%% PORTMANTEAU TEST FOR AUTOCORRELATION [from Luetkepohl 2005, New introduction to multiple time series analysis]

% null hypothesis: joint whiteness

% if pp<alpha, reject -> non white

function [pp,Qh,critlo,crithi,crit1tail,C0,stringout,stringflag]=test\_whiteness(u,p,h,alpha);

% %%% input: u, p, alpha, h

% u: matrice dei residui (in riga!!!)

% h=10; %number of lags to test

% alpha=0.05; %significance

% p=7; % model order

% u=u'; %residui in riga

T=size(u,2); K=size(u,1); % notazione di Lutkepohl

C=zeros(K,K,h+1); %il primo è C0, l'(h+1)esimo è Ch

%% stima matrici di correlazione dei residui

% LAG 0

C0=zeros(K,K);

for t=1:T

C0=C0+u(:,t)\*u(:,t)';

end

C0=C0./T;

%LAG 1,...,h

C=zeros(K,K,h);

for i=1:h

for t=i+1:T

C(:,:,i)=C(:,:,i)+u(:,t)\*u(:,t-i)';

end

C(:,:,i)=C(:,:,i)./T;

% C(:,:,i)=C(:,:,i)./(T-i);

end

%% portmanteau statistic (extension of Ljung Box test to multivariate time series)

Qh=0;

for j=1:h

Qh=Qh+trace(C(:,:,j)'\*inv(C0)\*C(:,:,j)\*inv(C0)) / (T-j);

end

Qh=Qh\*T\*(T+2);

dg=K\*K\*(h-p);

critlo=chi2inv(alpha/2,dg);

crithi=chi2inv(1-alpha/2,dg);

crit1tail=chi2inv(1-alpha,dg);

pp=1-chi2cdf(Qh,dg); %se alpha/2<pp<1-alpha/2, don't reject -> OK is white!

if pp<0.05

stringout='rejection: signals are NOT WHITE';

stringflag=1;

else

stringout='non-rejection: signals are WHITE';

stringflag=0;

end