperencously. and to shock in i and y with a lags and that is why it will be 0.

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B- Model

$A \rightarrow I_n$ (Identity matrix)

$$\begin{pmatrix} & 6 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} u^{m_3} \\ u^{i} \\ u^{y} \end{pmatrix} = \begin{pmatrix} B_{11} & 0 & 0 \\ B_{21} & B_{22} & 0 \\ B_{31} & B_{32} & B_{33} \end{pmatrix} \begin{pmatrix} e^{m_3} \\ e^{i} \\ e^{y} \end{pmatrix}$$

$$u^{m_3} = B_{11} e^{m_3}$$

$$u^{i} = B_{21} e^{m_3} + B_{22} e^{i}$$

$$u^{y} = {}_{31} e^{m_3} + B_{32} e^{i} + B_{33} e^{y}$$

$M_3 = B_{11} e^{M_3}$

$i' = B_{21} e^{M_3} + B_{22} e^{i}$

$Y = B_{31} e^{M_3} +$

B_{21} will be covariance

B'_{21} will have two errors e

There will be two shocks in the covariance matrix. One on itself.

A-B MODEL

Restriction $2k^2 - \frac{k(k-1)}{2}$

If k

$2(9) - \frac{3(3-1)}{2}$

$18 - 3 = 15$

we need 15 restrictions here

* we need to fix two matrix.
(Identity)
I_{k1} Lower Diagonal

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{pmatrix} \begin{pmatrix} u^{m_3} \\ u^{i} \\ u^{y} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} e^{m_3} \\ e^{i} \\ e^{y} \end{pmatrix}$$

(6 restrictions here) (9 restriction here)

Exactly Identified model.

The restriction are pure recursive in nature. without any theoritical background

$u^{3} = e^{m_3}$

$a_{21} u^{m_3} + u^{i} = e^{i}$

$a_{31} u^{m_3} + a_{32} u^{i} + u^{y} = e^{y}$

$m_3 = u^{m_3}$

$i = a_{21} u^{m_3} + u^{i}$

$y = a_{31} u^{m_3} + a_{32} u^{i} + u^{y}$

m_3 will respond contemperanously to changes in u^{m_3}

i " " " " " " u^{m_3} and u^{i}

y " " " " " " u^{m_3}, u^{i} and u^{y}

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WOLD RESTRICTION

OR

WOLD IDENTIFICATION

$$A u_t = B e_t$$

$$\begin{pmatrix} a_{11} & \cdots & a_{13} \\ a_{21} & \cdots & a_{23} \\ a_{31} & \cdots & a_{33} \end{pmatrix} \begin{pmatrix} u_1^{m_3} \\ u_2^{i} \\ u_3^{y} \end{pmatrix} = \begin{pmatrix} \sigma^2 & cov & cov \\ cov & \sigma^2 & cov \\ cov & cov & \sigma^2 \end{pmatrix} \begin{pmatrix} e_1^{m_3} \\ e_2^{i} \\ e_3^{y} \end{pmatrix}$$

There has to be a justification for the restriction in wold identification.

It is an extension of the AB model but now we have to give economic ~~meanings~~ justification for I_n

I_n (Identity matrix) will make it to be 9 restrictions.

JUSTIFICATION FOR MATRIX B TO B_E

Shocks will pass through and all covariances will be 0

1. All shocks are orthogonal.

i.e. impact of one shock on a variable will not prevent the other shock to affect same variable.

shocks are free to move and affect any variable. M_3 can affect y and i can also affect y.

$Cov(i^{th}, j^{th}) = 0$

Covariance b/w i^{th} and j^{th} shock will be 0.

This mean all the covariances will be 0 if we go by this definition

IDENTITY

2. $\sigma^2 = e^{M_3} \cdot e^{M_3}$ (shock of M_3 on M_3) it is affecting itself

e^j. on $e^j = 1$

The response of that shock on itself will be 1.

This means all the variance will change to 1.

* In all the cases to follow these two restrictions will hold.

Wold Identification

A large set of macroeconomic variables W_t vector

stock Price

$$W_t = [M_3, i, Y, S.P, \cancel{\quad}]$$

$$M_3 = f(i, Y, S.P., \cancel{\quad})$$

W_t can take any combination of variables.

1) Divide variables into 3 groups, that is, W_t into three groups namely

a) Slow moving variables

b) fast moving variable.

c) Policy block

M_3 and Y can be slow moving because they respond with lags.

SP represents Fast moving block

i represents policy block

ORDER (Important)

monetary and Fiscal policy

1. Slow moving variables $\rightarrow M_3$, $\rightarrow Y$
2. P/olicy Block $\rightarrow i$
3. F/ast Block $\rightarrow$ S.P

All the commodity price

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* With in each block

Variables in slow moving block will respond contemperaneously to its own shock

It will label it as Y_{m_3}

it means m_3 will lead to change in y

$$
\begin{array}{c}
y \\ m_3 \\ i \\ sp
\end{array}
\begin{pmatrix}
a_{11} & 0 & 0 & 0 \\
a_{21} & a_{22} & 0 & 0 \\
a_{31} & a_{32} & a_{33} & 0 \\
a_{41} & a_{42} & a_{43} & a_{44}
\end{pmatrix}
\begin{pmatrix}
u_1^y \\ u_2 \\ u_3 \\ u_4
\end{pmatrix}
$$

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With each

Nature of IRF

$y = a_{11}(u^y)$

$m_3 = a_{21} u^y + a_{22} u^{m_3}$

$i = a_{31} u^y + a_{32} u^{m_3} + a_{33} u^i$

$sp = a_{41} u^y + a_{42} u^{m_3} + a_{43} u^i + a_{44} u^{sp}$

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Variables in Slow moving block cannot respond contemporaneously to variables.

Policy only affects slow moving variable.

Policy responds contemperenously to changes in slow moving variables and itself

The fast moving variables will respond contemporaneously will respond instantly to changes in the economy.

Important Within each variables the variables that respond slowly will come first

M_3

M_1

M_0

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* The identification will depend on

1) Objective of study

2) nature of variables you have

and the general ordering will not hold. Policy block will come last.

$w_t = m_3, i, y, sp$

$S_B \Rightarrow$ slow-moving

$F_B \Rightarrow$ Fast-moving

$P_B \Rightarrow i = a_{31} u^{m_3} + a_{32} u^{y} + a_{33} u$

$F_B = a_{21} u^{m_3} + a_{22} u^{i}$

$S_B = a_{11} u^{m_3}$

and you want the study the response of MPK = (non-systemic change in other variables)

monetary policy to non systematic component of our model.

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2) the respons of macro economic variables to monetary policy - This can be the second objective

<u>Identification</u>

1) P_B (Policy block)

2) S_B (Slow moving block)

3) F_B (Fast-moving block)

No where will you have Fast moving before Slow moving

$$P_B = a_{11} u^{P_B}$$

$$S_B = a_{21} u^{i} + a_{22} u^{SB}$$

$$F_B = a_{31} u^{P_B} + a_{32} u^{SB} + a_{33} u^{FB}$$

In all the cases we have 3 restriction we have to take 3 more restriction.

TOTAL OF SIX - RESTRICT-IONS

$$M_3 = a_{11} u^{m_3}$$

$$i = a_{21} u^{m_3} + a_{22} u^{i}$$

$$Y = a_{31} u^{m_3} + a_{32} u^{i} + a_{33} u^{Y}$$

The response of M_3 is instantaneous and the magnitude of response is full. That is it is 1.

$a_{11} = 1$

In this case we will have $a_{11} u^{m_3}_{30} = 1$

Then the whole system will be like this

$$M_3 = u^{m_3}$$

$$i = a_{21} u^{m_3} + u^{i}$$

$$Y = a_{31} u^{m_3} + a_{32} u_{22}^{i} + u^{Y}$$