RIPPLES ON FINANCIAL NETWORKS

SUDARSHAN KUMAR | AVIJIT BANSAL | ANINDYA S. CHAKRABARTI

NAMAN GUPTA

CONTENT

RIPPLE EFFECT

SINGLE DROP <=> SINGLE ASSET

MULTIPLE DROPS <=> MULTIPLE ASSETS

GOALS AND OBJECTIVES

"To find the exact path the ripple effect follows on the whole network of assets"

WHY DOES RIPPLE PROPOGATE?

"Because of the interlinkages across stocks, volatility shock to a particular asset propagates through the network creating a ripple effect."

INTRODUCTION

‘If any one of the domestic companies should fail, we believe there is a strong chance that the entire industry would face severe disruption ’.

A. MULLALY, CHIEF EXECUTIVE OF FORD MOTORS

‘Due to the complexity and interconnectivity of today’s financial markets, the failure of a major counterparty has the potential to severely disrupt many other financial institutions, their customers, and other markets ’

PLOSSER (2009)

BACKGROUND/ ASSUMPTIONS

- To construct the asset network, two natural candidates are the return series and the volatility series.
- Volatility is not observed and has to be estimated from the data.
- We'll study top 100 NYSE stocks (based on market cap) from 2002-2017 in 4 windows

WHY THIS TIME FRAME?

Because it captures periods of all - boom, crisis, recovery and stability.

MATHEMATICAL MANIPULATIONS

RETURNS

$$r_{it} = \log(p_{it}) - \log(p_{i,t-1})$$

CONDITIONAL VOLATILITY

$$r_{it} = \mu_i + \sigma_{it}\epsilon_{it}$$

$$\sigma_{it}^2 = c_i + \sum_{l=1}^{p} \alpha_{il} r_{i,t-l}^2 + \sum_{j=1}^{q} \beta_{ij} \sigma_{i,t-j}^2.$$

(BASED ON GARCH MODEL)

CORRELATION MATRIX

$$\gamma_{ij}^x = \frac{E\left((x_{it} - \bar{x}_i)(x_{jt} - \bar{x}_j)\right)}{\sigma_i^x.\sigma_j^x}$$

CORRELATION MATRIX T_X FROM BOTH THE RETURN SERIES {R_IT} AND THE VOLATILITY SERIES {Σ_IT} ARE CALCULATED

GARCH?

AR(1)

R_t = (k)*R_t-1 + E_t

Auto-Regression Model

ARMA(1,1)

R_t = (phi)*R_t-1 + (sigma)E_t-1 + E_t

Auto-Regression Moving Average Model

ARCH(1)

R_t = E_t * (a+b*(R_t-1)^2)^0.5 = E_t * (sigma)_t

Autoregressive conditional Heteroskedasticity Model

GARCH(1,1)

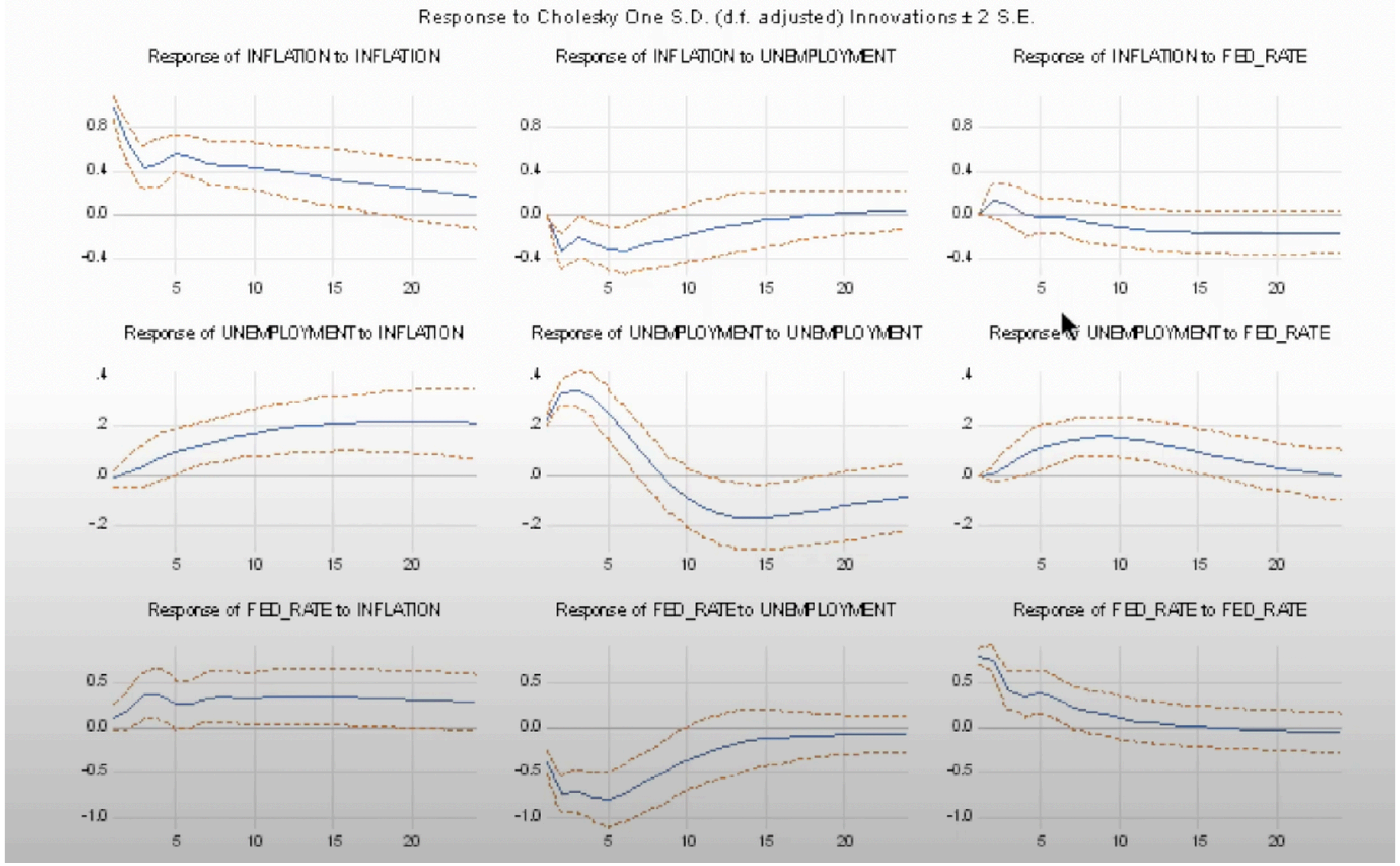
R_t = E_t * [a+b*(R_t-1)^2+c*(sigma_t-1)^2]^0.5 = E_t * (sigma)_t

Autoregressive conditional Heteroskedasticity Model

AN EXAMPLE HOW WE CALCULATE THE IMPULSE RESPONSE FUNCTION

$$A_{zt} = \begin{bmatrix} b_{11} & 0 & 0 \\ b_{21} & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} \pi_t \\ u_t^{une} \\ r_t^{Fed} \end{bmatrix} = BZ_{t-1} + \epsilon_t$$

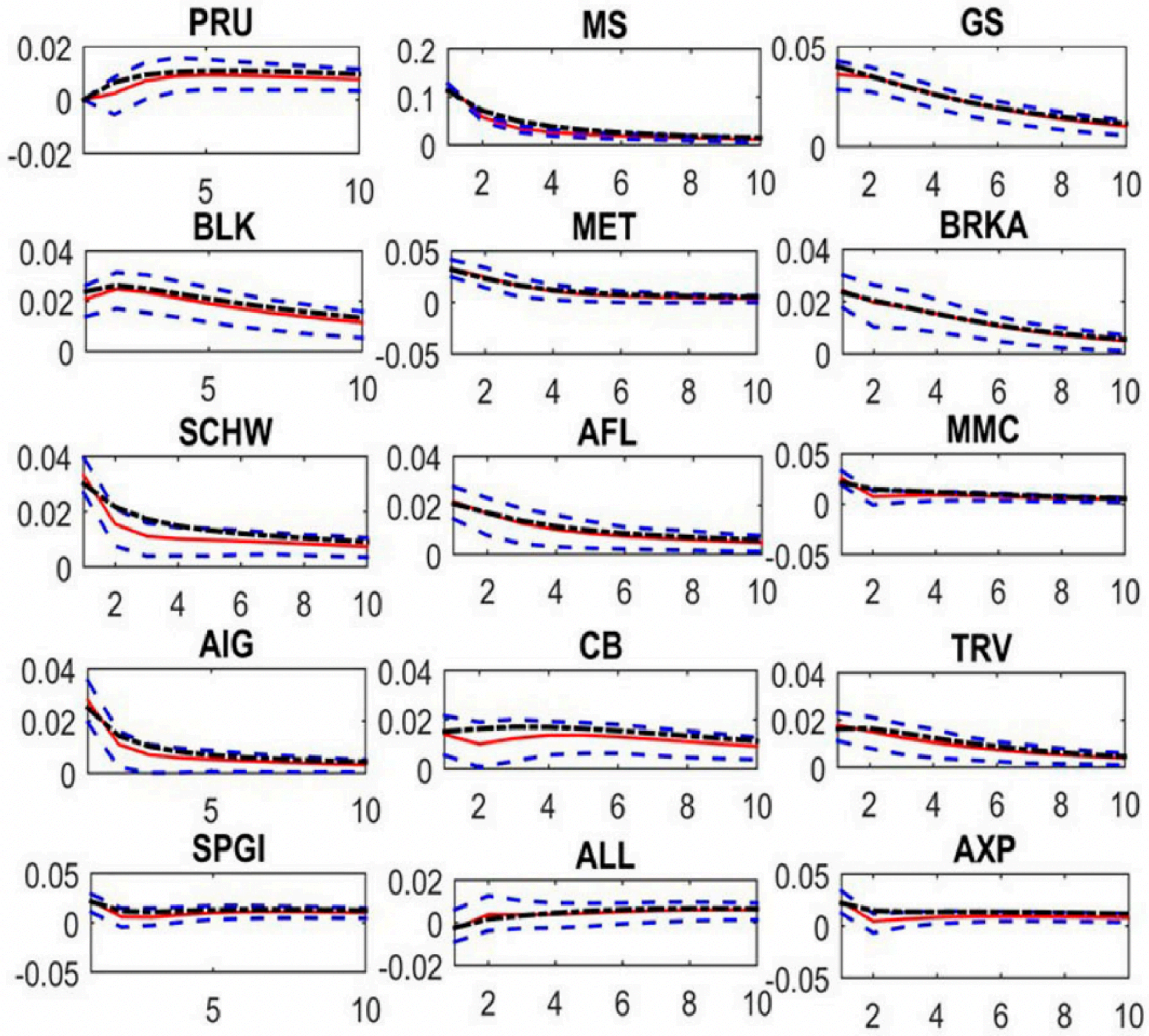
Suppose given, inflation rate, unemployment rate and federal rate.



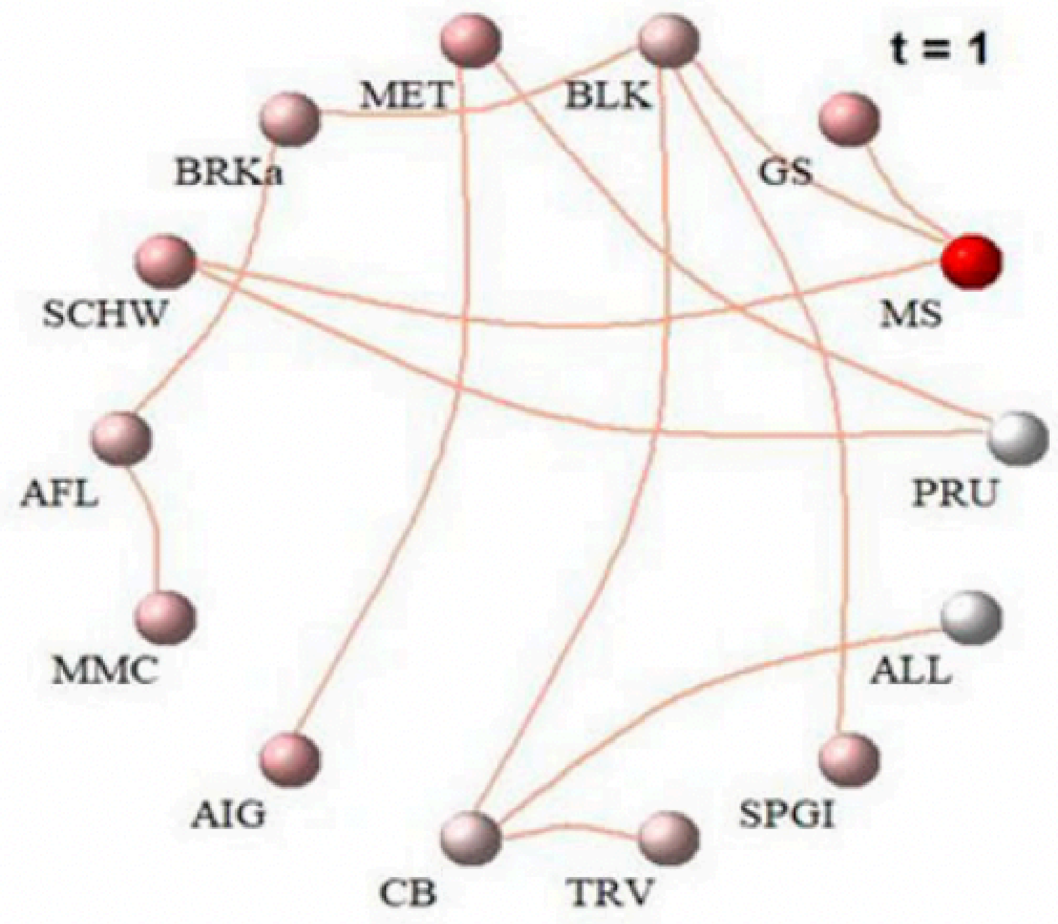
Then these graphs show the effect of 1 SD shock given to one on others

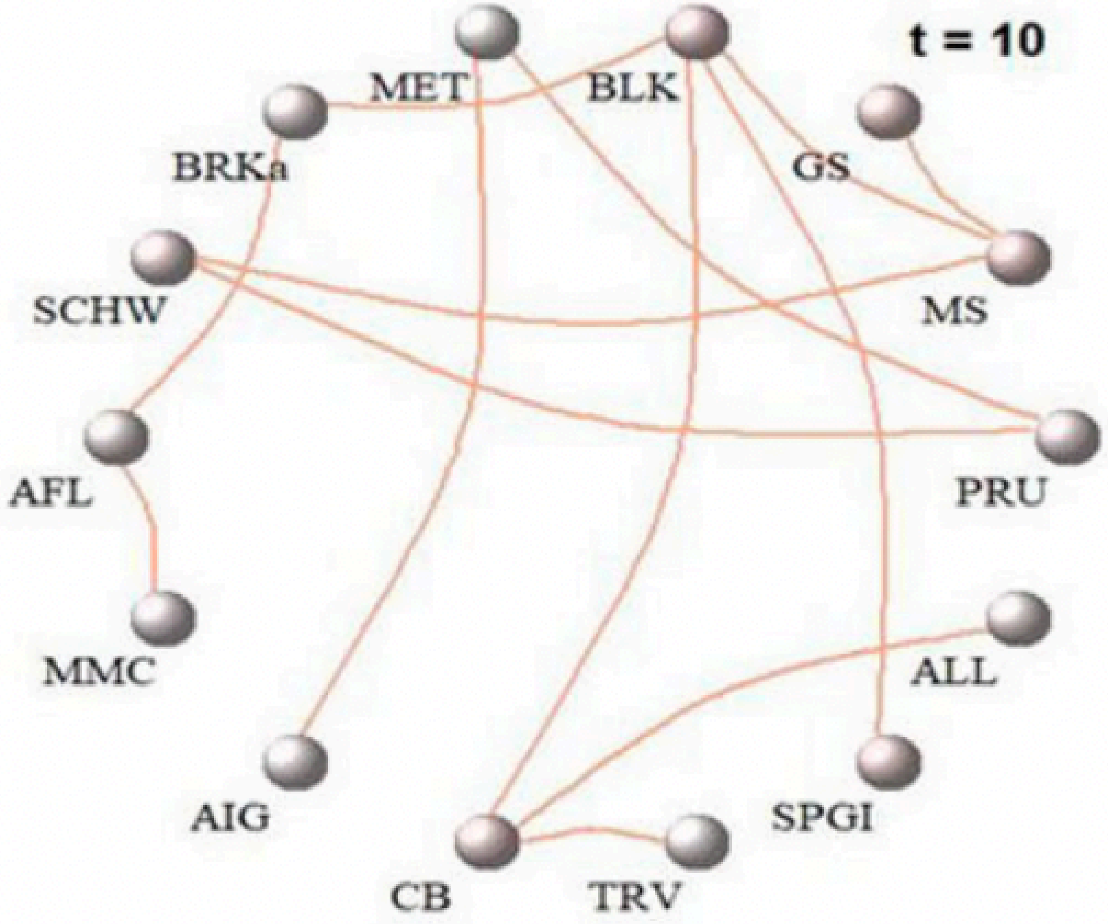
GRAPHS FOR THE STOCKS WE SELECTED

IMPULSE RESPONSE FUNCTIONS ALONG WITH 90% CONFIDENCE INTERVALS ACROSS DIFFERENT STOCKS, IN REACTION TO A POSITIVE VOLATILITY SHOCK GIVEN TO MORGAN STANLEY(MS)



BETTER VISUALISATION?





DISTANCE & CORRELATION -> $d_{ij} = \sqrt{2(1 - \gamma_{ij})}.$

01 02 03 04 05

SELECTION

We choose N stocks/ assets and a timeframe with discrete periods

ESTIMATION

We estimate latent volatility series from each of the return series by using GARCH model

CENTRALITY

Estimate a vector autoregression model on the log of latent volatility series across all stocks in the sample.

IMPULSES

Characterise the shock propagation over the stocks by using estimated impulse response functions obtained the identified VAR model.

VISUALISATION

We construct a network based on the correlation structure of the stocks and extract the minimum spanning tree .

WHY RETURN CENTRALITY?

- From a financial perspective, eigenvector centrality represents the relative weights of different stocks in a market portfolio. It measures the contributions of different stocks to market-wide movements and the impact of exogenous shocks on these stocks.

WHICH CENTRALITY MEASURE?

Here, we analyze the stability of the rank-ordering obtained from for two types of identification criteria. In principle, both of the dominant eigenvectors of the return correlation matrix and the volatility correlation matrix could have been candidates for identification criteria in terms of relative exogeneity. However, return is an observed variable and hence, free of measurement noise and/or model specification errors. Volatility, on the other hand, is latent and hence needs to be estimated. Such estimation results will be model specific. Thus return centrality is a more robust choice.

CONCLUSION?

THANK YOU !