ภาคผนวก

ภาคผนวก ก

ผลการทดสอบ Unit Root Test โดยการทดสอบ Augmented Dickey – Fuller

1) ผลการทดสอบ Unit Root Test ของราคาทองคำ

1.1) Level without intercept and trend

Null Hypothesis: GOLD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.081730	0.9914
Test critical values:	1% level	-2.569604	
	5% level	-1.941459	
	10% level	-1.616273	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD)
Method: Least Squares
Date: 06/08/07 Time: 10:19
Sample (adjusted): 2 500
Included observations: 499 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOLD(-1)	0.000672	0.000323	2.081730	0.0379

R-squared	0.000953	Mean dependent var	5.210421
Adjusted R-squared	0.000953	S.D. dependent var	59.28291
S.E. of regression	59.25464	Akaike info criterion	11.00357
Sum squared resid	1748534.	Schwarz criterion	11.01201
Log likelihood	-2744.390	Durbin-Watson stat	2.046651

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1.2) Level with intercept

Null Hypothesis: GOLD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.519431	0.9994
Test critical values:	1% level	-3.443228	
	5% level	-2.867112	
	10% level	-2.569800	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD)
Method: Least Squares
Date: 06/08/07 Time: 10:10
Sample (adjusted): 2 500
Included observations: 499 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOLD(-1)	0.005997	0.003947	1.519431	0.1293
C	-43.91831	32.44208	-1.353745	0.1764

R-squared	0.004624	Mean dependent var	5.210421
Adjusted R-squared	0.002621	S.D. dependent var	59.28291
S.E. of regression	59.20517	Akaike info criterion	11.00389
Sum squared resid	1742110.	Schwarz criterion	11.02078
Log likelihood	-2743.472	F-statistic	2.308672
Durbin-Watson stat	2.065105	Prob(F-statistic)	0.129290

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1.3) Level with intercept and trend

Null Hypothesis: GOLD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.720405	0.9703
Test critical values:	1% level	-3.976554	
	5% level	-3.418852	
	10% level	-3.131965	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD)
Method: Least Squares
Date: 06/08/07 Time: 10:17
Sample (adjusted): 2 500
Included observations: 499 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOLD(-1)	-0.005353	0.007431	-0.720405	0.4716
C	33.46525	53.79077	0.622137	0.5341
@TREND(1)	0.062394	0.034639	1.801230	0.0723

R-squared	0.011092	Mean dependent var	5.210421
Adjusted R-squared	0.007105	S.D. dependent var	59.28291
S.E. of regression	59.07194	Akaike info criterion	11.00138
Sum squared resid	1730789.	Schwarz criterion	11.02671
Log likelihood	-2741.845	F-statistic	2.781764
Durbin-Watson stat	2.055277	Prob(F-statistic)	0.062896

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1.4) First difference without intercept and trend

Null Hypothesis: D(GOLD) has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-22.64101	0.0000
Test critical values:	1% level	-2.569614	
	5% level	-1.941460	
	10% level	-1.616272	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD,2)
Method: Least Squares
Date: 06/08/07 Time: 10:21
Sample (adjusted): 3 500
Included observations: 498 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLD(-1))	-1.021177	0.045103	-22.64101	0.0000

R-squared	0.507730	Mean dependent var	0.200803
Adjusted R-squared	0.507730	S.D. dependent var	84.82708
S.E. of regression	59.51631	Akaike info criterion	11.01238
Sum squared resid	1760469.	Schwarz criterion	11.02084
Log likelihood	-2741.084	Durbin-Watson stat	1.988982

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

1.5) First difference with intercept

Null Hypothesis: D(GOLD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-22.79197	0.0000
Test critical values:	1% level	-3.443254	
	5% level	-2.867124	
	10% level	-2.569806	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD,2)
Method: Least Squares
Date: 06/08/07 Time: 10:19
Sample (adjusted): 3 500
Included observations: 498 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLD(-1))	-1.028580	0.045129	-22.79197	0.0000
C	5.261086	2.668529	1.971530	0.0492

R-squared	0.511558	Mean dependent var	0.200803
Adjusted R-squared	0.510573	S.D. dependent var	84.82708
S.E. of regression	59.34420	Akaike info criterion	11.00859
Sum squared resid	1746780.	Schwarz criterion	11.02550
Log likelihood	-2739.140	F-statistic	519.4740
Durbin-Watson stat	1.990549	Prob(F-statistic)	0.000000

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

1.6) First difference with intercept and trend

Null Hypothesis: D(GOLD) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-23.02113	0.0000
Test critical values:	1% level	-3.976591	
	5% level	-3.418870	
	10% level	-3.131976	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD,2)
Method: Least Squares
Date: 06/08/07 Time: 10:20
Sample (adjusted): 3 500
Included observations: 498 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLD(-1))	-1.038531	0.045112	-23.02113	0.0000
C	-5.719366	5.321670	-1.074731	0.2830
@TREND(1)	0.044030	0.018491	2.381124	0.0176

R-squared	0.517089	Mean dependent var	0.200803
Adjusted R-squared	0.515138	S.D. dependent var	84.82708
S.E. of regression	59.06680	Akaike info criterion	11.00122
Sum squared resid	1726999.	Schwarz criterion	11.02659
Log likelihood	-2736.304	F-statistic	265.0173
Durbin-Watson stat	1.994636	Prob(F-statistic)	0.000000

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

1.7) Second difference without intercept and trend

Null Hypothesis: D(GOLD,2) has a unit root
Exogenous: None
Lag Length: 5 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.26716	0.0000
Test critical values:	1% level	-2.569671	
	5% level	-1.941468	
	10% level	-1.616267	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD,3)
Method: Least Squares
Date: 06/17/07 Time: 14:56
Sample (adjusted): 9 500
Included observations: 492 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLD(-1),2)	-4.015225	0.262997	-15.26716	0.0000
D(GOLD(-1),3)	2.126934	0.239241	8.890337	0.0000
D(GOLD(-2),3)	1.338513	0.200343	6.681105	0.0000
D(GOLD(-3),3)	0.824521	0.150809	5.467318	0.0000
D(GOLD(-4),3)	0.434525	0.095912	4.530430	0.0000
D(GOLD(-5),3)	0.166575	0.045739	3.641874	0.0003

R-squared	0.817908	Mean dependent var	0.203252
Adjusted R-squared	0.816035	S.D. dependent var	146.5661
S.E. of regression	62.86392	Akaike info criterion	11.13194
Sum squared resid	1920610.	Schwarz criterion	11.18314
Log likelihood	-2732.458	Durbin-Watson stat	2.020913

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

1.8) Second difference with intercept

Null Hypothesis: D(GOLD,2) has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.25187	0.0000
Test critical values:	1% level	-3.443415	
	5% level	-2.867195	
	10% level	-2.569844	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD,3)
Method: Least Squares
Date: 06/17/07 Time: 14:53
Sample (adjusted): 9 500
Included observations: 492 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLD(-1),2)	-4.015289	0.263265	-15.25187	0.0000
D(GOLD(-1),3)	2.126998	0.239485	8.881555	0.0000
D(GOLD(-2),3)	1.338581	0.200548	6.674633	0.0000
D(GOLD(-3),3)	0.824583	0.150963	5.462143	0.0000
D(GOLD(-4),3)	0.434558	0.096010	4.526155	0.0000
D(GOLD(-5),3)	0.166574	0.045785	3.638155	0.0003
C	0.331053	2.837087	0.116688	0.9072

R-squared	0.817913	Mean dependent var	0.203252
Adjusted R-squared	0.815661	S.D. dependent var	146.5661
S.E. of regression	62.92781	Akaike info criterion	11.13598
Sum squared resid	1920556.	Schwarz criterion	11.19571
Log likelihood	-2732.451	F-statistic	363.0944
Durbin-Watson stat	2.020967	Prob(F-statistic)	0.000000

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

1.9) Second difference with intercept and trend

Null Hypothesis: D(GOLD,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic based on SIC, MAXLAG=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.23743	0.0000
Test critical values:	1% level	-3.976819	
	5% level	-3.418981	
	10% level	-3.132041	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLD,3)
Method: Least Squares
Date: 06/17/07 Time: 14:54
Sample (adjusted): 9 500
Included observations: 492 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLD(-1),2)	-4.015577	0.263534	-15.23743	0.0000
D(GOLD(-1),3)	2.127286	0.239730	8.873679	0.0000
D(GOLD(-2),3)	1.338838	0.200753	6.669068	0.0000
D(GOLD(-3),3)	0.824781	0.151118	5.457844	0.0000
D(GOLD(-4),3)	0.434676	0.096109	4.522749	0.0000
D(GOLD(-5),3)	0.166595	0.045831	3.634950	0.0003
C	-0.565233	5.810182	-0.097283	0.9225
@TREND(1)	0.003536	0.019996	0.176823	0.8597

R-squared	0.817925	Mean dependent var	0.203252
Adjusted R-squared	0.815292	S.D. dependent var	146.5661
S.E. of regression	62.99075	Akaike info criterion	11.13998
Sum squared resid	1920432.	Schwarz criterion	11.20825
Log likelihood	-2732.435	F-statistic	310.6066
Durbin-Watson stat	2.021098	Prob(F-statistic)	0.000000

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

ภาคผนวก ข

การประมาณค่าพารามิเตอร์

1) การประมาณค่าพารามิเตอร์ของราคาทองคำ โดยใช้แบบจำลอง ARIMA(6,2,0)

Dependent Variable: D(GOLD,2)
Method: Least Squares
Date: 06/11/07 Time: 23:02
Sample (adjusted): 9 500
Included observations: 492 after adjustments
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.082448	0.706580	0.116686	0.9072
AR(1)	-0.888291	0.045054	-19.71626	0.0000
AR(2)	-0.788416	0.059187	-13.32080	0.0000
AR(3)	-0.513998	0.066970	-7.675085	0.0000
AR(4)	-0.390025	0.067116	-5.811184	0.0000
AR(5)	-0.267984	0.059577	-4.498117	0.0000
AR(6)	-0.166574	0.045785	-3.638155	0.0003

R-squared	0.458801	Mean dependent var	0.304878
Adjusted R-squared	0.452106	S.D. dependent var	85.01473
S.E. of regression	62.92781	Akaike info criterion	11.13598
Sum squared resid	1920556.	Schwarz criterion	11.19571
Log likelihood	-2732.451	F-statistic	68.52634
Durbin-Watson stat	2.020967	Prob(F-statistic)	0.000000

Inverted AR Roots	.41-.60i	.41+.60i	-.22+.74i	-.22-.74i
	-.64-.34i	-.64+.34i		

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

2) การประมาณค่าพารามิเตอร์ของราคาทองคำ โดยใช้แบบจำลอง ARIMA(5,2,0)

Dependent Variable: D(GOLD,2)
Method: Least Squares
Date: 06/11/07 Time: 23:04
Sample (adjusted): 8 500
Included observations: 493 after adjustments
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.089226	0.830943	0.107379	0.9145
AR(1)	-0.865528	0.045110	-19.18722	0.0000
AR(2)	-0.745847	0.058689	-12.70854	0.0000
AR(3)	-0.443689	0.064834	-6.843413	0.0000
AR(4)	-0.269204	0.059014	-4.561699	0.0000
AR(5)	-0.125817	0.045530	-2.763406	0.0059

R-squared	0.444374	Mean dependent var	0.405680
Adjusted R-squared	0.438670	S.D. dependent var	84.95777
S.E. of regression	63.65205	Akaike info criterion	11.15684
Sum squared resid	1973121.	Schwarz criterion	11.20796
Log likelihood	-2744.160	F-statistic	77.89785
Durbin-Watson stat	2.029893	Prob(F-statistic)	0.000000

Inverted AR Roots	.23-.62i	.23+.62i	-.37-.59i	-.37+.59i
	-.59			

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

3) การประมาณค่าพารามิเตอร์ของราคาทองคำ โดยใช้แบบจำลอง GARCH-M

Dependent Variable: D(GOLD,2)
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/15/07 Time: 10:58
Sample (adjusted): 9 500
Included observations: 492 after adjustments
Convergence achieved after 83 iterations
Variance backcast: OFF
GARCH = C(9) + C(10)*RESID(-1)^2 + C(11)*GARCH(-1) + C(12)
*GARCH(-2) + C(13)*GARCH(-3)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.089592	0.052875	1.694418	0.0902
C	-6.396620	3.860469	-1.656954	0.0975
AR(1)	-0.874516	0.054933	-15.91975	0.0000
AR(2)	-0.720805	0.074670	-9.653198	0.0000
AR(3)	-0.548021	0.075558	-7.252997	0.0000
AR(4)	-0.438405	0.081280	-5.393789	0.0000
AR(5)	-0.304336	0.063805	-4.769774	0.0000
AR(6)	-0.137508	0.044105	-3.117761	0.0018
Variance Equation				
C	188.2453	100.3971	1.875008	0.0608
RESID(-1)^2	0.125864	0.026133	4.816327	0.0000
GARCH(-1)	0.961700	0.047333	20.31758	0.0000
GARCH(-2)	0.943036	0.061365	-15.36757	0.0000
GARCH(-3)	0.810325	0.049768	16.28220	0.0000

R-squared	0.458194	Mean dependent var	0.304878
Adjusted R-squared	0.444621	S.D. dependent var	85.01473
S.E. of regression	63.35617	Akaike info criterion	10.97562
Sum squared resid	1922708.	Schwarz criterion	11.08655
Log likelihood	-2687.002	F-statistic	33.75673
Durbin-Watson stat	2.074077	Prob(F-statistic)	0.000000

Inverted AR Roots	.42-.64i	.42+.64i	-.24-.68i	-.24+.68i
	-.61+.28i	-.61-.28i		

ที่มา: การคำนวณโดยใช้โปรแกรม Eviews 5.1

ภาคผนวก ค

คำสั่งที่ใช้ในโปรแกรม MATLAB 6.5

1) คำสั่งที่ใช้ในขั้นตอน Training และ Validation

```
%%Introduction%%
%Matirx A is for training with the true value B.%
%Matrix C is for validation with the true value D.%
%Matrix E is for testing with the true value F.%
%Please note that B,D,F are the row vectors.%

%%Step 1: Data preparation%%
%Import data and give them names of A,B,C,D,E,F accordingly.%
%To verify that you are correct%
%If everything OK in this step, you will see all 6 matrices on your screen.%
A
B
C
D
E
F

%%Step 2 Contruct an ANNs%%
net=newff( minmax(A),  [ 10 ,  1 ,  1 ] , {'purelin' , 'purelin' ,  'purelin'} ,'traincgf' ) ;
net = init(net);
net.trainParam.epochs = 100 ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);
```

```
%%Validation%%
%Model selection criteria is Mean Squared Error (MSE).%
Y=sim(net,C);
y=Y';
d=D';
e=(d-y);
p=sign(d);
OBSV=p'*p;
msevalid=(e'*e)/OBSV;
mse_v=[ msevalid ];

%training round 2 %
for loop= 2:1:10
loop
net.trainParam.epochs = 100 ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);

%%Validation%%
%Model selection criteria is Mean Squared Error (MSE).%
Y=sim(net,C);
y=Y';
d=D';
e=(d-y);
p=sign(d);
OBSV=p'*p;
msevalid=(e'*e)/OBSV;
mse_v=[ mse_v ; msevalid ];
```

```
end

index = [ 1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9 ; 10 ];
S = [ index mse_v ];

%Change number of neuron%

for j = 2:1:10

j
net=newff( minmax(A),  [  10 ,  j ,  1 ] , {'purelin' , 'purelin' ,  'purelin'} ,'traincgf' ) ;
net = init(net);
net.trainParam.epochs = 100 ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);

%%Validation%%
%Model selection criteria is Mean Squared Error (MSE).%
Y=sim(net,C);
y=Y';
d=D';
e=(d-y);
p=sign(d);
OBSV=p'*p;
msevalid=(e'*e)/OBSV;
mse_v=[ msevalid ];

%training round 2 %
for loop= 2:1:10
```

```
loop
j
net.trainParam.epochs = 100 ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);

%%Validation%%
%Model selection criteria is Mean Squared Error (MSE).%
Y=sim(net,C);
y=Y';
d=D';
e=(d-y);
p=sign(d);
OBSV=p'*p;
msevalid=(e'*e)/OBSV;
mse_v=[ mse_v ; msevalid ];

end

index = [ 1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9 ; 10 ];
Sister = [ index mse_v ];
S = [ S ; Sister ];

end

Summary=S;
Summary
```

2) คำสั่งที่ใช้ในขั้นตอน Testing

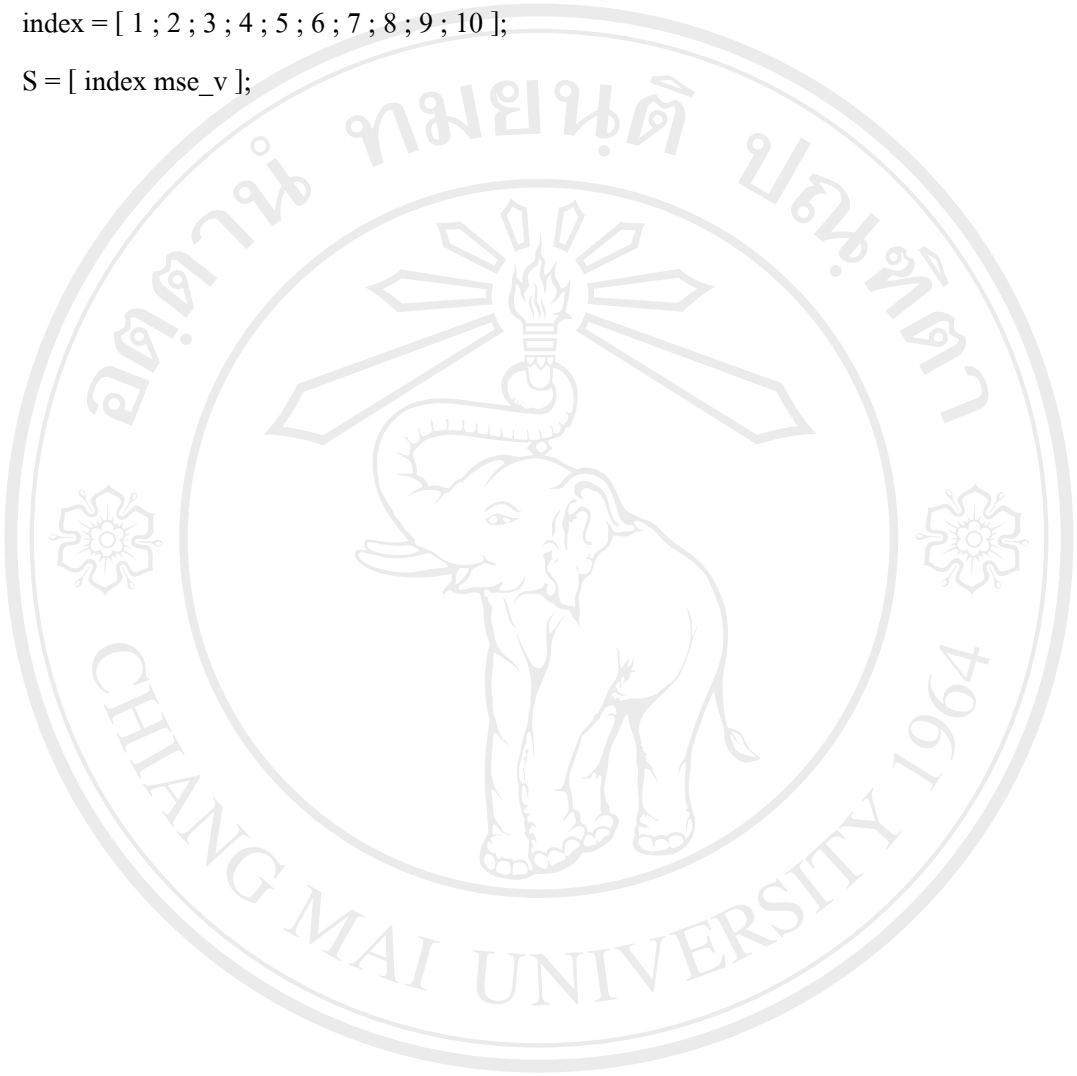
```
N1=10
N2=30
Epochs=100

net=newff( minmax(A),  [  N1, N2, 1 ] , {'purelin', 'purelin' , 'purelin'} ,'traincgf' ) ;
net = init(net);
net.trainParam.epochs = Epochs ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);

%Prediction%
Z=sim(net,E);
z=Z';
z
```

3) คำสั่งที่ใช้ในขั้นตอนการหา Quadratic Interpolation

```
%Interpolation%
net=newff( minmax(A),  [ 10,  30,  1 ] , {'purelin' , 'purelin' ,  'purelin'} ,'traincgf' ) ;
net = init(net);
net.trainParam.epochs = 100 ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);

%%Validation%%
%Model selection criteria is Mean Squared Error (MSE).%
```

```
Y=sim(net,C);
y=Y';
d=D';
e=(d-y);
p=sign(d);
OBSV=p'*p;
msevalid=(e'*e)/OBSV;
mse_v=[ msevalid ];

%training round 2 %
for loop= 2:1:10

loop
net.trainParam.epochs = 100 ;
net.trainParam.show=10 ;
net.trainParam.goal=0 ;
[net ,tr] =train(net,A,B);

%%Validation%%
%Model selection criteria is Mean Squared Error (MSE).%
Y=sim(net,C);
y=Y';
d=D';
e=(d-y);
p=sign(d);
OBSV=p'*p;
msevalid=(e'*e)/OBSV;
mse_v=[ mse_v ; msevalid ];
```

```
end

index = [ 1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9 ; 10 ];
S = [ index mse_v ];
```



ประวัติผู้เขียน

ชื่อ	นางสาวนุชศรา เกษรประทุม
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