Stock Market Integration, Return Forecastability and Implications for Market Efficiency: a Panel Study

Seminar Presented by

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I. Motivations

Since financial market deregulation in the 1980s, stock mkts worldwide have become more and more open.

Portfolio flows across countries have sharply increased.

Researchers attempt to understand and to characterize the degree of mkt linkage and spillover and to study implications of international interactions for mkt efficiency.

What are the relative returns and diversification benefits of investing in international mkts?

How well are mkts integrated?

What are implications of market integration?

Important issues for policy makers and investors

II. Background

According to Lucus (1978) model, if a group of economies show “convergence” in the sense of Barro and Sala-i-Martin (1995), then their stock prices should show a common stochastic trend over the long run.

Kasa (1992) claims that stock prices between US and other 4 developed mkts are integrated.

Richards (1995) criticizes this result on the ground that the use of asymptotic critical values used by Kasa are not appropriate. When finite sample critical values are used, Richards finds no significant evidence of mkt integration.

Other work include:

Bekaert and Harvey (1995)

Bekaert (1995)

Siklos and Ng (2001)

III. Basic Setting and Empirical Methodology

$$p_t^i = y_t + x_t^i \quad (1)$$

$$y_t = \alpha + y_{t-1} + \varepsilon_t \quad (2)$$

where y is the common random walk component, and x is the transitory country-specific component, which is stationary.

$$x_t^i = (1-\delta^i)\mu^i + \delta^i x_{t-1}^i + \eta_t \quad (3)$$

If $\delta<1$, then x is stationary.

$\lambda = (1 - \delta)$ measures the speed of integration between country i and a reference country.

However, the power of this test is very low.

To improve power, we use panel data and SUR.

Test statistics ($\lambda = 0$) are:

$$z_\lambda = T\hat{\lambda} \quad \text{and} \quad t_\lambda = \hat{\lambda}/s(\lambda)$$

IV. Data and Test for Market Integration

See Tables.

V. Implications

How big is the transitory component?

What is the implication of 20% reversion per year? Can that be exploited?

State-space representation of country stock prices:

$$p_t^i = y_t + x_t^i \tag{4}$$

$$y_t = \alpha + y_{t-1} + \delta_t \tag{5}$$

$$x_t^i = (1-\delta^i)\mu^i + \delta^i x_{t-1}^i + \sum_{j=1}^{k} \rho_j [r_{t-j}^i - E(r_{t-j}^i)] + \eta_t^i \tag{6}$$

Using the Kalman filter, we estimate a series of $x_{t|t}$, $x_{t+1|t}$, $y_{t|t}$, $y_{t+1|t}$, and parameters.

Now given information available at time t, we try to forecast returns at t+1, and ask the following question: which part is due to common expected return, mean reversion, and momentum?

$$\hat{r}_{t+1|t} \equiv p_{t+1|t} - p_t$$

$$= (x_{t+1|t} + y_{t+1|t}) - p_t$$

$$= \hat{\alpha}_t + [\hat{\mu}_t^i + (\hat{\delta}_t - 1)x_{t|t}] + \sum_{j=1}^{k} \hat{\rho}_{j,t}[r_{t+1-j}^i - \hat{\alpha}_t]$$

$$= \hat{r}_{t+1|t,rw} + \hat{r}_{t+1|t,mrv} + \hat{r}_{t+1|t,mom}$$

Results: See tables and graphs.

VI. Conclusion

(1) HK stock shares a common permanent component with the rest of world. HK market is integrated with the world market.

(2) Speed of reversion of about 20% per year and a half life of 3 years.

(3) Substantial transitory (country-specific) component. Results also show both long-term mean reversion and short-run return continuation (momentum).

(4) By exploiting the properties of the transitory component, one may design a portfolio switching strategy. This strategy produces an excess return

(Max1-Min1) =16.7%,
(Max3-Min3) = 11.9%.

(5) The excess returns cannot be explained by simple beta risks, or transactions costs.

(6) An overreaction hypothesis or bubble explanation might be plausible.

(7) A challenge to the simple EMH.

Barberis et al (1998), Daniel et al (1998), and Hong and Stein (1999) have done important work in that direction.

Summary Statistics of National Stock-Index Returns

Country	Mean	Standard Error	β with World Index
AUSTRALIA	0.084	0.904	1.049
AUSTRIA	0.095	0.720	0.501
BELGIUM	0.147	0.639	0.808
CANADA	0.103	0.664	0.969
DENMARK	0.136	0.640	0.646
FRANCE	0.129	0.794	1.019
GERMANY	0.124	0.707	0.841
HONG KONG	0.180	1.348	1.262
ITALY	0.077	0.903	0.814
JAPAN	0.135	0.783	1.075
NETHERLANDS	0.155	0.613	0.922
NORWAY	0.113	0.942	1.001
SINGAPORE	0.134	1.048	1.189
SPAIN	0.106	0.783	0.823
SWEDEN	0.166	0.767	0.906
SWITZERLAND	0.132	0.654	0.903
UNITED KINGDOM	0.130	0.799	1.105
UNITED STATES	0.126	0.530	0.898
WORLD	0.121	0.495	1.000

Single-Equation Test for Market Integration of International Equity Prices

Country	Relative to World	Relative to HK	Relative to U.S.
AUS	1.667	0.000	2.562
AUT	1.784	-0.027	2.327
BEL	1.354	-1.453	1.750
CAN	0.705	0.000	-0.116
DEN	3.763**	-0.485	3.854**
FRA	1.740	-0.227	2.194
GER	3.151*	-0.435	3.569*
HKG	0.162		0.582
ITA	2.005	-0.582	1.837
JPN	1.322	-0.448	1.403
NLD	-0.307	-1.210	1.222
NOR	2.949	-2.034	4.710**
SIG	2.177	-0.115	1.796
SPN	1.863	-0.150	2.083
SWE	0.754	-1.016	1.490
SWT	2.103	-2.093	2.928
UKM	1.244	-0.285	1.408
USA	1.888	-0.785	
Critical Values			
10%	2.63	2.63	2.63
5%	3.00	3.00	3.00
1%	3.75	3.75	3.75

Panel Test for Market Integration of International Stock Prices

	Relative to World	Relative to HK	Relative to U.S.	Asia + US Relative to World
Point Estimate of λ	0.274	0.312	0.292	0.283
Z_λ	7.407	8.434	7.894	7.632
p-value	0.002	0.015	0.000	0.022
T_λ	11.431	11.151	11.277	5.235
p-value	0.044	0.077	0.022	0.011
Median-Unbiased Estimate of λ	0.182	0.222	0.202	0.193
90% Confidence Interval of λ	[0.110, 0.250]	[0.155, 0.290]	[0.135, 0.270]	[0.124, 0.261]
Implied Half-Life (Years)	3.5	2.80	3.1	3.2

Variance Decomposition

Moment	Estimate
δ	0.979
ρ	0.026
σ_R^2	3.157 E-3
σ_η^2	3.103 E-3
σ_{mrv}^2	3.060 E-5
σ_{mom}^2	2.560 E-5
$\gamma_{mrv,mom}$	-0.211
σ_η^2/σ_R^2 (%)	98.5
$\sigma_{mrv}^2/\sigma_R^2$ (%)	1.19
$\sigma_{mom}^2/\sigma_R^2$ (%)	0.81
$R-square$ (%)	2.07

Comparison of Model Performance

Panel A.

Model	Portfolio	Mean Return	t-ratio	β with World Portfolio	Expected Return	Percentage Switches in Portfolio
1	Max1	0.180	3.401	0.962	0.318	0.13
	Max1-Min1	0.167	2.449	-0.301	0.393	0.16
	Max3	0.203	4.528	0.984	0.260	0.10
	Max3-Min3	0.119	2.964	-0.064	0.367	0.10
2	Max1	0.184	2.583	1.284	0.212	0.35
	Max1-Min1	0.095	1.107	0.373	0.151	0.39
	Max3	0.177	3.374	0.154	0.191	0.25
	Max3-Min3	0.112	2.110	0.297	0.130	0.26
3	Max1	0.198	3.983	0.615	0.241	0.11
	Max1-Min1	0.085	1.248	-0.621	0.218	0.11
	Max3	0.153	3.945	0.837	0.212	0.10
	Max3-Min3	0.034	0.902	-0.245	0.198	0.09
4	Max1	0.141	2.077	1.284	0.238	0.03
	Max1-Min1	-0.043	-0.580	0.434	0.154	0.04
	Max3	0.115	2.402	1.177	0.216	0.05
	Max3-Min3	-0.028	-0.776	0.240	0.115	0.03
5	Max1	1.284	28.304	0.920	1.284	0.88
	Max1-Min1	2.275	45.572	-0.310	2.275	0.86
	Max3	0.979	25.356	0.924	0.979	0.78
	Max3-Min3	1.667	44.330	-0.201	1.667	0.79
6	Max1	0.277	4.991	1.134	0.263	0.20
	Max1-Min1	0.322	5.046	0.090	0.284	0.16
	Max3	0.230	4.816	1.078	0.232	0.12
	Max3-Min3	0.202	4.754	0.100	0.211	0.14
7	Max1	0.165	3.071	0.992	0.354	0.02
	Max1-Min1	0.105	1.638	-0.199	0.476	0.05
	Max3	0.218	5.268	0.917	0.275	0.06
	Max3-Min3	0.115	3.246	-0.117	0.355	0.06
8	Max1	0.212	4.164	0.934	0.318	0.14
	Max1-Min1	0.191	2.990	-0.292	0.389	0.17
	Max3	0.215	5.180	0.970	0.262	0.09
	Max3-Min3	0.132	3.448	-0.060	0.228	0.10
9	Max1	0.206	3.144	1.159	0.304	0.16
	Max1-Min1	0.130	1.704	-0.047	0.361	0.17
	Max3	0.230	4.183	1.069	0.260	0.11
	Max3-Min3	0.081	1.760	0.052	0.278	0.10

Panel B.

Model	Portfolio	Mean Return	t-ratio	β with World Portfolio	Expected Return	Percentage Switches in Portfolio
1	Max1	0.180	3.401	0.962	0.318	0.13
	Max1-Min1	0.167	2.449	-0.301	0.393	0.16
	Max3	0.203	4.528	0.984	0.260	0.10
	Max3-Min3	0.119	2.964	-0.064	0.367	0.10
2	Max1	0.199	3.549	1.018	0.359	0.25
	Max1-Min1	0.157	2.228	-0.171	0.439	0.25
	Max3	0.219	5.017	0.964	0.282	0.14
	Max3-Min3	0.115	2.846	-0.090	0.320	0.15
3	Max1	0.219	4.465	0.715	0.335	0.47
	Max1-Min1	0.209	3.189	-0.326	0.433	0.53
	Max3	0.194	4.371	0.986	0.274	0.40
	Max3-Min3	0.102	2.626	-0.021	0.325	0.41
4	Max1	0.234	3.752	1.070	0.583	0.83
	Max1-Min1	0.203	2.791	0.212	0.828	0.86
	Max3	0.208	4.862	0.941	0.446	0.69
	Max3-Min3	0.143	3.952	-0.074	0.640	0.72
5	Max1	0.207	3.310	1.050	0.336	0.22
	Max1-Min1	0.178	2.283	-0.105	0.438	0.17
	Max3	0.223	4.629	1.063	0.296	0.13
	Max3-Min3	0.112	2.680	0.080	0.357	0.12
6	Max1	0.173	2.777	1.115	0.393	0.25
	Max1-Min1	0.117	1.551	-0.028	0.476	0.24
	Max3	0.203	4.081	1.106	0.325	0.15
	Max3-Min3	0.103	2.351	0.120	0.336	0.16
7	Max1	0.174	2.868	1.075	0.350	0.58
	Max1-Min1	0.110	1.425	-0.034	0.456	0.46
	Max3	0.200	4.253	1.050	0.304	0.35
	Max3-Min3	0.087	2.261	0.052	0.329	0.34
8	Max1	0.226	3.495	1.093	0.590	0.82
	Max1-Min1	0.153	1.955	0.117	0.862	0.80
	Max3	0.212	5.022	0.945	0.448	0.68
	Max3-Min3	0.135	3.717	0.010	0.589	0.69

Performance of Portfolio Switching Strategies with Transactions Cost

Model	Portfolio	Mean Return	t-ratio	β with World Portfolio	Expected Return	Percentage Switches In Portfolio
1	Max1	0.180	3.401	0.962	0.318	0.13
	Max1-Min1	0.167	2.449	-0.301	0.393	0.16
	Max3	0.203	4.528	0.984	0.260	0.10
	Max3-Min3	0.119	2.964	-0.064	0.367	0.10
2	Max1	0.179	3.313	1.042	0.301	0.01
	Max1-Min1	0.172	2.599	-0.079	0.357	0.03
	Max3	0.184	4.104	0.988	0.248	0.02
	Max3-Min3	0.108	2.734	-0.024	0.269	0.02
3	Max1	0.127	1.757	1.334	0.185	0.05
	Max1-Min1	-0.015	-0.189	0.360	0.110	0.05
	Max3	0.125	2.671	1.094	0.158	0.03
	Max3-Min3	0.010	0.227	0.198	0.055	0.03
4	Max1	0.157	2.539	1.096	0.219	0.00
	Max1-Min1	0.088	1.543	-0.060	0.170	0.01
	Max3	0.171	4.301	0.870	0.192	0.01
	Max3-Min3	0.081	2.424	-0.241	0.134	0.01
5	Max1	0.158	2.035	1.180	0.229	0.00
	Max1-Min1	0.014	0.172	0.285	0.142	0.00
	Max3	0.117	2.132	1.143	0.198	0.00
	Max3-Min3	-0.021	-0.474	0.175	0.096	0.00

Risk-Adjusted Excess Returns

Model	Portfolio	Mean return	t-ratio	α	t-ratio	β_{wld}	t-ratio	β_{vmg}	t-ratio
1	Max1	0.180	3.401	0.031	0.699	0.993	11.262	0.323	1.568
	Min1	0.013	0.201	-0.156	-3.058	1.266	12.302	0.032	0.131
	Max1-Min1	0.167	2.449	0.186	2.702	-0.273	-1.959	0.291	0.896
	Max3	0.203	4.528	0.049	1.539	1.030	16.138	0.476	3.193
	Min3	0.083	1.938	-0.070	-2.545	1.063	19.011	0.162	1.244
	Max3-Min3	0.119	2.964	0.119	2.917	-0.032	-0.391	0.314	1.629
2	Max1	0.184	2.583	0.001	0.114	1.329	11.147	0.460	1.652
	Min1	0.089	1.381	-0.005	-0.944	0.936	7.874	0.258	0.931
	Max1-Min1	0.095	1.107	0.005	0.718	0.393	2.245	0.201	0.492
	Max3	0.177	3.374	0.001	0.318	1.188	15.636	0.350	1.975
	Min3	0.066	1.521	-0.006	-2.223	0.885	12.919	0.279	1.744
	Max3-Min3	0.112	2.110	0.007	1.642	0.304	2.826	0.071	0.285
3	Max1	0.198	3.983	0.069	1.519	0.683	7.403	0.697	3.234
	Min1	0.113	1.857	-0.053	-1.124	1.237	12.944	0.008	0.035
	Max1-Min1	0.085	1.248	0.122	1.858	-0.554	-4.156	0.689	2.214
	Max3	0.153	3.945	0.011	0.378	0.885	15.595	0.480	3.622
	Min3	0.120	2.758	-0.035	-1.320	1.087	20.191	0.050	0.402
	Max3-Min3	0.034	0.902	0.046	1.240	-0.203	-2.717	0.429	2.465

Fig 1(1) Impulse Response Following a 10% Innovation in η_t
12−Month Momentum with Mean Reversion, One Parameter Case

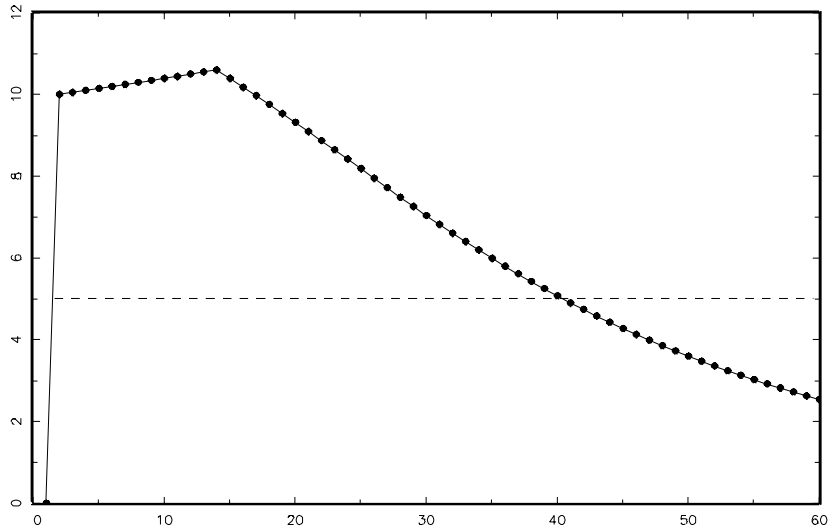

Fig 1(2) Impulse Response Following a 10% Innovation in η_t
Pure Momentum

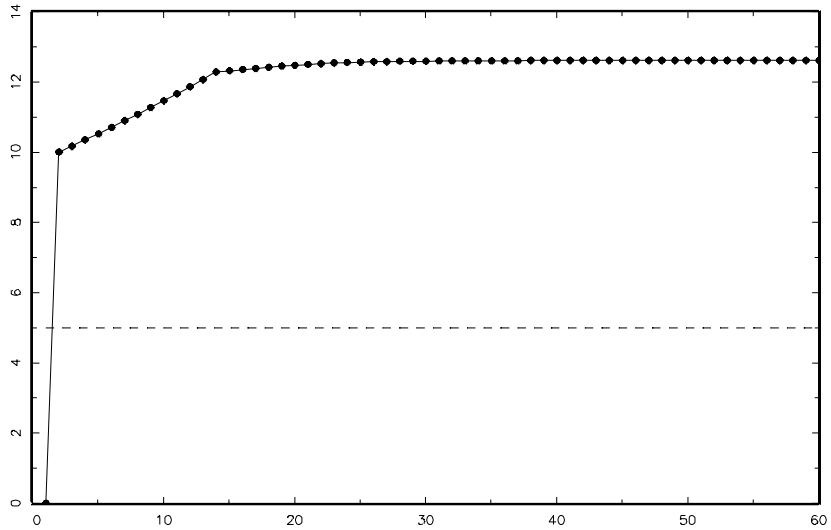

Fig 1(3) Impulse Response Following a 10% Innovation in η_t
Pure Mean Reversion

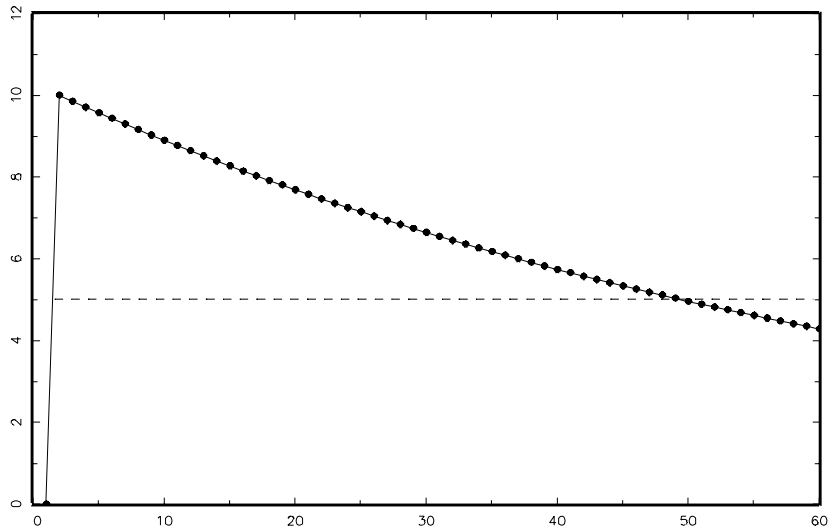

Fig 1(4) Impulse Response Following a 10% Innovation in η_t
24−Month Momentum with Mean Reversion, 3−Almon Lag Case

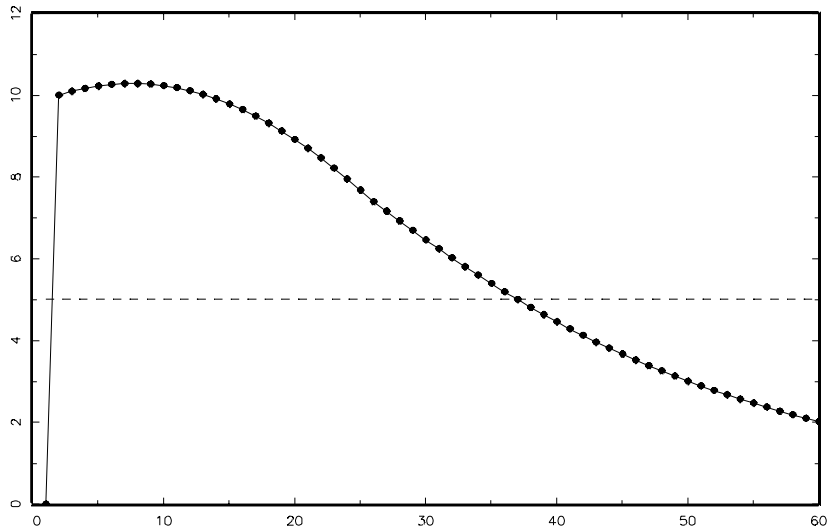

Fig 2(1) Mean Return of Max1--Max18 Portfolios
δ same, ρ same for lags and countries: Baseline

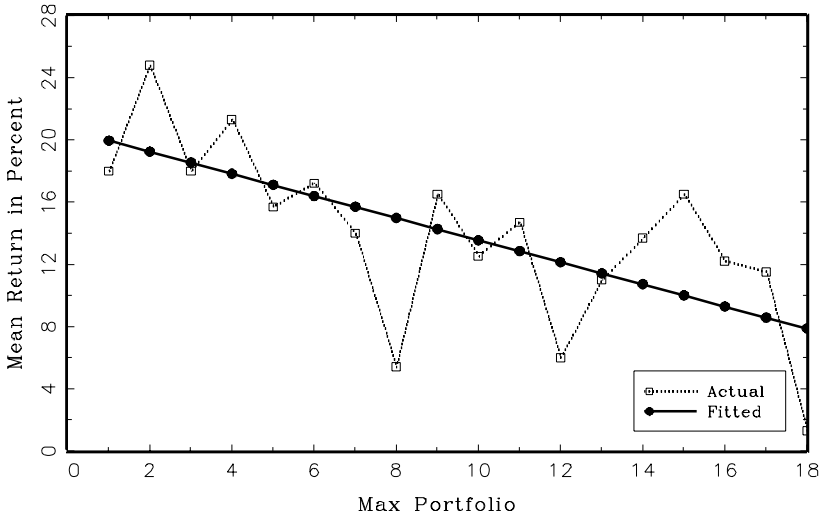

Fig 2(2) Mean Return of Max1--Max18 Portfolios
δ same, ρ same for lags but diff for countries

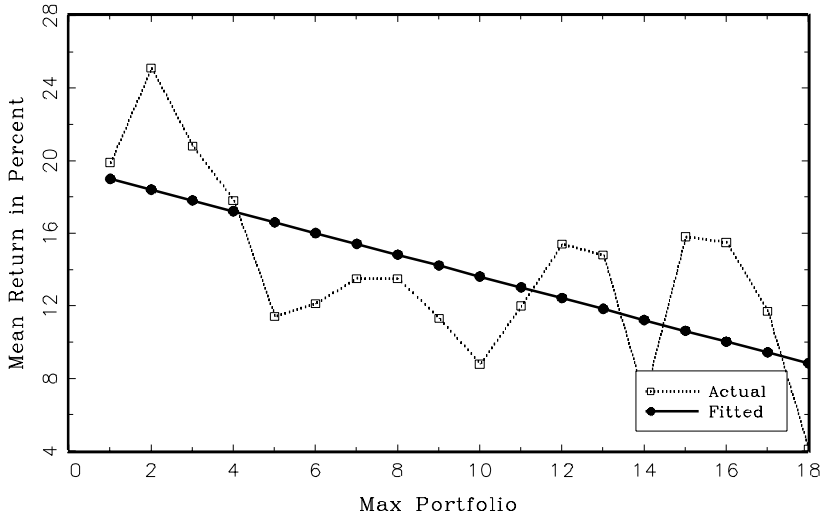

Fig 2(3) Mean Return of Max1--Max18 Portfolios
δ same, ρ same for countries but diff for lags

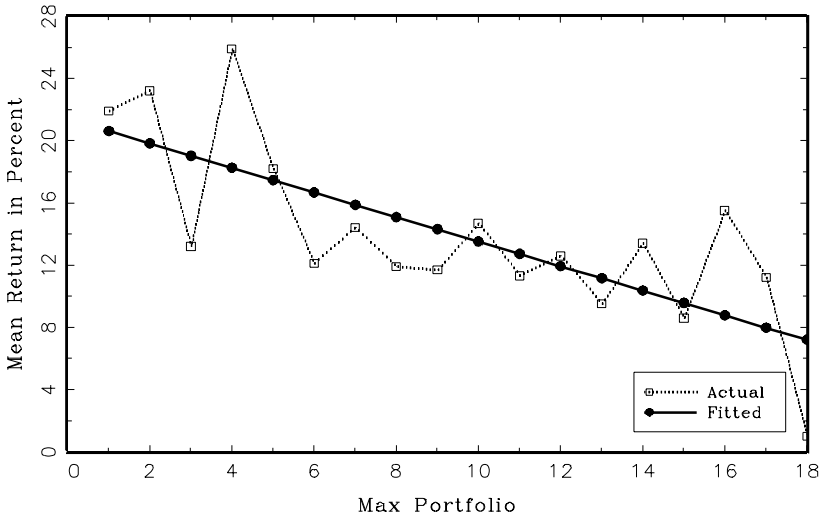

Fig 2(4) Mean Return of Max1--Max18 Portfolios
δ same, ρ diff for lags and countries

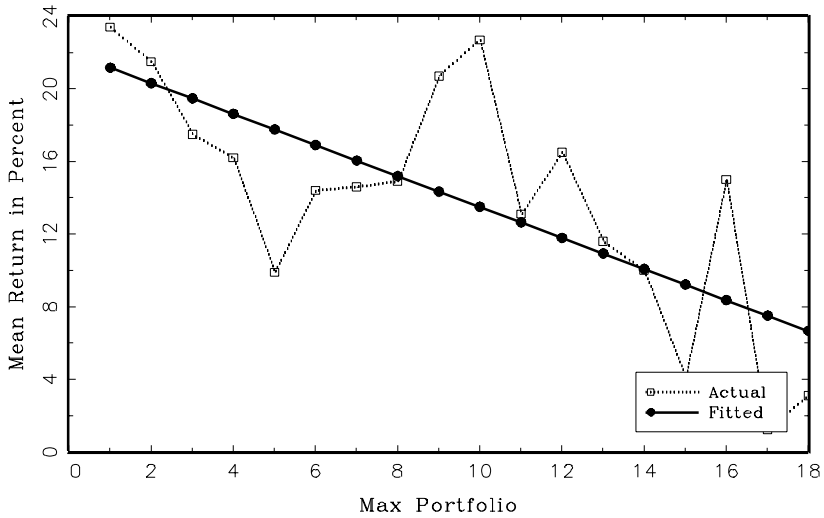

Fig 2(5) Mean Return of Max1--Max18 Portfolios
δ diff, ρ same for lags and countries

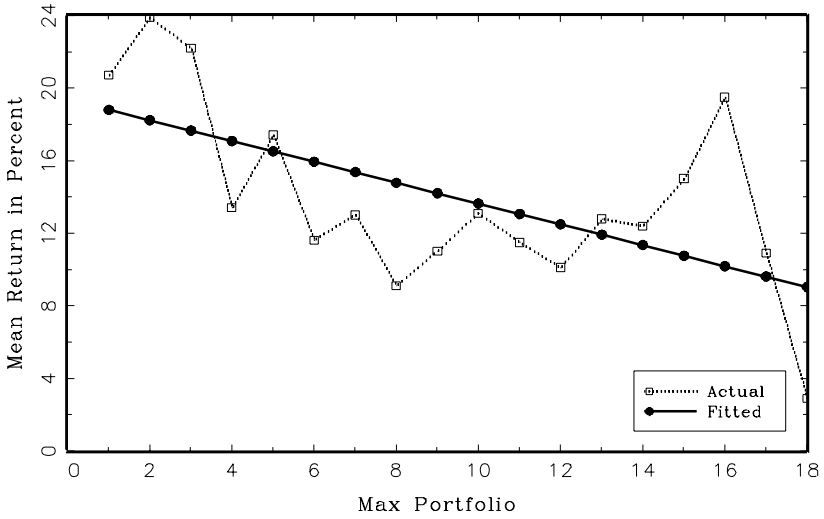

Fig 2(6) Mean Return of Max1--Max18 Portfolios
δ diff, ρ same for lags but diff for countries

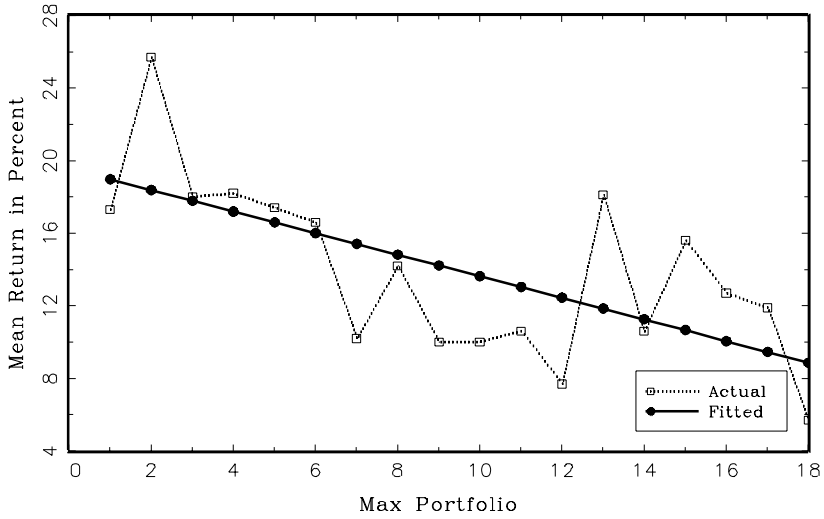

Fig 2(7) Mean Return of Max1--Max18 Portfolios
δ diff, ρ same for countries but diff for lags

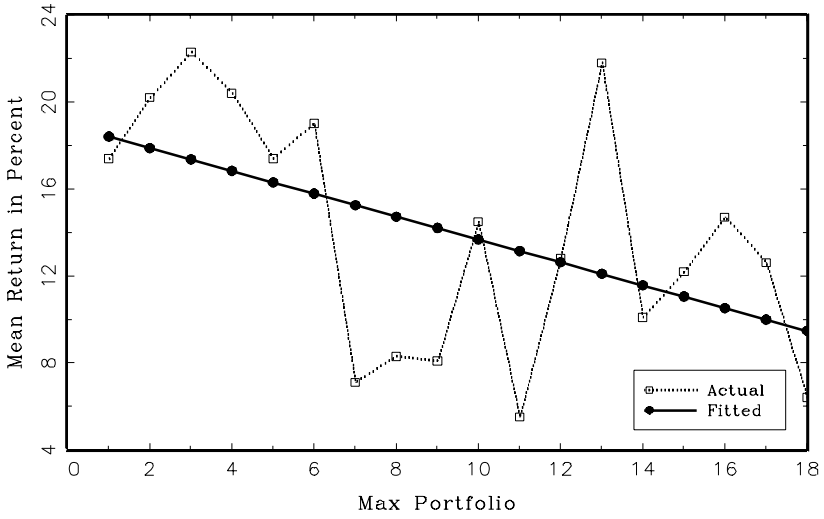

Fig 2(8) Mean Return of Max1--Max18 Portfolios
δ diff, ρ diff for lags and countries

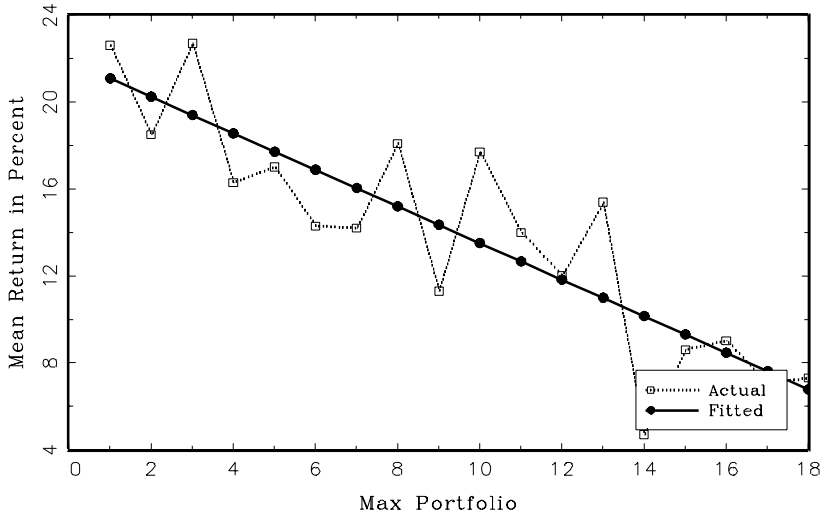

Fig 3(1) Standard Dev of Max1--Max18 Portfolios
δ same, ρ same for lags and countries: Baseline

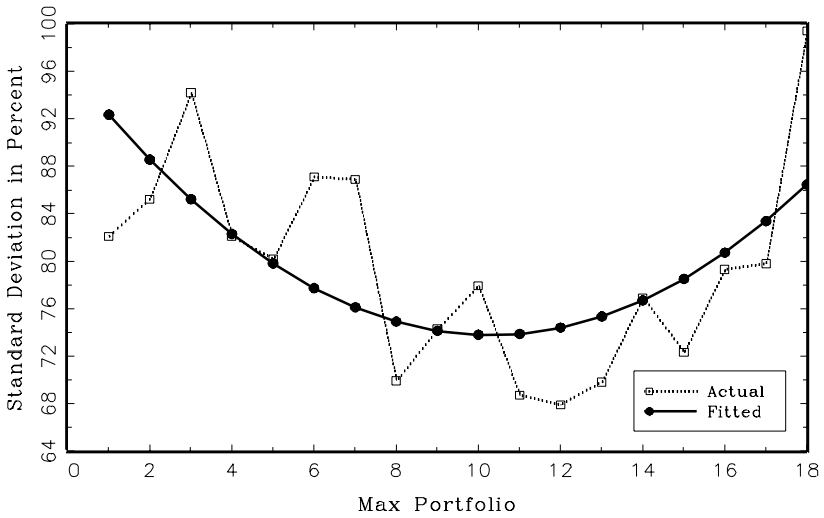

Fig 3(2) Standard Dev of Max1--Max18 Portfolios
δ same, ρ same for lags but diff for countries

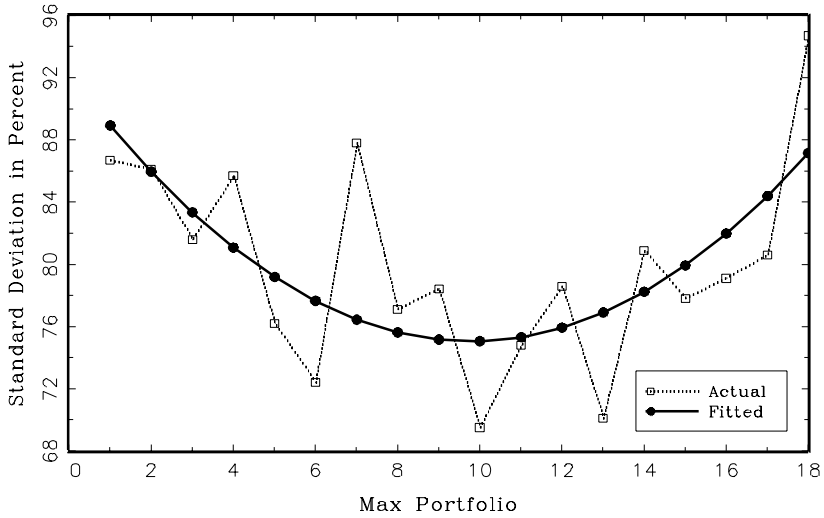

Fig 3(3) Standard Dev of Max1--Max18 Portfolios
δ same, ρ same for countries but diff for lags

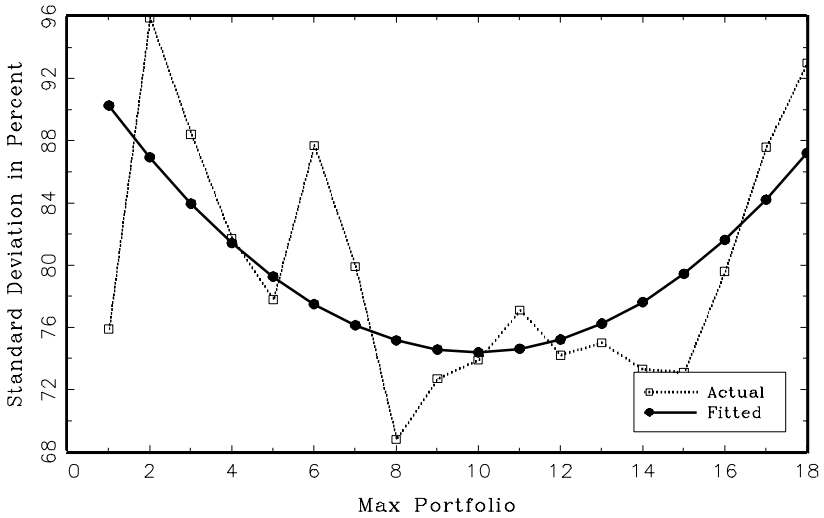

Fig 3(4) Standard Dev of Max1--Max18 Portfolios
δ same, ρ diff for lags and countries

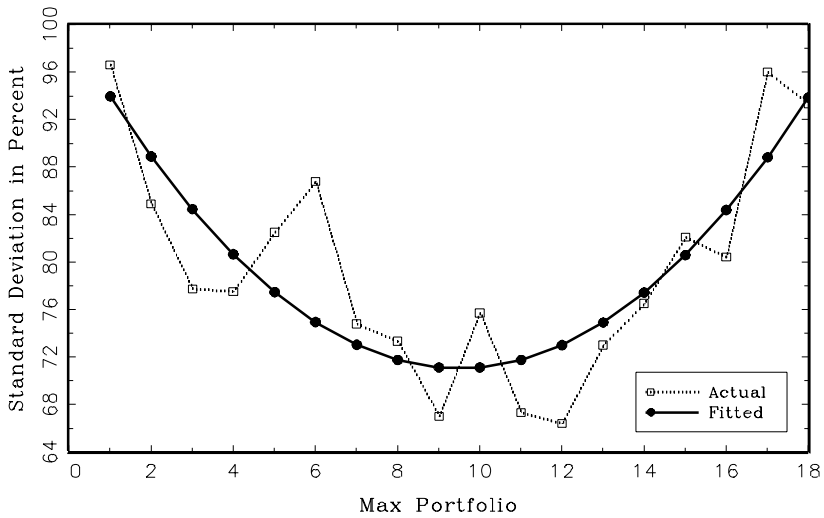

Fig 3(5) Standard Dev of Max1--Max18 Portfolios
δ diff, ρ same for lags and countries

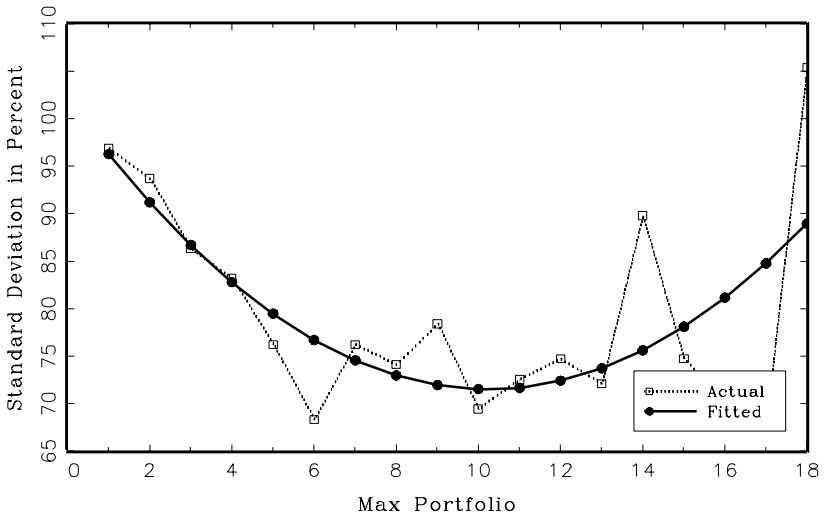

Fig 3(6) Standard Dev of Max1--Max18 Portfolios
δ diff, ρ same for lags but diff for countries

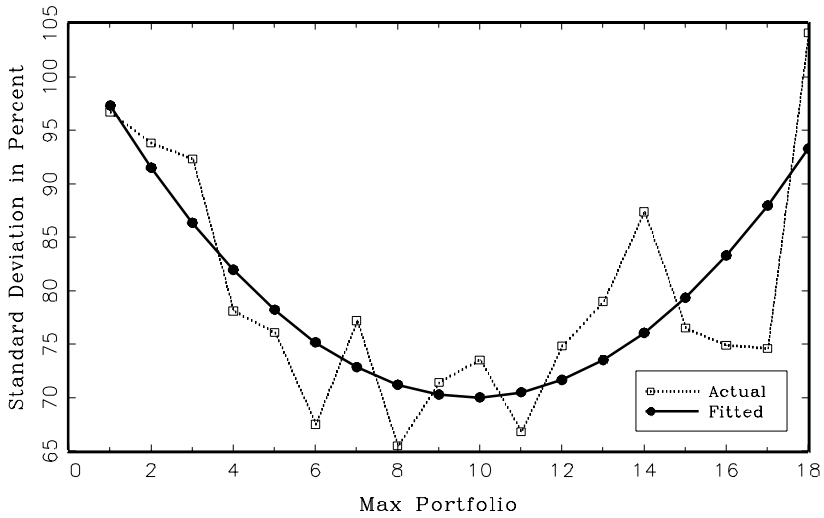

Fig 3(7) Standard Dev of Max1--Max18 Portfolios
δ diff, ρ same for countries but diff for lags

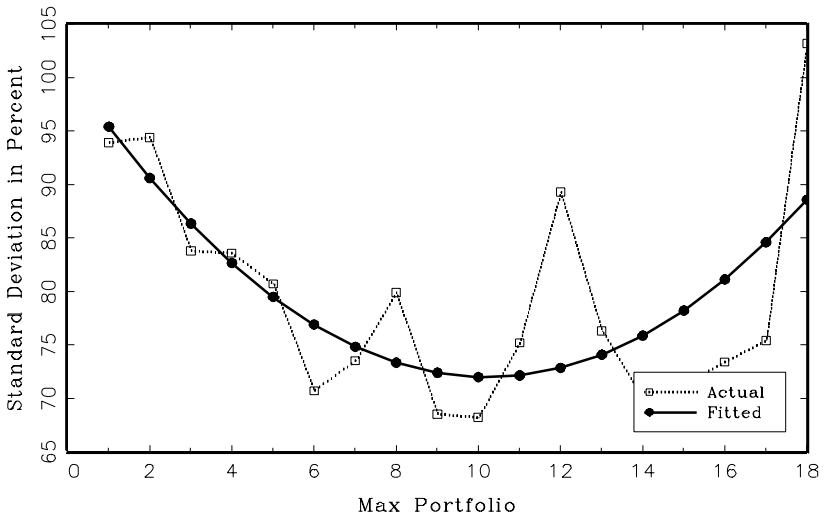

Fig 3(8) Standard Dev of Max1--Max18 Portfolios
δ diff, ρ diff for lags and countries

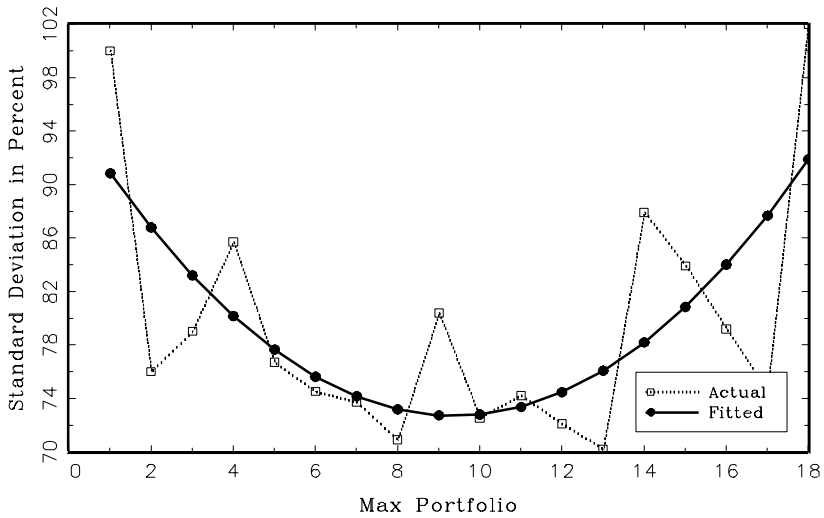

Fig 4(1) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ same, ρ same for lags and countries: Baseline

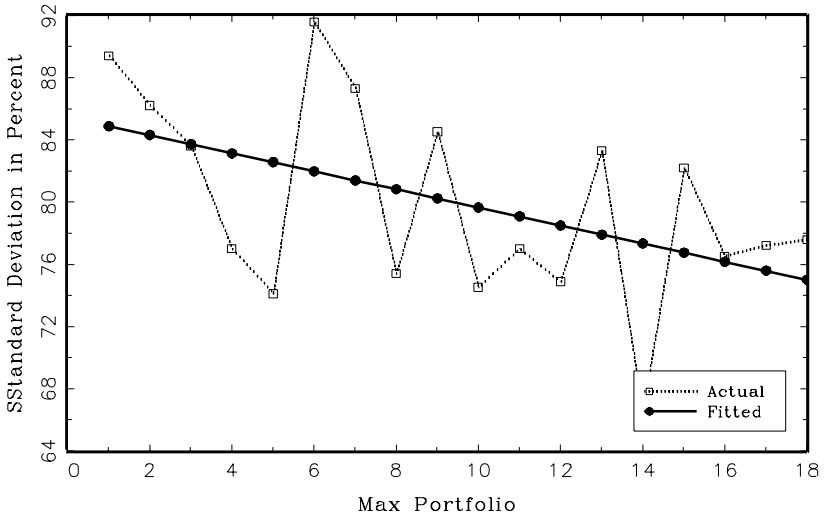

Fig 4(2) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ same, ρ same for lags but diff for countries

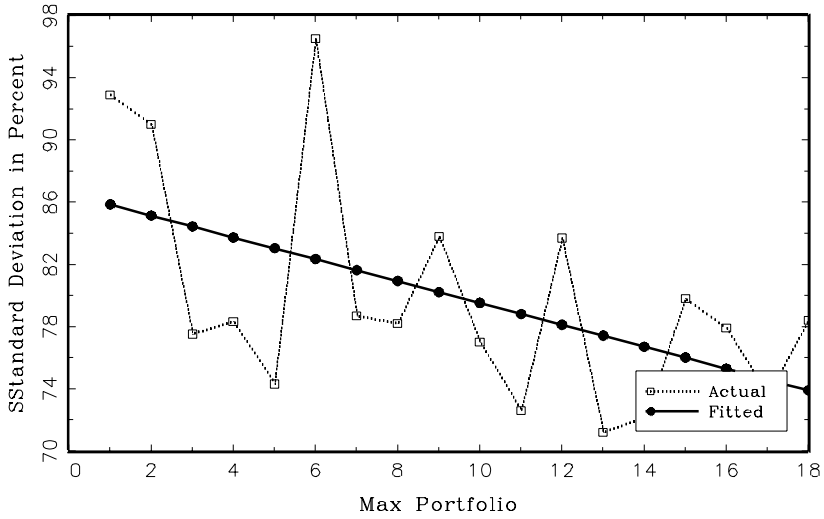

Fig 4(3) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ same, ρ same for countries but diff for lags

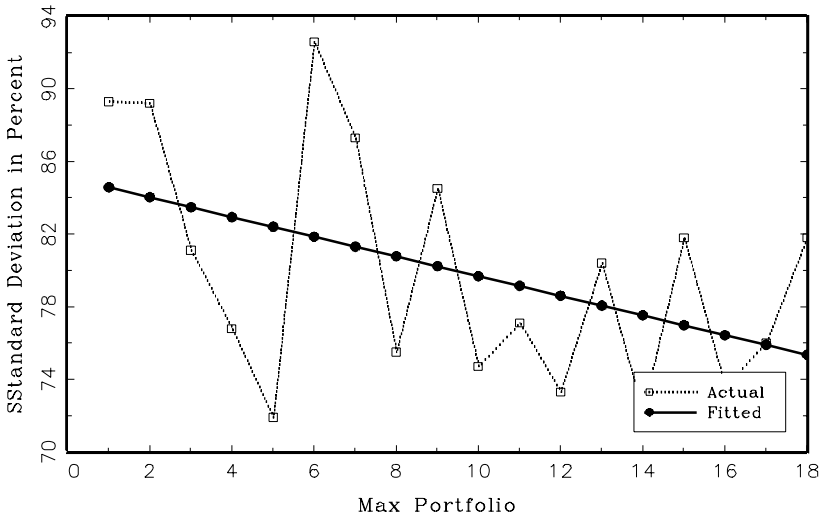

Fig 4(4) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ same, ρ diff for lags and countries

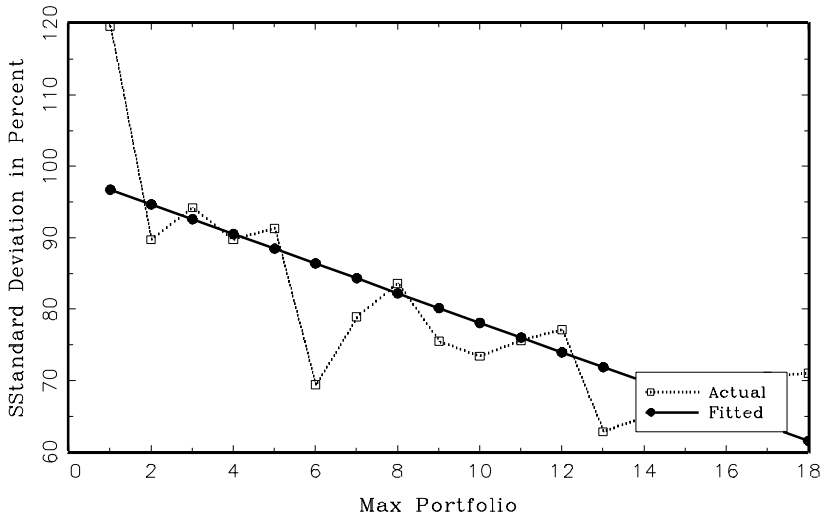

Fig 4(5) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ diff, ρ same for lags and countries

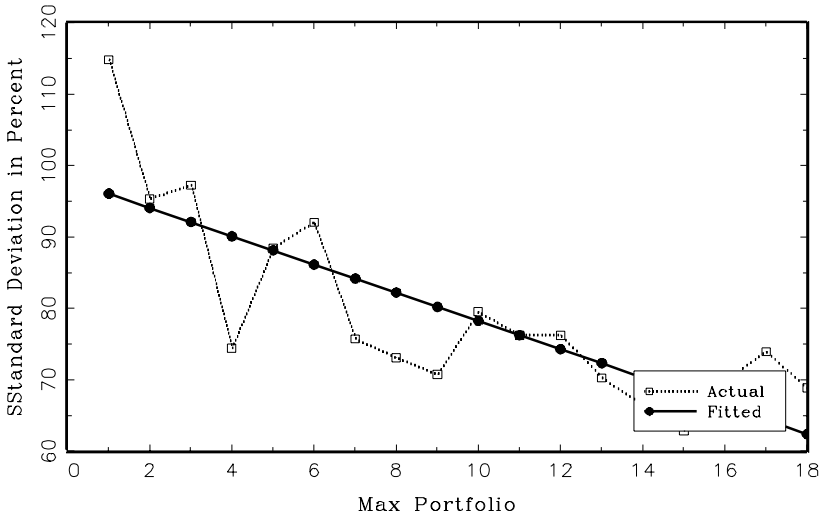

Fig 4(6) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ diff, ρ same for lags but diff for countries

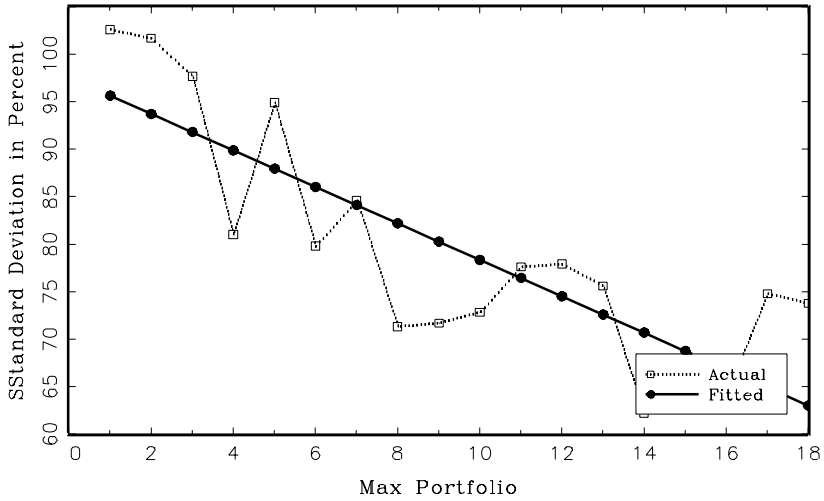

Fig 4(7) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ diff, ρ same for countries but diff for lags

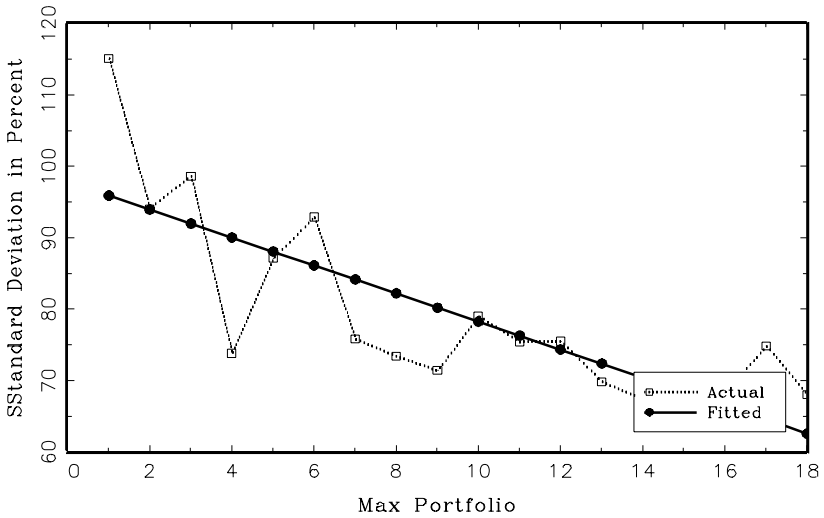

Fig 4(8) S.D. of Max1--Max18 Ranked by Ex Ante MSE
δ diff, ρ diff for lags and countries