Overview of GEMS® International Equity Indices

International Equity Indices

Index	Source	Description
International Diversified Equity	MSCI EAFE	The MSCI EAFE Index is a stock market index that is designed to measure the equity market performance of developed markets outside of the U.S. & Canada. It is maintained by MSCI Inc., a provider of investment decision support tools; the EAFE acronym stands for Europe, Australasia and Far East.
Aggressive Foreign Equity	MSCI Emerging Markets	The MSCI Emerging Markets Index captures large and mid cap representation across 27 Emerging Markets (EM) countries. With 1,381 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country.

Index	Price Returns	Dividend Yields
MSCI EAFE (Bloomberg: MXEA Index)	12/1969 – Present	1/1995 – Present
MSCI Emerging Markets (Bloomberg: MXEF Index)	1/1968 – Present	1/1997 – Present

CONNING

International Equity Indices – International Diversified Equity

Start by Regressing Historical Returns against US Large Cap (S&P 500)

- **Separate regressions for Price and Dividend Yield**

- **Use overlapping period with Aggressive Foreign Equity**

- **Given relatively short period available for Dividend Yield, will use different periods for the two calculations**

CONNING

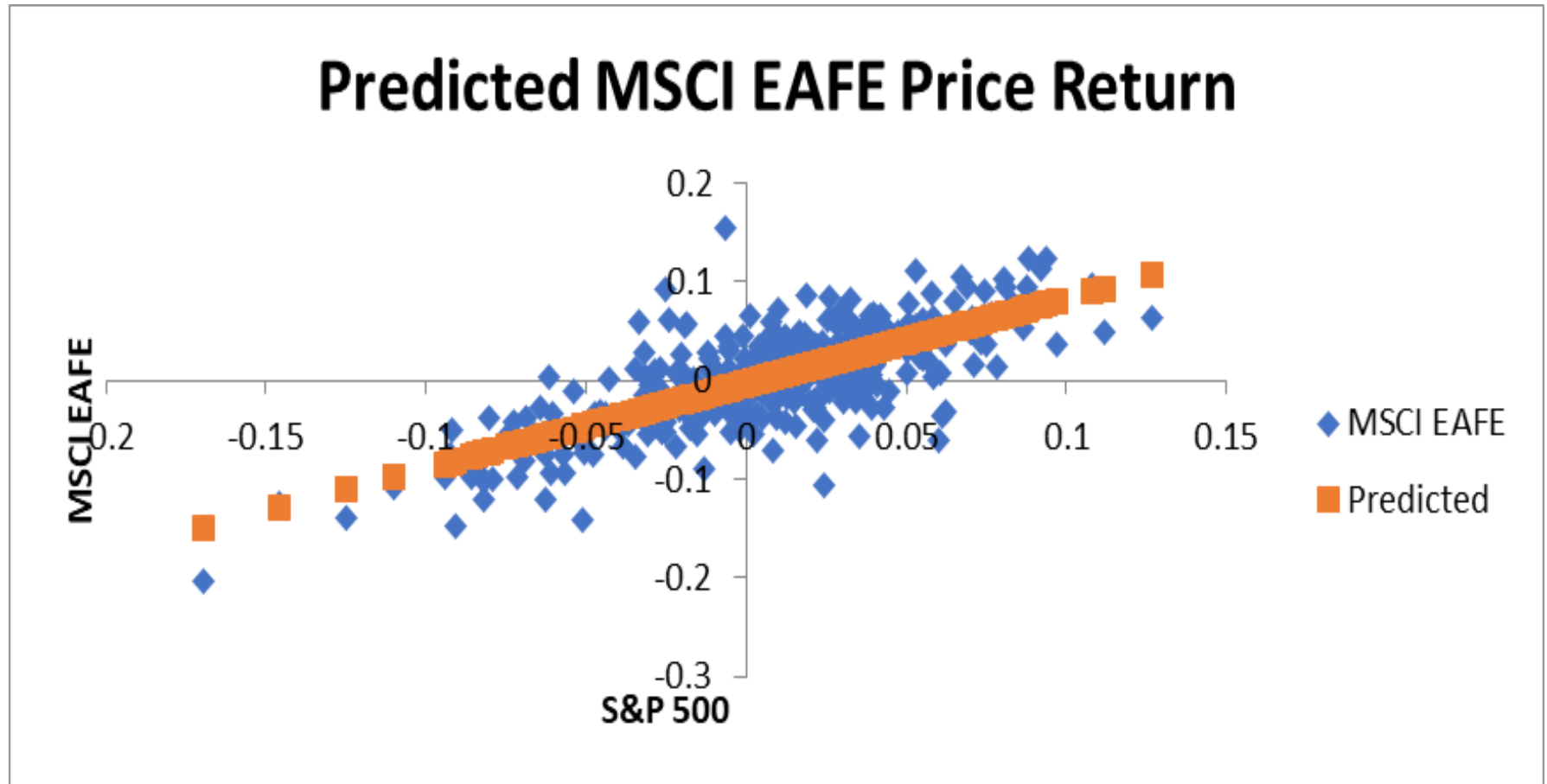# International Equity Indices – International Diversified Equity

Historical relationship:

- **MSCI EAFE Price Return = 86.4% * S&P 500 Price Return – 0.30% + Residual with 3.2% standard deviation**

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.744695625							
R Square	0.554571574							
Adjusted R Square	0.55342945							
Standard Error	0.032264357							
Observations	392							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.505464094	0.505464094	485.561543	1.75777E-70			
Residual	390	0.405985605	0.001040989					
Total	391	0.911449699						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.003075464	0.001657043	-1.855994971	0.064208367	-0.00633332	0.000182391	-0.00633332	0.000182391
S&P 500	0.864090916	0.039213653	22.03546103	1.75777E-70	0.786994313	0.941187519	0.786994313	0.941187519

International Equity Indices – International Diversified Equity

Historical relationship:

- **MSCI EAFE Price Return = 86.4% * S&P 500 Price Return – 0.30% + Residual with 3.2% standard deviation**

Predicted MSCI EAFE Price Return

International Equity Indices – International Diversified Equity

Historical relationship:

- **MSCI EAFE Dividend Yield = 165.2% * S&P 500 Dividend Yield – 0.24% + Residual with 0.36% standard deviation**

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.881015252
R Square	0.776187874
Adjusted R Square	0.775394214
Standard Error	0.003614859
Observations	284

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.012779536	0.012779536	977.9853487	1.16037E-93
Residual	282	0.003684952	1.30672E-05		
Total	283	0.016464488			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.002419346	0.001009811	-2.395839668	0.01723425	-0.004407071	-0.000431621	-0.004407071	-0.000431621
S&P 500	1.652161117	0.052830683	31.27275729	1.16037E-93	1.548168572	1.756153661	1.548168572	1.756153661

CONNING

International Equity Indices – International Diversified Equity

Historical relationship:

- **MSCI EAFE Dividend Yield = 165.2% * S&P 500 Dividend Yield – 0.24% + Residual with 0.36% standard deviation**

Predicted MSCI EAFE Dividend Yield
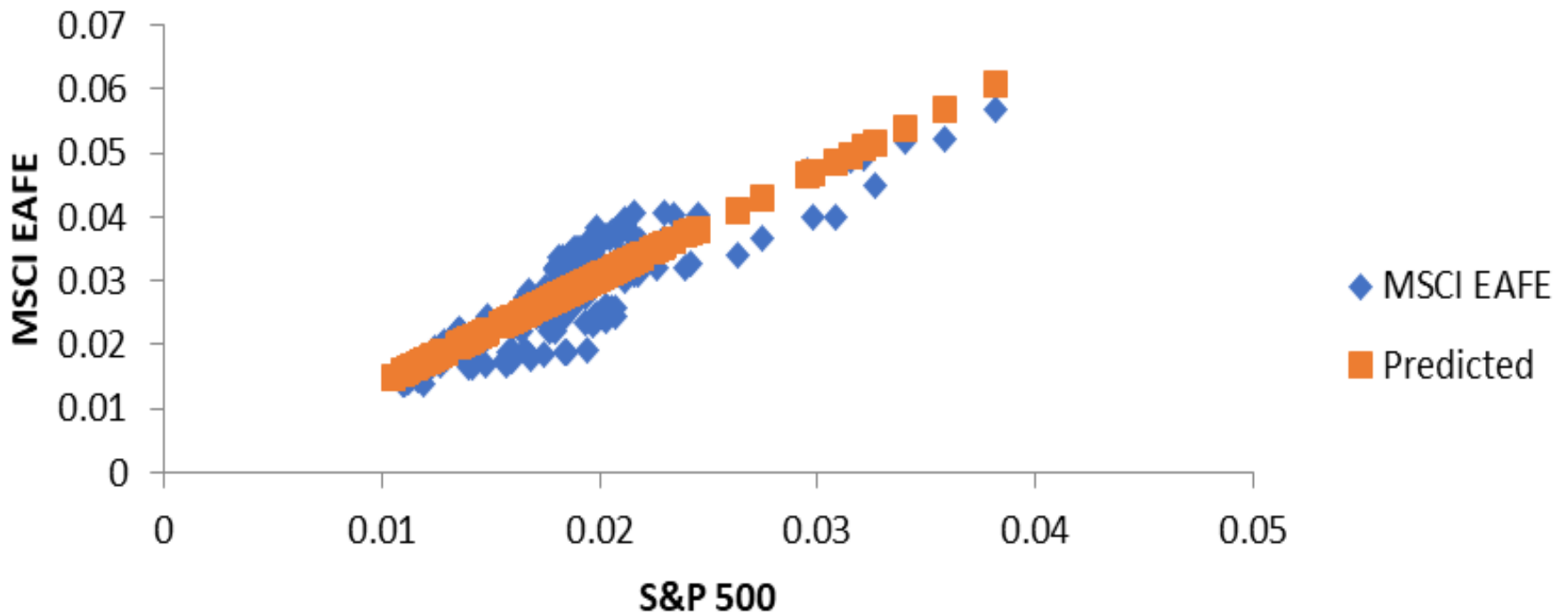
International Equity Indices – Aggressive Foreign Equity

Regress Historical Returns against US Large Cap and International Diversified Equity

- **Need to avoid issues with multicollinearity**

  - Two dependent variables are highly correlated

  - Can lead to issues with standard regression analysis

  - Can lead to unstable results for projections

- **Avoid this issue by performing multiple regressions**

  - First, regress the actual data against the S&P 500 since this is the native GEMS index

  - Second, regress the residual against MSCI EAFE

  - Correlated variables aren't included in the same regression, so no issue with multicollinearity

  - Similar to Cholesky factorization process used to decompose correlation matrices

International Equity Indices – Aggressive Foreign Equity

Historical relationship:

- **MSCI EM Price Return = 104.8% * S&P 500 Price Return + 0.03% + Residual**

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.672905042							
R Square	0.452801196							
Adjusted R Square	0.451398122							
Standard Error	0.047985389							
Observations	392							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.743096259	0.743096259	322.7208558	5.18978E-53			
Residual	390	0.898013053	0.002302598					
Total	391	1.641109312						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.00026384	0.002464449	0.107058487	0.91479763	-0.004581428	0.005109109	-0.004581428	0.005109109
S&P 500	1.047699705	0.058320778	17.96443308	5.18978E-53	0.933037246	1.162362164	0.933037246	1.162362164

International Equity Indices – Aggressive Foreign Equity

Historical relationship:

- **MSCI EM Residual Price Return = 28.2% * MSCI EAFE Price Return - 0.10% + Residual with 4.6% standard deviation**
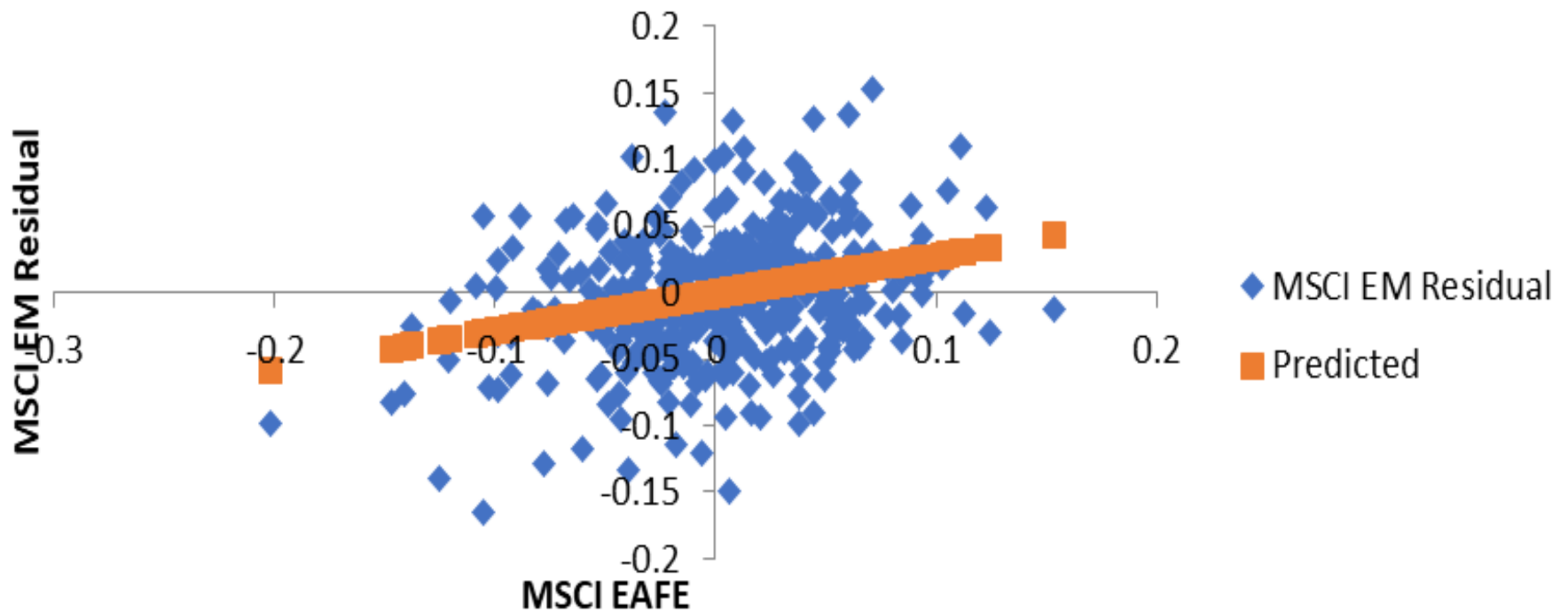
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.284070076
R Square	0.080695808
Adjusted R Square	0.078338618
Standard Error	0.04600856
Observations	392

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.072465889	0.072465889	34.23389716	1.03619E-08
Residual	390	0.825547164	0.002116788		
Total	391	0.898013053			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.000998976	0.002330047	-0.428736436	0.668351749	-0.005580001	0.003582049	-0.005580001	0.003582049
MSCI EAFE	0.281968413	0.048191705	5.850974035	1.03619E-08	0.187220373	0.376716452	0.187220373	0.376716452

CONNING

International Equity Indices – Aggressive Foreign Equity

Combined Model:

- **MSCI EM Price Return = 104.8% * S&P 500 Price Return + 28.2% * MSCI EAFE Price Return - 0.07% + Residual with 4.6% standard deviation**

Predicted MSCI EM Residual Price Return

International Equity Indices – Aggressive Foreign Equity

Historical relationship:

- **MSCI EM Dividend Yield = 87.5% * S&P 500 Dividend Yield + 0.82% + Residual**

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.696915995
R Square	0.485691904
Adjusted R Square	0.483868116
Standard Error	0.003668557
Observations	284

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.003584075	0.003584075	266.3094708	1.30059E-42
Residual	282	0.003795243	1.34583E-05		
Total	283	0.007379317			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.008246184	0.001024812	8.046535029	2.38662E-14	0.006228932	0.010263435	0.006228932	0.010263435
X Variable 1	0.874950289	0.053615465	16.31899111	1.30059E-42	0.769412971	0.980487608	0.769412971	0.980487608

International Equity Indices – Aggressive Foreign Equity

Historical relationship:

- **MSCI EM Residual Dividend Yield = 11.9% * MSCI EAFE Dividend Yield - 0.33% + Residual with 0.36% standard deviation**

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.247422781							
R Square	0.061218033							
Adjusted R Square	0.057889019							
Standard Error	0.003554492							
Observations	284							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.000232337	0.000232337	18.38923823	2.4757E-05			
Residual	282	0.003562905	1.26344E-05					
Total	283	0.003795243						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.003378377	0.000815565	-4.142378379	4.54715E-05	-0.004983745	-0.00177301	-0.004983745	-0.00177301
X Variable 1	0.118791493	0.027701512	4.288267509	2.4757E-05	0.064263508	0.173319479	0.064263508	0.173319479

International Equity Indices – Aggressive Foreign Equity
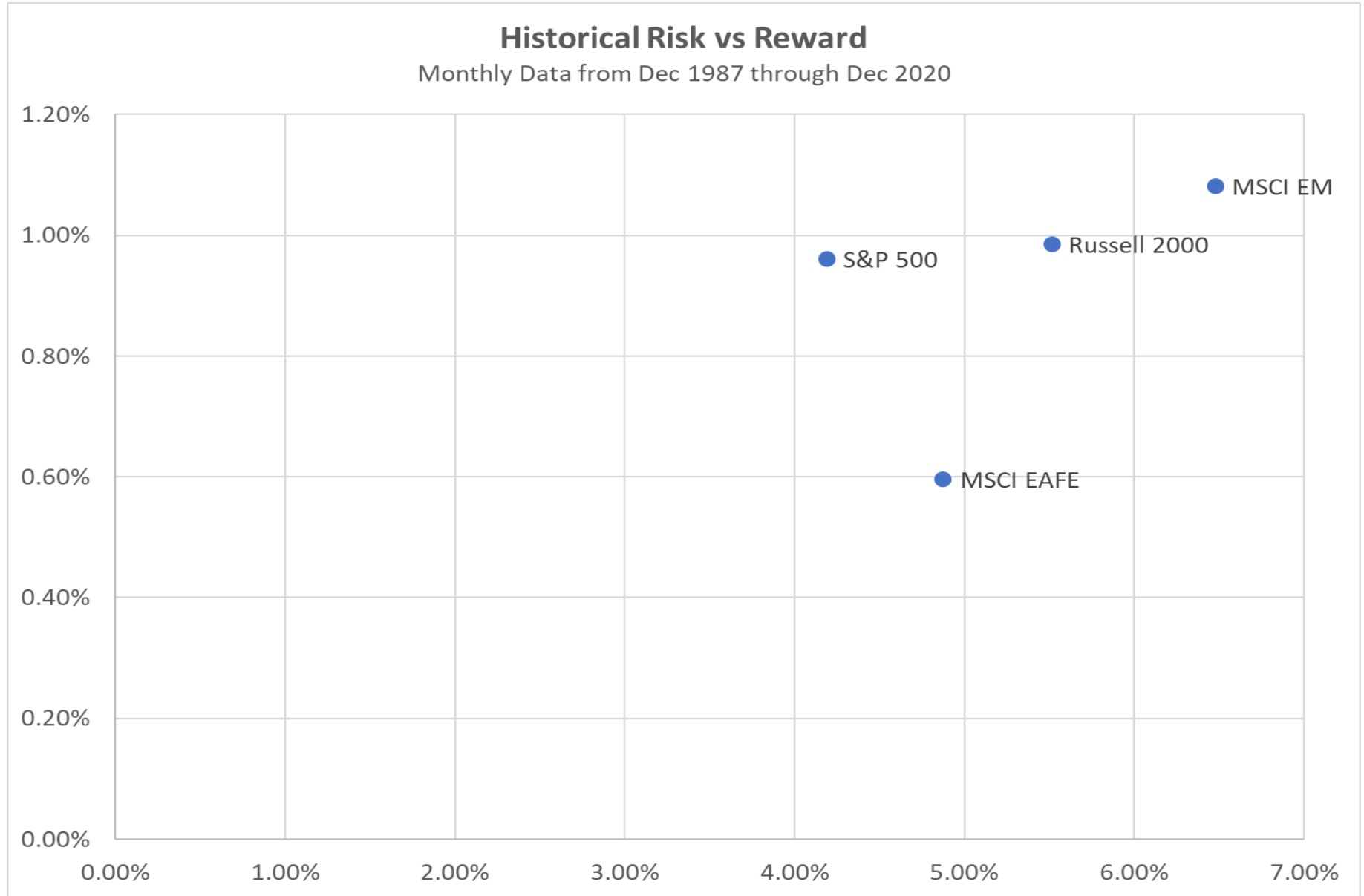
Combined Model:

- **MSCI EM Dividend Yield = 87.5% * S&P 500 Dividend Yield + 11.9% * MSCI EAFE Dividend Yield - 0.33% + Residual with 0.36% standard deviation**
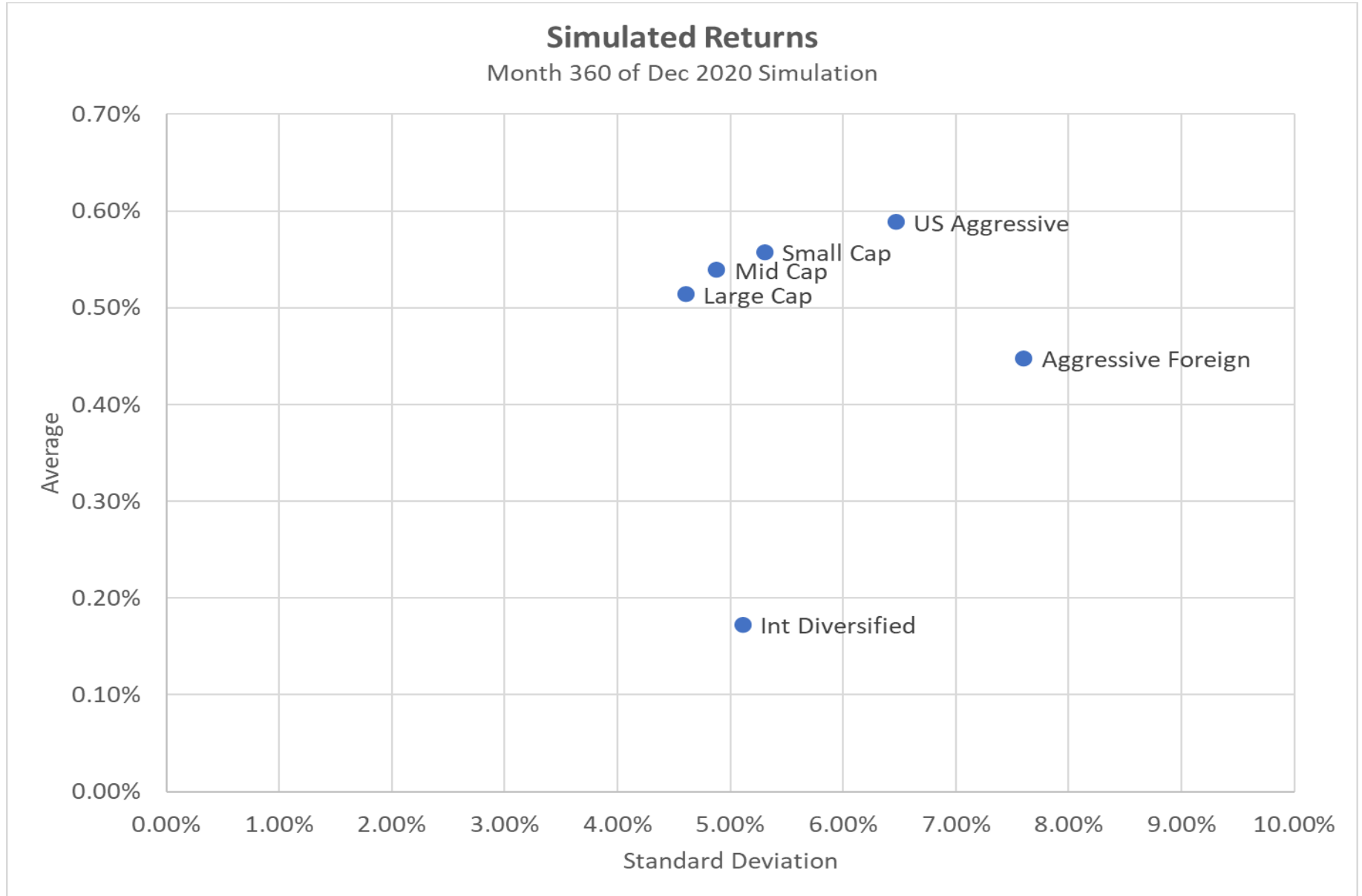

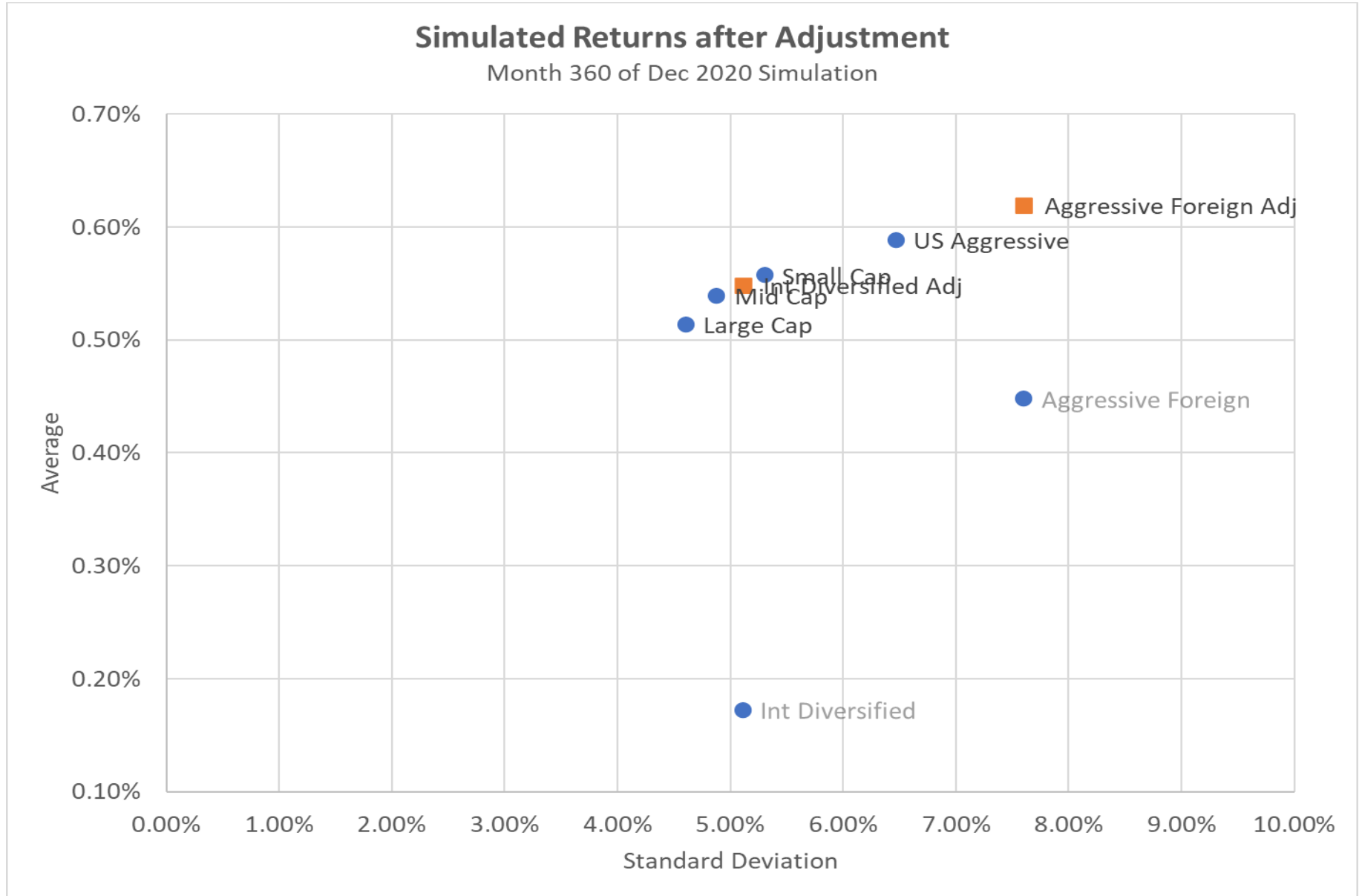Predicted MSCI EM Residual Dividend Yield
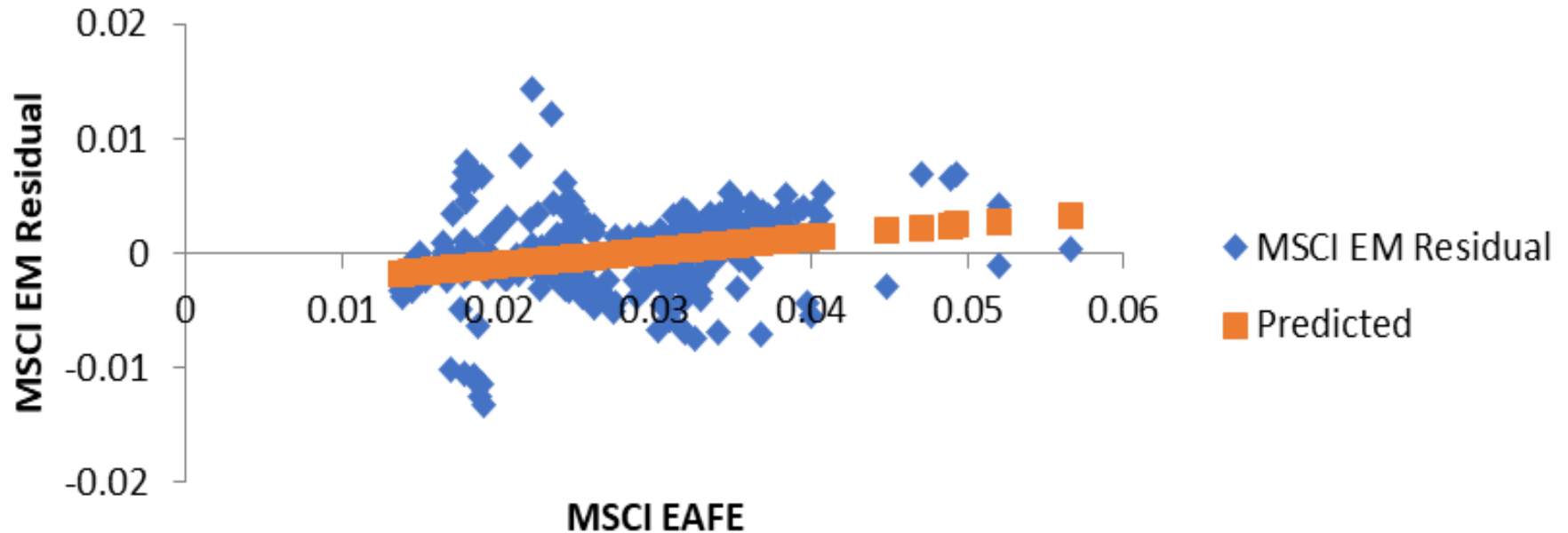
Simulated Results – Historical Returns

Historical Risk vs Reward
Monthly Data from Dec 1987 through Dec 2020

CONNING

Simulated Results – Month 360 from Dec 2020 run

Simulated Results – Month 360 from Dec 2020 run

Simulated Returns after Adjustment
Month 360 of Dec 2020 Simulation

Simulated Results – Month 360 from Dec 2020 run

Historical Correlation:

Index	S&P 500	MSCI EAFE
MSCI EAFE	74%	
MSCI EM	67%	71%

Simulated Correlation:

Index	S&P 500	MSCI EAFE
MSCI EAFE	78%	
MSCI EM	78%	68%

CONNING

International Equity Indices – Final Models

International Diversified:

- **Price Return = 86.4% * S&P 500 Price Return + 0.07% + Residual with 3.2% standard deviation**

- **Dividend Yield = 165.2% * S&P 500 Dividend Yield – 0.24% + Residual with 0.36% standard deviation**

Aggressive Foreign:

- **Price Return = 104.8% * S&P 500 Price Return + 28.2% * MSCI EAFE Price Return - 0.24% + Residual with 4.6% standard deviation**

- **Dividend Yield = 87.5% * S&P 500 Dividend Yield + 11.9% * MSCI EAFE Dividend Yield - 0.33% + Residual with 0.36% standard deviation**