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Why *listed equity* real estate?

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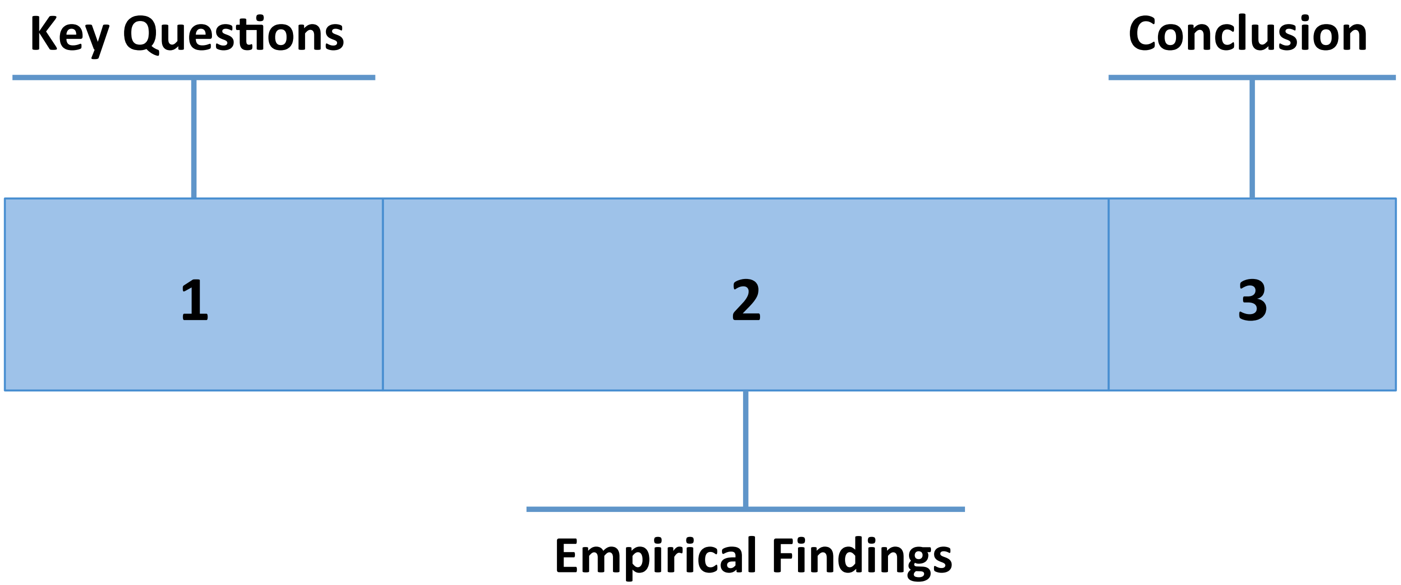
Key Questions
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Empirical Findings

1. Key Questions

Why listed equity real estate?

Return Enhancement?

Diversification Benefits?

Inflation Hedging?

Reflected in Optimization Excercises?

1. Key Questions

Methodologies

- Means; Medians; SDs
- VaR; CVaR
- Return-Risk Ratio; Alpha

- Constant Correlations
- Time-Varying Correlations (SMA; EWMA; DCC)

- Cointegration Tests (Short-Term)
- ECM (Long-Term)

- Spanning Tests
- M-Squared
- Out of Sample Tests

1. Key Questions

Data

	Name	Asset Class	Currency	Data available from	Provider	Vendor
Countries	GPR Country Indices	Real Estate	Local/USD	12/31/1984	GPR	GPR
	EPRA/NAREIT	Real Estate	Local/USD	12/31/1990	FTSE	Datastream
	MSCI Country Indices	Equity	Local/USD	12/31/1969	MSCI	Datastream
	Citigroup WGBI Subindices	Government Bond	Local/USD	12/31/1984	Citigroup	Datastream
	US Aggregate Index	Bonds	USD	01/01/1976	Barclays	Datastream
Global	GPR General	Real Estate	USD	12/31/1983	GPR	GPR
	GPR General Quoted	Real Estate	USD	12/31/1983	GPR	GPR
	GPR 250	Real Estate	USD	12/31/1989	GPR	GPR
	GPR 250 Reits	Real Estate	USD	12/31/1989	GPR	GPR
	MSCI World	Equity	USD	12/31/1969	MSCI	Datastream
	MSCI All Country World	Equity	USD	12/31/1987	MSCI	Datastream
	Barclays Global Aggregate	Bonds	USD	01/31/1990	Barclays	Datastream
	S&P GSCI Commodity	Commodities	USD	12/31/1969	S&P	Datastream
Inflation Analysis	Real Gross Domestic Product-USA	-	USD	12/31/1946	US. Bureau of Economic Analysis	FRB of St. Louis
	Industrial Production Index-USA	-	USD	12/31/1918	Board of Governors of the FRS	FRB of St. Louis
	M2 Money Stock	-	USD	12/31/1958	Board of Governors of the FRS	FRB of St. Louis
	CPI for All Urban Consumers: All Items	-	USD	12/31/1912	US. BLS	FRB of St. Louis
	CPI for All Urban Consumers: Rent of primary Residence	-	USD	12/31/1939	US. BLS	FRB of St. Louis
	CPI for All Urban Consumers: Owners' equivalent rent	-	USD	12/31/1981	US. BLS	FRB of St. Louis
	3 Month Libor	Treasury Bill	USD	01/31/1971	US Federal Reserve Data Releases	Quandl.com
	3 Month Treasury Bill USA	Treasury Bill	USD	12/12/1953	US Federal Reserve Data Releases	Datastream
Others	Risk Loadings & One Month Treasury Bill	-	USD	01/07/1926	Kenneth R. French Website	WRDS

2. Empirical Findings

Return Enhancement

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• High returns → Absolute return enhancement	• High volatility • Large tail risk

No evidence for risk-adjusted return-enhancement capabilities

2. Empirical Findings

Diversification Benefits

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• Low correlations with other asset classes • Diversification possibilities between global real estate markets	• Benefits decreased with the occurrence of the financial crisis

2. Empirical Findings

Portfolio Optimization

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+	–
• Weights in low-risk portfolios undermine diversification possibilities • High weights in risky portfolios substantiate absolute return enhancement	• Tests suggest no significant statistical and economical difference

2. Empirical Findings

Inflation Hedging

+

- Long-term equilibrium relationship with inflation

−

- No short-term hedging capabilities
- Slow adjustment process to long-term equilibrium

3. Conclusion

Why listed equity real estate?

+ Diversify with global Real Estate
+ Hedge Portfolio better against Inflation

- Be aware of high volatility & tail risk
- Do not see it as a safe haven

Horizon??
Risk-Aversion??
→ **Goals??**

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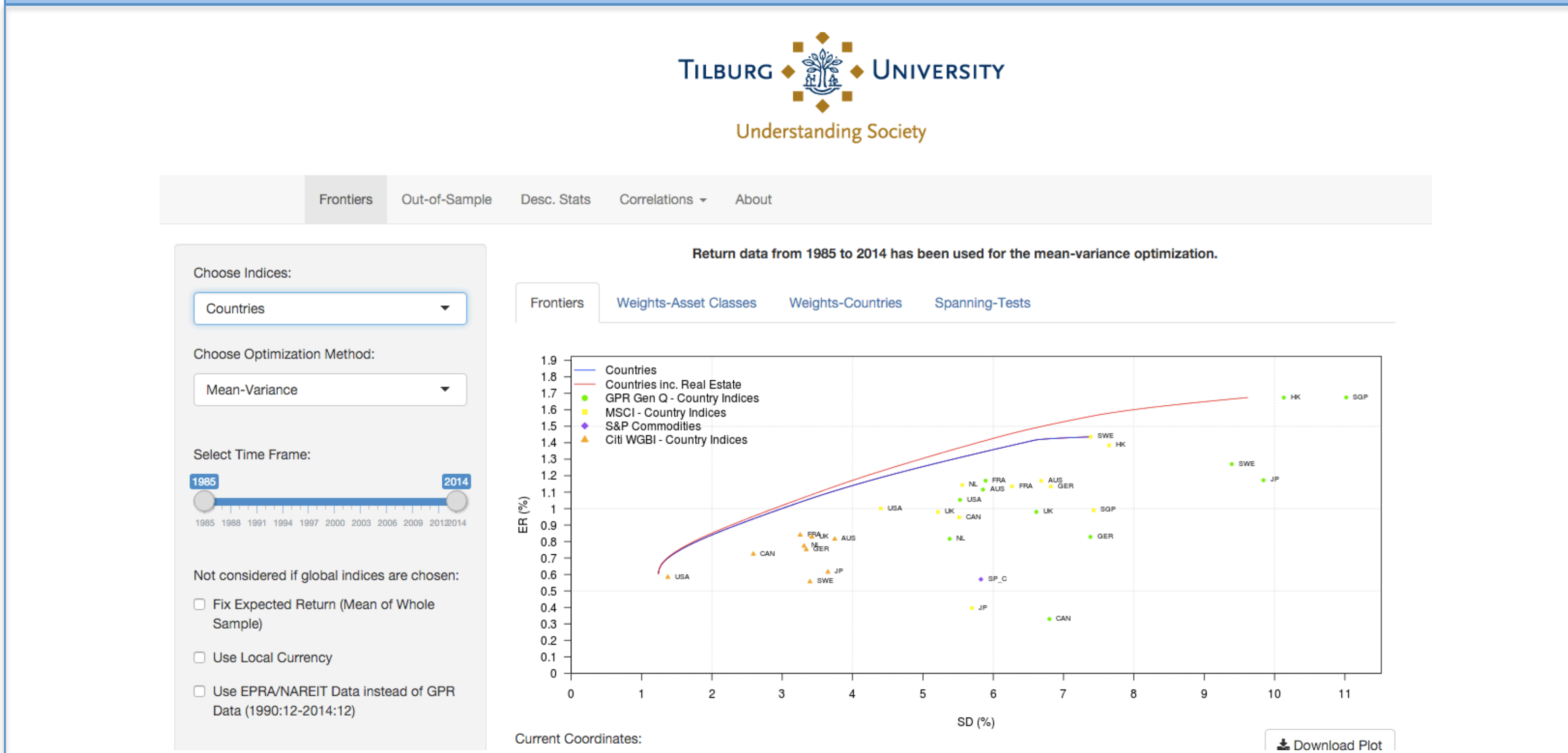
https://bernhardschlepper.shinyapps.io/MasterThesis




GICS
COMING IN 2016:
REAL ESTATE
THE 11TH GICS HEADLINE SECTOR

Des. Stats Country Indices

	Country Averages		**US alone**	
	Real Estate	Equity	Real Estate	Equity
Mean	1.10	1.06	1.05	1.00
Median	1.09	1.22	1.35	1.32
SD	7.62	6.24	5.53	4.40
Skewness	5.23	-16.19	-0.858	-0.799
Excess Kurtosis	3.01	5.50	10.22	5.302
ES	-14.45	-16.19	-19.60	-11.53
Max. Drawdown	-76.88	-61.16	-69.52	-50.65

Equity REITs – Qualification Criteria (US)

- Invest at least 75 percent of its total assets in real estate
- Derive at least 75 percent of its gross income from rents from real property or from sales of real estate
- Pay at least 90 percent of its taxable income in the form of shareholder dividends each year
- Be an entity that is taxable as a corporation
- Be managed by a board of directors or trustees
- Have a minimum of 100 shareholders
- Have no more than 50 percent of its shares held by five or fewer individuals

GPR Gen. Qu. – Qualification Criteria (US)

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- >75 % of operational turnover from investment activities
- Bank funds are excluded
- Mkt Cap > $50M
- No liquidity constraints
- >75 % of operational turnover from different country, company is attributed to the country where assets are located

Suggestions for future research

- Investigate ail dependencies between asset classes AND between global real estate markets
- Identify real estate unique return drivers
- Use Portfolio optimization techniques focusing on downside risk
- Time diversification & lifecycle investment strategies
- Cross-country evidence for Inflation Hedging

Table 1: Real Estate Exposure of Equity Indices

Index	MSCI Equity (USD mio)	MSCI Real Estate (USD mio)	Exp. (%)	GPR General Quoted (USD mio)	Exp. (%)
All Countries	38,526,172	1,193,996	3.10	1,251,482	3.25
Developed Countries	34,327,890	1,080,983	3.15		
Europe	8,807,254	117,946	1.34	286,735	3.26
Asia Pacific	7,488,185	461,784	6.17	362,742	4.84
Australia*	966,092	78,780	8.16	57,676	5.97
Canada	1,318,212	38,301	2.91	52,139	3.96
France*	1,327,315	45,409	3.42	64,802	4.88
Germany*	1,232,612	19,249	3.68	39,856	3.23
Hong Kong*	445,563	135,257	30.35	90,686	20.35
Japan*	2,997,691	136,919	4.57	123,332	4.11
Netherlands	367,091	-	-	-	-
Singapore*	265,471	33,433	12.59	58,039	21.86
Sweden	404,649	-	-	19,498	4.82
USA	19,495,784	675,214	3.46	658,709	3.38
UK*	2,740,503	45,374	0.70	99,497	3.63

Table 2: National – Descriptive Statistics of monthly Returns

	1985:1 – 2014:12			1985:1 – 1999:12			2000:1 – 2014:12		
	Mean	**SD**	**Ratio**	**Mean**	**SD**	**Ratio**	**Mean**	**SD**	**Ratio**
Equity	1.001	4.401	0.227	1.574	4.306	0.366	0.428	4.432	0.097
Gov. Bonds	0.584	1.374	0.425	0.722	1.422	0.508	0.445	1.313	0.339
Real Estate	1.053	5.528	0.191	0.888	4.413	0.201	1.218	6.462	0.189
Commodities	0.570	5.825	0.098	0.822	4.721	0.174	0.319	6.755	0.047

Table 3: National – VaR and ES

	Equity	Gov. Bonds	Real Estate	Commodities
ES Monthly				
Empirical	-10.003	-2.350	-13.394	-12.913
Cornish Fisher	-11.534	-2.342	-19.599	-13.986
ES Quarterly				
Empirical	-17.528	-2.787	-23.674	-25.078
Cornish Fisher	-17.358	-2.968	-27.932	-26.356
VaR Monthly				
Empirical	-7.189	-1.722	-6.723	-9.411
Cornish Fisher	-6.970	-1.636	-8.491	-9.071
VaR Quarterly				
Empirical	-13.502	-2.113	-11.324	-13.654
Cornish Fisher	-11.818	-2.251	-14.745	-16.415

Table 4: National – Multi-Factor Model Regressions

	1985:1-2014:12			1985:1-1999:12			2000:1-2014:12		
	Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.	
Alpha	-0.002	0.389		-0.004	0.092	*	-0.002	0.559	
MSCI USA	0.815	0.000	***	0.788	0.000	***	0.805	0.000	***
Barclays US Aggregate	0.742	0.000	***	0.389	0.021	**	1.383	0.000	***
S&P Commodities	-0.041	0.335		-0.068	0.169		-0.028	0.582	
SMB	0.503	0.000	***	0.521	0.000	***	0.482	0.000	***
HML	0.769	0.000	***	0.542	0.000	***	0.897	0.000	***
MOM	-0.115	0.033	**	-0.013	0.851		-0.142	0.031	**
Adj. R squared	0.604			0.627			0.619		

Table 5: National – Constant Correlations

	Real Estate	Equity	Gov. Bonds	Commodities
Real Estate	1.000	0.618	0.047	0.096
Equity	0.618	1.000	-0.003	0.148
Gov. Bonds	0.047	-0.003	1.000	-0.075
Commodities	0.096	0.148	-0.075	1.000

Table 6: National – ADF and PP Tests

	Equity	Real Estate	Gov. Bonds	Commodities
Teststatistic	1.27	0.93	0.66	-2.16
Crit(1%)	-3.44	-3.44	-3.44	-3.44
Crit(5%)	-2.87	-2.87	-2.87	-2.87
Crit(10%)	-2.57	-2.57	-2.57	-2.57
PP Test (P-Value)	0.94	0.81	0.42	0.28

Table 7: National – Spanning Tests

Portfolio	Intercept			Coefficient Benchmark Porfolio		
	Value	t-stat	Prob.	Value	t-stat	Prob.
MVP	0.000	0.559	0.576	1.000	-0.098	0.922
SD2	0.000	0.866	0.387	0.961	-1.194	0.233
SD2.5	0.000	0.821	0.412	0.956	-1.126	0.261
SD3	0.001	0.811	0.418	0.950	-1.167	0.244
SD3.5	0.001	0.828	0.408	0.944	-1.291	0.198
SD4	0.001	0.797	0.426	0.944	-1.263	0.207
60 % per Asset Constraint						
	Value	t-stat	Prob.	Value	t-stat	Prob.
MVP	0.000	0.931	0.353	0.982	-1.245	0.214
SD2	0.000	0.866	0.387	0.961	-1.194	0.233

Table 8: National – Out-of-Sample Tests

		Without Maximum Allocation			Maximum Allocation 60% per Asset		
Target SD (%)	Portfolio	Mean Return	SD (%)	Ratio	Mean Return (%)	SD (%)	Ratio
1.5	Benchmar	0.376	1.368	0.275			
	incl. RE	0.415	1.768	0.235			
2	Benchmar	0.297	1.885	0.158	0.363	1.991	0.182
	incl. RE	0.389	2.535	0.153	0.405	2.587	0.156
2.5	Benchmar	0.220	2.396	0.092	0.288	2.483	0.116
	incl. RE	0.351	3.259	0.108	0.361	3.290	0.110
3	Benchmar	0.166	2.862	0.058	0.294	2.996	0.098
	incl. RE	0.332	3.908	0.085	0.396	3.944	0.100
3.5	Benchmar	0.109	3.247	0.033	0.247	3.274	0.075
	incl. RE	0.255	4.475	0.057	0.363	4.216	0.086
4	Benchmar	0.053	3.358	0.016	0.247	3.274	0.075
	incl. RE	0.198	4.687	0.042	0.366	4.257	0.086

Table 9: National – Contemporaneous Fisher Regressions

		Sample: 1985:1 -2014:12			Sample: 1985:1 - 1999:12			Sample: 2000:1 - 2014:12		
Dep. Var.	**Exp. Var.**	**Coeff.**	**Prob.**		**Coeff.**	**Prob.**		**Coeff.**	**Prob.**	
Real Estate	Constant	0.033	0.105		0.076	0.020		0.028	0.263	
	Inflation	-0.036	0.987		-6.083	0.102		1.671	0.440	
Equity	Constant	0.027	0.094	*	0.077	0.001	**	0.007	0.684	
	Inflation	0.525	0.750		-3.676	0.117		1.131	0.504	
Bonds	Constant	0.024	0.000	***	0.035	0.000	**	0.019	0.000	**
	Inflation	-0.985	0.001	***	-1.647	0.028	**	-0.972	0.006	***
Commodities	Constant	-0.060	0.000	***	-0.085	0.024	***	-0.051	0.001	**
	Inflation	11.873	0.000	***	14.177	0.001	***	11.481	0.000	***

Table 10: National – Fama-Schwert Regressions

Dep. Var.	Exp. Var.	Sample: 1985:1 - 2014:12 Coeff.	Prob.		Sample: 1985:1 - 1999:12 Coeff.	Prob.		Sample: 2000:1 - 2014:12 Coeff.	Prob.	
Real Estate	Constant	0.055	0.105		0.061	0.143		0.055	0.334	
	Expected Inflation	-3.436	0.419		-4.491	0.404		-3.386	0.659	
	Unexpected Inflation	0.777	0.708		-7.977	0.068	*	2.524	0.107	
Equity	Constant	0.041	0.035	**	0.071	0.001	**	0.036	0.237	
	Expected Inflation	-1.593	0.482		-2.958	0.270		-3.648	0.360	
	Unexpected Inflation	1.025	0.544		-4.586	0.231		2.007	0.130	
Bonds	Constant	0.013	0.004	***	0.022	0.032	**	0.011	0.026	**
	Expected Inflation	0.555	0.311		-0.122	0.905		0.293	0.702	
	Unexpected Inflation	-1.441	0.000	***	-2.722	0.001	***	-1.270	0.000	***
Commodities	Constant	-0.084	0.000	***	-0.084	0.003	***	-0.052	0.029	**
	Expected Inflation	14.319	0.000	***	14.319	0.000	***	11.202	0.001	***
	Unexpected Inflation	14.595	0.000	***	14.595	0.010	**	11.391	0.000	***

Table 11: National – Error Correction Model – Level Regressions

	Real Estate			Equity			Bonds			Commodities		
	Sample: 1985:1 - 2014:12			Sample: 1985:1 - 2014:12			Sample: 1985:1 - 2014:12			Sample: 1985:1 - 2014:12		
	Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.	
Constant	0.632	0.007	***	-0.259	0.044	**	0.257	0.000	***	0.136	0.589	
Expected Inflation	5.793	0.026	**	-0.130	0.911		1.304	0.000	***	3.832	0.207	
Unexpected Inflation	1.196	0.731		-4.127	0.032	**	-0.379	0.528		16.605	0.000	***
MSCI World	0.439	0.037	**	0.840	0.000	***	-0.288	0.000	***	0.357	0.380	
MSCI USA	-0.289	0.355					0.208	0.000	***	-0.739	0.116	
Industrial Production USA	-0.244	0.792		2.246	0.000	***	-0.295	0.228		0.997	0.594	
M2	-1.269	0.032	**	0.173	0.587		0.105	0.530		-1.398	0.219	
Real GDP USA	5.938	0.001	***	-2.564	0.089	*	0.787	0.160		1.082	0.816	
Libor	-7.685	0.000	***	-0.213	0.959		0.111	0.860		0.927	0.858	
Treasury Bill 3 Month	0.127	0.937		1.318	0.620		0.277	0.519		0.061	0.987	
Adjusted R squared:	0.978			0.989			0.910			0.910		

Table 12: National – Error Correction Model – First Difference Regressions

	Real Estate			Equity			Bonds			Commodities		
	Sample: 1985:1 - 2014:12			Sample: 1985:1 - 2014:12			Sample: 1985:1 - 2014:12			Sample: 1985:1 - 2014:12		
	Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.	
Constant	0.032	0.156		0.004	0.662		0.006	0.386		-0.063	0.000	***
Expected Inflation	1.446	0.559		0.495	0.639		-0.280	0.747		15.650	0.000	***
Unexpected Inflation	-1.033	0.219		-1.022	0.001	**	-1.021	0.002	***	12.177	0.000	***
MSCI World	0.286	0.015	**	0.911	0.000	***	-0.017	0.821		0.556	0.006	***
MSCI USA	0.408	0.011	**				-0.065	0.407		-0.457	0.004	***
Industrial Production USA	-0.414	0.516		0.065	0.800		-0.114	0.458		1.313	0.022	**
M2	-2.236	0.014	**	-0.192	0.585		0.169	0.517		-0.796	0.313	
Real GDP USA	2.564	0.087		0.254	0.617		0.921	0.011	**	-3.055	0.008	***
Libor	-10.089	0.154		-4.548	0.154		0.811	0.642		-10.124	0.034	**
Treasury Bill 3 Month	3.209	0.463		2.409	0.231		0.113	0.925		5.295	0.107	
ECT	-0.282	0.000	***	-0.154	0.011	**	-0.342	0.000	***	-0.201	0.001	***
Return (t-1)	0.257	0.000	***	0.081	0.048	**	0.087	0.327		0.012	0.881	
Return (t-2)	-0.013	0.798		-0.024	0.427		-0.024	0.758		-0.012	0.823	
Adj. R squared	0.560			0.851			0.335			0.667		

Table 13: Global – Descriptive Statistics of monthly Returns

	Real Estate			Equity			Bonds		
	Mean	**SD**	**Ratio**	**Mean**	**SD**	**Ratio**	**Mean**	**SD**	**Ratio**
National									
USA	0.996	5.691	0.175	0.871	4.244	0.205	0.511	1.280	0.399
International									
Australia	1.010	5.648	0.179	0.935	5.962	0.157	0.754	3.403	0.222
Canada	0.067	6.801	0.010	0.848	5.589	0.152	0.625	2.563	0.244
France	0.921	5.802	0.159	0.735	5.865	0.125	0.642	3.052	0.210
Germany	0.419	7.489	0.056	0.808	6.591	0.123	0.573	3.037	0.189
Hong Kong	1.434	10.062	0.142	1.182	7.362	0.161			
Japan	0.467	8.463	0.055	0.053	5.724	0.009	0.431	3.368	0.128
Netherlands	0.629	5.666	0.111	0.883	5.623	0.157	0.598	3.047	0.196
Singapore	1.235	10.310	0.120	0.840	7.156	0.117	0.451	1.992	0.226
Sweden	0.896	9.722	0.092	1.114	7.526	0.148	0.556	3.394	0.164
UK	0.744	6.264	0.119	0.715	4.744	0.151	0.685	2.898	0.236
Barclays Global Agg.							0.520	1.572	0.331
GPR General Quoted	0.693	5.184	0.134						
GPR 250	0.665	5.223	0.127						
GPR 250 REITs	0.876	4.681	0.187						
MSCI World				0.654	4.376	0.149			
MSCI ACWI				0.656	4.458	0.147			

Table 14: Global – Multi-Factor Model Regressions

	1990:1-2014:12			1990:1-1999:12			2000:1-2014:12		
	Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.	
Alpha	-0.002	0.263		-0.006	0.027	**	0.001	0.604	
MSCI ACWI	0.861	0.000	***	1.013	0.000	***	0.802	0.000	***
Barclays Global Aggregate	0.693	0.000	***	0.505	0.009	***	0.769	0.000	***
S&P Commodities	-0.020	0.458		0.057	0.054	*	-0.033	0.394	
SMB	0.259	0.000	***	0.157	0.063	*	0.274	0.000	***
HML	0.437	0.000	***	0.227	0.033	**	0.516	0.000	***
MOM	-0.070	0.060	*	-0.279	0.000	***	-0.047	0.179	
Adj. R squared	0.750			0.730			0.792		

Table 15: Global – ES per Month

	Real Estate		Equity		Bonds	
	Cornish Fisher	Empirical	Cornish Fisher	Empirical	Cornish Fisher	Empirical
National						
USA	-19.599	-13.394	-11.534	-10.003	-2.342	-2.350
International						
Australia	-19.433	-14.170	-23.839	-15.460	-9.492	-8.717
Canada	-18.655	-16.500	-15.599	-12.673	-6.003	-5.385
France	-14.162	-12.158	-13.422	-13.624	-5.772	-5.846
Germany	-8.543	-14.253	-15.956	-16.057	-6.108	-6.301
Hong Kong	-14.039	-20.243	-21.195	-16.269		
Japan	-9.469	-16.807	-12.466	-12.044	-5.811	-6.552
Netherlands	-15.306	-12.900	-14.421	-13.453	-6.140	-6.262
Singapore	-13.521	-22.374	-22.027	-17.891	-4.499	-4.288
Sweden	-10.182	-18.202	-16.150	-16.211	-6.479	-6.493
UK	-16.070	-14.092	-11.464	-10.574	-5.637	-6.309
Barclays Global Aggregate					-1.955	-1.984
GPR General Quoted	-13.859	-12.177				
GPR 250	-15.486	-12.591				
GPR 250 REITs	-18.887	-11.758				
MSCI World			-11.004	-10.314		
MSCI ACWI			-10.932	-10.149		

Table 16: Global – Constant Correlations between broad Indices

	GPR Gen. Qu.	MSCI World AC	Barclays Global Agg.	S&P Commodities
GPR Gen. Qu.	1.00	0.80	0.42	0.22
MSCI ACWI	0.80	1.00	0.31	0.25
Barclays Global Agg.	0.42	0.31	1.00	0.18
S&P Commodities	0.22	0.25	0.18	1.00

Table 17: Global – Correlations with the GPR General Quoted Country Indices

		GPR General Quoted Indices										
		Australia	Canada	France	Germany	Hong	Japan	Netherlands	Singapore	Sweden	UK	USA
GPR General Quoted Indices	Australia	1.00	0.48	0.48	0.42	0.44	0.29	0.53	0.41	0.39	0.53	0.52
	Canada	0.48	1.00	0.41	0.33	0.35	0.32	0.44	0.35	0.36	0.42	0.50
	France	0.48	0.41	1.00	0.62	0.29	0.32	0.82	0.31	0.44	0.58	0.50
	Germany	0.42	0.33	0.62	1.00	0.26	0.24	0.64	0.26	0.33	0.48	0.45
	Hong Kong	0.44	0.35	0.29	0.26	1.00	0.16	0.31	0.67	0.23	0.33	0.33
	Japan	0.29	0.32	0.32	0.24	0.16	1.00	0.30	0.22	0.28	0.30	0.25
	Netherlands	0.53	0.44	0.82	0.64	0.31	0.30	1.00	0.35	0.46	0.58	0.52
	Singapore	0.41	0.35	0.31	0.26	0.67	0.22	0.35	1.00	0.22	0.37	0.42
	Sweden	0.39	0.36	0.44	0.33	0.23	0.28	0.46	0.22	1.00	0.39	0.38
	UK	0.53	0.42	0.58	0.48	0.33	0.30	0.58	0.37	0.39	1.00	0.55
	USA	0.52	0.50	0.50	0.45	0.33	0.25	0.52	0.42	0.38	0.55	1.00
MSCI Indices	Australia	0.81	0.50	0.44	0.42	0.51	0.28	0.49	0.51	0.40	0.51	0.47
	Canada	0.57	0.63	0.42	0.35	0.55	0.25	0.45	0.55	0.35	0.43	0.52
	France	0.49	0.43	0.69	0.50	0.40	0.30	0.61	0.40	0.35	0.49	0.47
	Germany	0.45	0.40	0.60	0.53	0.40	0.20	0.58	0.39	0.33	0.48	0.45
	Hong Kong	0.50	0.39	0.32	0.28	0.93	0.13	0.33	0.67	0.25	0.38	0.39
	Japan	0.35	0.36	0.31	0.23	0.28	0.65	0.30	0.34	0.33	0.34	0.35
	Netherlands	0.54	0.49	0.62	0.55	0.47	0.29	0.64	0.48	0.39	0.57	0.51
	Singapore	0.50	0.40	0.35	0.30	0.70	0.20	0.39	0.89	0.27	0.42	0.46
	Sweden	0.50	0.42	0.48	0.41	0.43	0.27	0.53	0.46	0.54	0.47	0.44
	UK	0.57	0.49	0.56	0.46	0.49	0.32	0.55	0.50	0.34	0.74	0.50
	USA	0.51	0.46	0.38	0.34	0.48	0.24	0.42	0.56	0.34	0.46	0.62
Citigroup Indices	Australia	0.73	0.37	0.43	0.35	0.34	0.23	0.44	0.32	0.33	0.40	0.33
	Canada	0.42	0.52	0.39	0.30	0.29	0.24	0.42	0.27	0.34	0.31	0.36
	France	0.26	0.15	0.63	0.44	0.11	0.22	0.57	0.10	0.18	0.35	0.17
	Germany	0.24	0.14	0.61	0.44	0.08	0.20	0.55	0.07	0.17	0.32	0.12
	Japan	0.03	0.01	0.25	0.14	0.06	0.34	0.18	0.07	0.06	0.15	-0.02
	Netherlands	0.26	0.14	0.61	0.45	0.10	0.20	0.57	0.08	0.18	0.33	0.14
	Singapore	0.51	0.36	0.51	0.42	0.39	0.32	0.54	0.45	0.47	0.42	0.39
	Sweden	0.48	0.31	0.55	0.41	0.25	0.26	0.53	0.27	0.32	0.39	0.30
	UK	0.26	0.21	0.39	0.30	0.09	0.29	0.36	0.04	0.12	0.49	0.11
	USA	-0.03	0.04	0.10	0.01	-0.08	0.10	0.03	-0.06	-0.02	0.00	0.05

Table 18: Global – ADF and PP Tests

	MSCI ACWI	Barclays Global Agg.	GPR Gen Qu.	S&P Commodities
Teststatistic	-0.12	-0.24	0.14	-2.28
Crit(1%)	-3.44	-3.44	-3.44	-3.44
Crit(5%)	-2.87	-2.87	-2.87	-2.87
Crit(10%)	-2.57	-2.57	-2.57	-2.57
PP Test (P-Value)	0.41	0.41	0.53	0.36

Table 19: Global – Spanning Tests

Portfolio	Intercept			Benchmark Portfolio Coefficient		
	Value	t-stat	Prob.	Value	t-stat	Prob.
MVP	0.000	0.878	0.381	0.983	-0.813	0.417
SD2	0.000	1.216	0.225	0.976	-1.002	0.317
SD2.5	0.000	0.818	0.414	0.985	-0.663	0.508
SD3	0.000	0.920	0.358	0.979	-0.944	0.346
SD3.5	0.001	0.909	0.364	0.971	-1.211	0.227
SD4	0.001	0.883	0.378	0.964	-1.207	0.228

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	I0		I1	
	ADF	PP Test	ADF	PP Test
Real Estate			***	***
Equity			***	***
Bonds	**		***	***
Commodities			***	***
MSCI World		*	***	***
Industrial Production USA			***	***
M2			***	***
Libor			**	
Treasury Bill 3M				
MSCI USA			***	***
Real GDP USA			***	***
Realized Inflation			*	**
Expected Inflation			*	***
Unexpected Inflation	***	***	***	***

Appendix E: Error Correction Model with different CPI subindices

	Dependent Variabel					
	Owners' equivalent rent			Rent of primary residence		
Levels	Coeff.	Prob.		Coeff.	Prob.	
Constant	0.564	0.052	*	0.580	0.121	
Expected Inflation	8.231	0.044	**	9.487	0.099	*
Unexpected Inflation	7.788	0.118		8.798	0.170	
MSCI World	0.522	0.018	**	0.194	0.675	
MSCI USA	-0.114	0.657		0.102	0.728	
Industrial Production USA	-0.459	0.707		-0.351	0.797	
M2	-1.315	0.055	*	-2.961	0.075	*
Real GDP USA	3.650	0.013	**	5.027	0.000	***
Libor	-8.963	0.000	***	-3.076	0.259	
Treasury Bill 3 Month	-0.386	0.845		-3.404	0.346	
Adjusted R squared:	0.977			0.975		
First Differences	Coeff.	Prob.		Coeff.	Prob.	
Constant	0.014	0.356		0.006	0.730	
Expected Inflation	6.505	0.095	*	7.146	0.030	**
Unexpected Inflation	-0.836	0.671		1.241	0.799	
MSCI World	0.202	0.182		0.140	0.361	
MSCI USA	0.549	0.005	***	0.597	0.002	***
Industrial Production USA	-0.596	0.397		-0.263	0.683	
M2	-2.253	0.028	**	-2.717	0.017	**
Real GDP USA	1.565	0.234		2.204	0.097	*
Libor	-12.507	0.040	**	-9.551	0.081	*
Treasury Bill 3 Month	2.726	0.559		1.457	0.726	
ECM	-0.258	0.001	***	-0.244	0.002	***
Lag1	0.283	0.001	***	0.261	0.000	***
Lag2	0.024	0.693		0.002	0.968	
Adj. R squared	0.542					

Appendix G: Descriptive Statistics of GPR General Quoted and FTSE EPRA/NAREIT Country Indices

	GPR General Quoted				FTSE EPRA/NAREIT			
	Mean	SD	Sharpe	ES	Mean	SD	Sharpe	ES
Australia	1.031	5.722	0.180	-19.241	0.972	5.970	0.163	-30.727
Canada	0.234	6.551	0.036	-17.712	0.584	6.340	0.092	-28.752
France	0.967	5.852	0.165	-14.885	1.104	6.094	0.181	-15.892
Germany	0.358	7.552	0.047	-8.790	0.578	7.787	0.074	-9.171
Hong Kong	1.477	10.178	0.145	-11.090	1.296	9.928	0.131	-13.577
Japan	0.662	8.142	0.081	-14.450	0.740	9.044	0.082	-15.452
Netherlands	0.709	5.641	0.126	-15.703	0.682	5.642	0.121	-16.613
Singapore	1.352	10.355	0.131	-11.496	1.028	10.686	0.096	-15.432
Sweden	1.018	9.738	0.105	-10.207	0.864	9.701	0.089	-14.354
UK	0.756	6.250	0.121	-16.566	0.670	6.243	0.107	-18.041
USA	1.173	5.624	0.209	-20.219	1.314	5.679	0.231	-19.200

Appendix H: Global – VaR per Month

	Real Estate		Equity		Bonds	
	Cornish Fisher	Empirical	Cornish Fisher	Empirical	Cornish Fisher	Empirical
National						
USA	-8.491	-6.723	-6.970	-7.189	-1.636	-1.722
International						
Australia	-9.642	-8.418	-10.950	-9.085	-5.930	-5.733
Canada	-11.308	-10.541	-8.858	-7.471	-3.754	-3.370
France	-8.808	-7.860	-9.537	-10.530	-4.287	-4.423
Germany	-8.543	-8.768	-10.655	-10.525	-4.567	-4.659
Hong Kong	-12.460	-12.115	-11.379	-10.686		
Japan	-9.469	-12.825	-9.005	-8.216	-4.665	-5.097
Netherlands	-8.647	-7.942	-8.997	-9.042	-4.530	-4.751
Singapore	-13.390	-14.454	-11.692	-11.143	-3.059	-2.746
Sweden	-10.182	-12.287	-11.046	-11.281	-4.968	-4.891
UK	-10.173	-8.932	-7.759	-7.247	-4.291	-4.479
Barclays Global Aggregate					-1.318	-1.361
GPR General Quoted	-7.990	-7.510				
GPR 250	-8.679	-7.729				
GPR 250 REITs	-7.628	-6.190				
MSCI World			-7.016	-6.691		
MSCI ACWI			-7.137	-7.227		

Appendix J: Global Portfolio **without** an explicit Real Estate Investment + Global Real Estate

		Fixed Rolling Window			Expanding Window		
Target SD	Portfolio	Mean (%)	Std. Dev. (%)	Ratio	Mean (%)	Std. Dev. (%)	Ratio
2	Benchmark	0.319	2.232	0.143	0.438	2.041	0.215
	incl. Real Estate	0.414	2.547	0.163	0.472	2.147	0.220
2.5	Benchmark	0.267	2.870	0.093	0.473	2.551	0.185
	incl. Real Estate	0.389	3.314	0.117	0.485	2.747	0.177
3	Benchmark	0.229	3.454	0.066	0.446	3.247	0.137
	incl. Real Estate	0.373	4.000	0.093	0.444	3.431	0.130
3.5	Benchmark	0.195	3.993	0.049	0.407	3.889	0.105
	incl. Real Estate	0.336	4.596	0.073	0.420	4.043	0.104
4	Benchmark	0.141	4.435	0.032	0.467	4.353	0.107
	incl. Real Estate	0.322	4.950	0.065	0.440	4.624	0.095

Appendix J: Global Portfolio **with** an explicit Real Estate Investment + Global Real Estate

		Fixed Rolling Window			Expanding Window		
Target SD	Portfolio	Mean (%)	Std. Dev. (%)	Ratio	Mean (%)	Std. Dev. (%)	Ratio
2	Benchmark	0.334	2.510	0.133	0.452	2.123	0.213
	incl. int. Real Estate	0.414	2.547	0.163	0.472	2.147	0.220
2.5	Benchmark	0.283	3.201	0.088	0.479	2.706	0.177
	incl. int. Real Estate	0.389	3.314	0.117	0.485	2.747	0.177
3	Benchmark	0.231	3.830	0.060	0.427	3.399	0.126
	incl. int. Real Estate	0.373	4.000	0.093	0.444	3.431	0.130
3.5	Benchmark	0.194	4.372	0.044	0.388	3.923	0.099
	incl. int. Real Estate	0.336	4.596	0.073	0.420	4.043	0.104
4	Benchmark	0.140	4.786	0.029	0.438	4.390	0.100
	incl. int. Real Estate	0.322	4.950	0.065	0.440	4.624	0.095

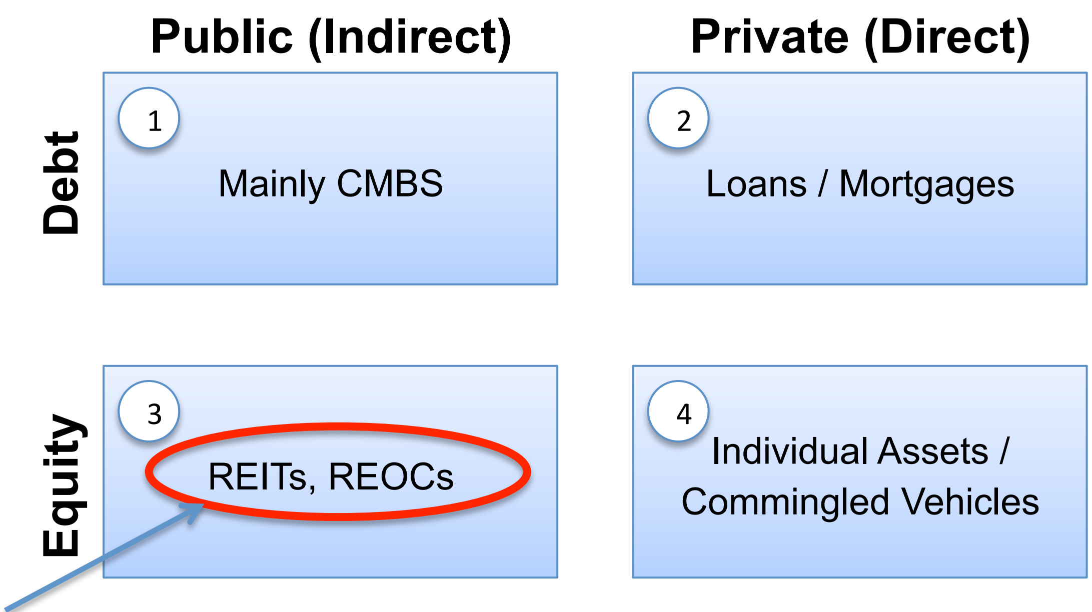
Benchmark Portfolio	Test Portfolio	Results
National Portfolio without access to an explicit Real Estate Investment	+ National Real Estate	Rolling Window: M Squared of only 7 basis points can be generated. The realized risk is significantly higher than the targeted 2% SD. Recursive: Return-Risk Ratio of the portfolio without real estate is better for an investor who targets 2% SD. Only investors, who are willing to take high risks and lower return-risk ratios, might benefit from an investment in terms of a higher M Squared.
Global Portfolio (Country Indices) without access to an explicit Real Estate Investment	+ Global Real Estate (Country Indices)	Rolling Window: M Squared of only 4 basis points for portfolios with a target SD of 2%. Deviation from the target SD is higher for the Portfolio with real estate. M Squared increases up to 22 basis points with higher targeted risk but return-risk ratios become considerably lower Recursive: M Squared of around 1 basis point considering a target SD of 2%. No strong indications for benefits of higher risk investors.
Global Portfolio (Country Indices) with access to only national Real Estate	+ International Real Estate (Country Indices)	Rolling Window: M Squared of 7 basis points with a target SD of 2%. M Squared increases up 23 basis points with higher targeted risk but the return-risk ratios drop at the same time. Recursive: M Squared of only 1.5 basis points with a target SD of 2%. No strong indications for benefits of higher risk portfolios.

Mixed-Asset Benchmark Portfolio	+ National Real Estate	+ Global Real Estate (Country Indices)	+ Global Real Estate (Broad Indices)
National without Real Estate	No Advantage	Statistically different for SD of two percent	No Advantage
Global without Real Estate (Broad Indices)	Statistically different along the whole Frontier	-	No Advantage
Global without a Real Estate Investment (Country Indices)	No Advantage	No Advantage	No Advantage
Global with a national Real Estate Investment (Country Indices)	-	No Advantage	No Advantage

Appendix L: Summary Pros and Cons

Pros	Cons
Return Enhancement	
Highest mean returns over the whole sample and over several subperiods suggest absolute return enhancing capabilities for less risk-averse investors.	No indications for superior risk-adjusted returns.
Lower tail risk of many countries compared to the local equity indices.	High volatility and tail risk.
Diversification	
Low correlations with other Asset Classes. In particular, on a national level and between country indices.	Decreasing Diversification opportunities due to increasing correlations with equity and commodities in times of higher volatility indicating tail dependencies.
Less integrated international real estate markets compared to the international equity and bond markets.	
Lower volatility and downside risk of annualized returns for mid-term investors compared to equity and commodities (stronger indications for national indices).	No evidence for mean reversion can be found.
Lower correlations between asset classes for mid-term investors.	
Inflation Hedging	
Positive long-term equilibrium relation with realized and expected inflation. No indications for long-term hedging capabilities of equity or commodities.	Rather slow adjustment process towards the equilibrium relation – slower compared to bonds
	No evidence for short-term hedging capabilities.
Portfolio Optimization	
Static national as well as global frontiers indicate absolute return enhancement capabilities of a real estate investment for less risk-averse investors.	Most spanning tests cannot find statically significant benefits of adding real estate.
Time-varying M Squared analysis and also the out-of-sample tests suggest that an extension can be beneficial during several time periods.	Out-of-sample-tests do not strongly promote an extension to real estate.
Weights substantiate great additional diversification benefits of real estate – also in low risk portfolios.	

Fig. 1: Commercial Real Estate Quadrants (p. 2)



+ Transparency
+ Liquidity / Transaction Costs
+ Accessible for Retail Investors
+ International Investments possible

Fig. 2: Research Question and Subquestions (p. 2)

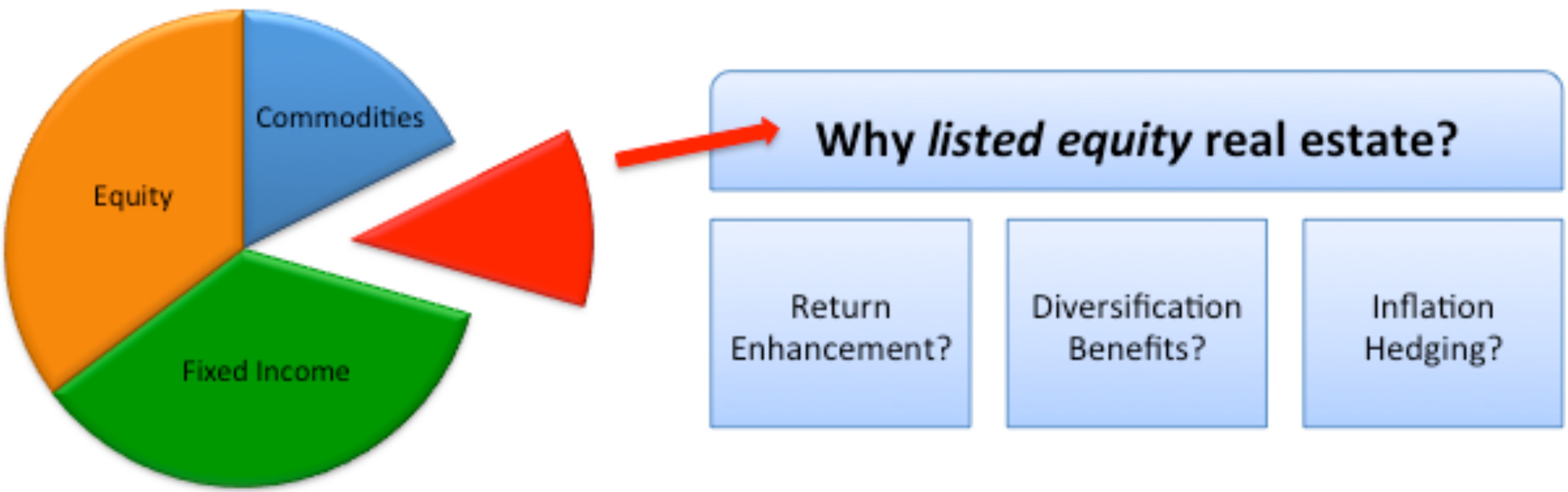


Fig. 3: Cumulative Return – GPR Indices (p. 22)

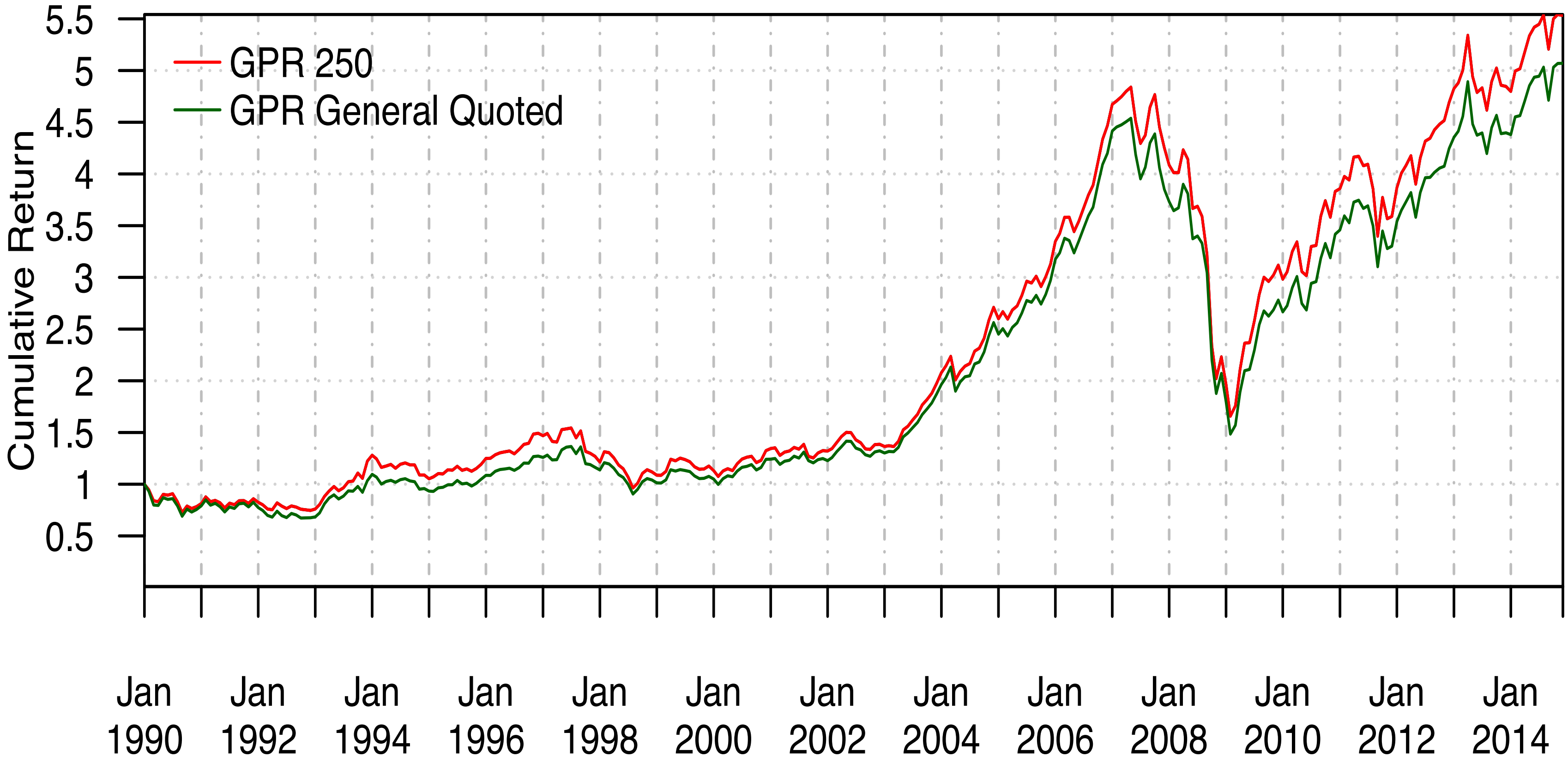


Fig. 4: National – Cumulative Returns (p. 26)

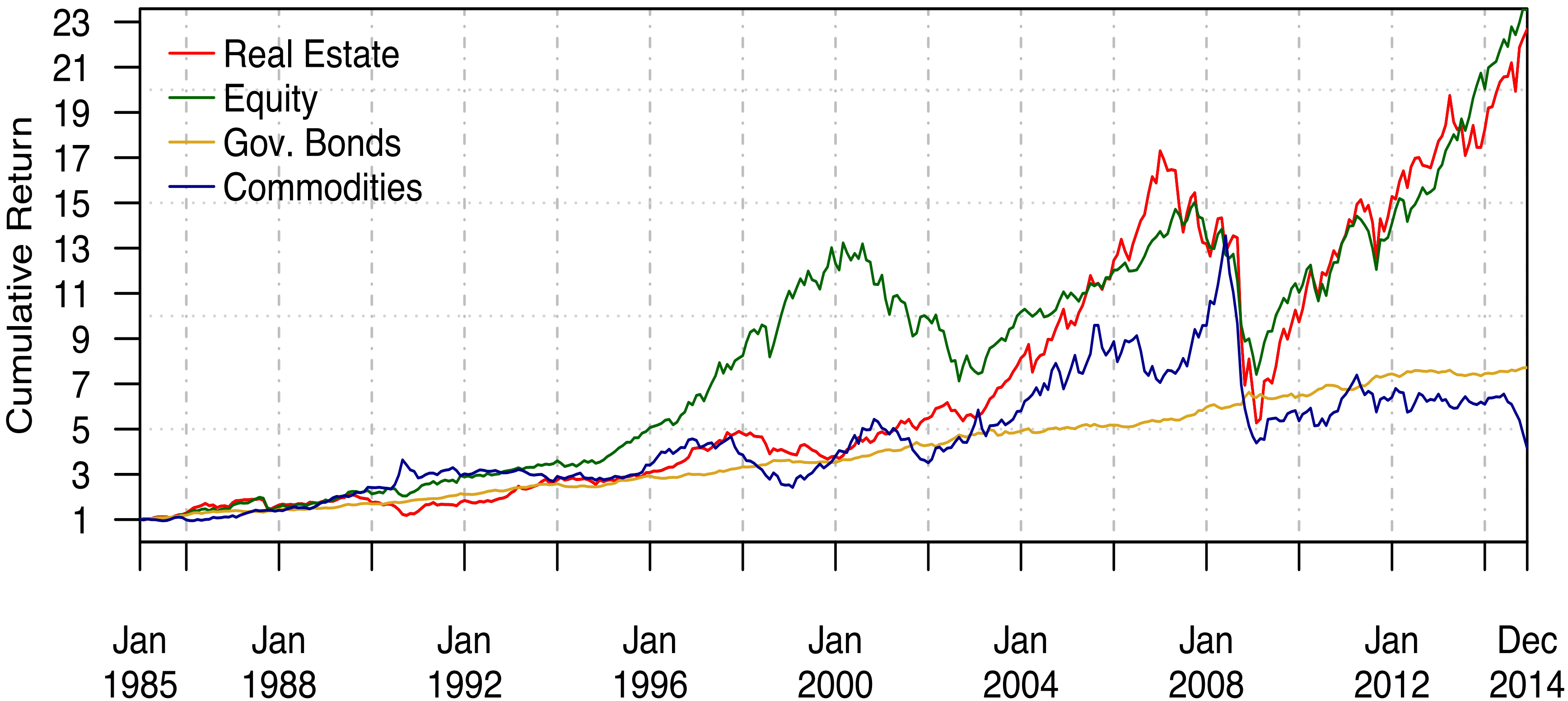


Fig. 5: National – Histograms (p. 27)

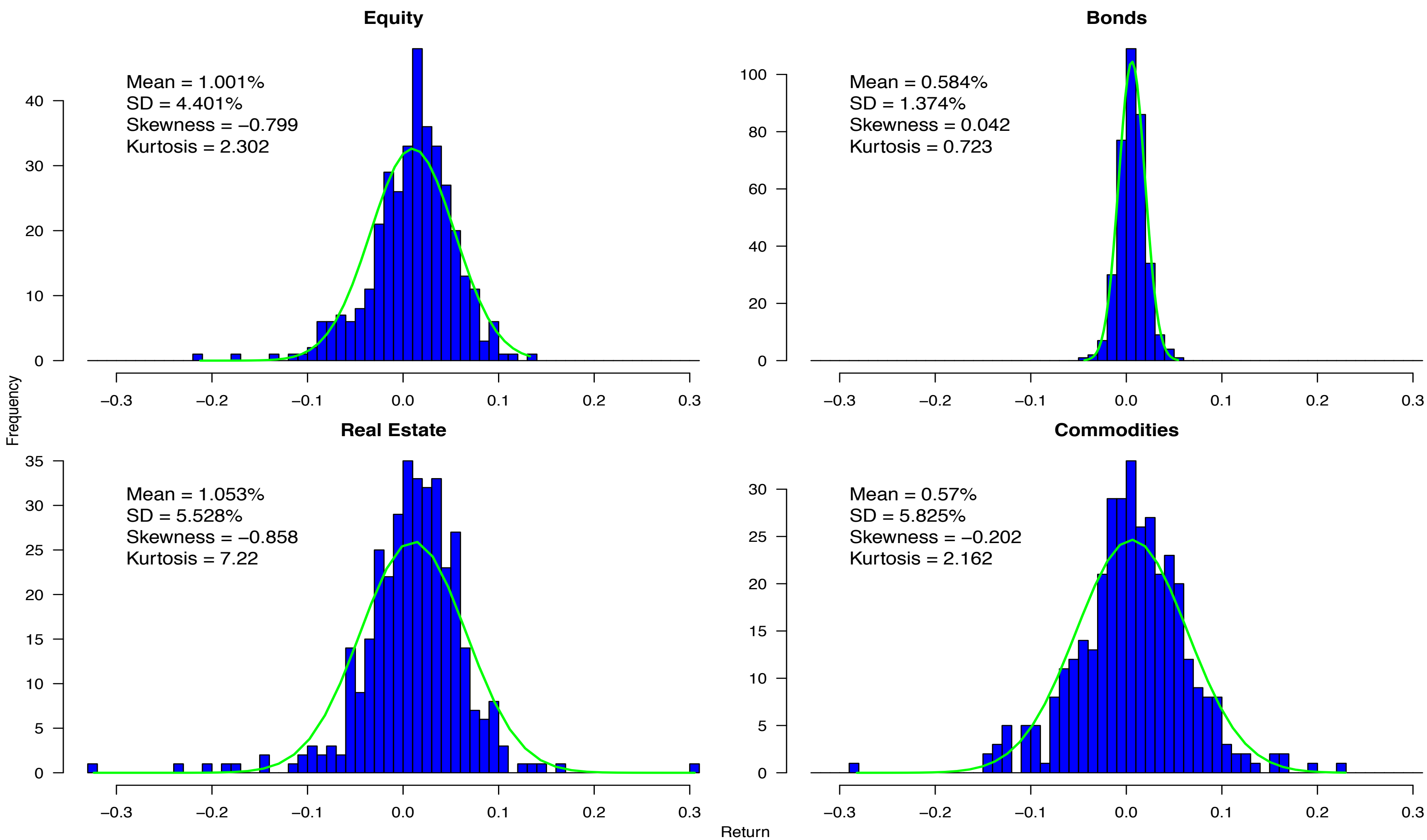


Fig. 6: National – Monthly Returns of Real Estate over Time (p. 28)

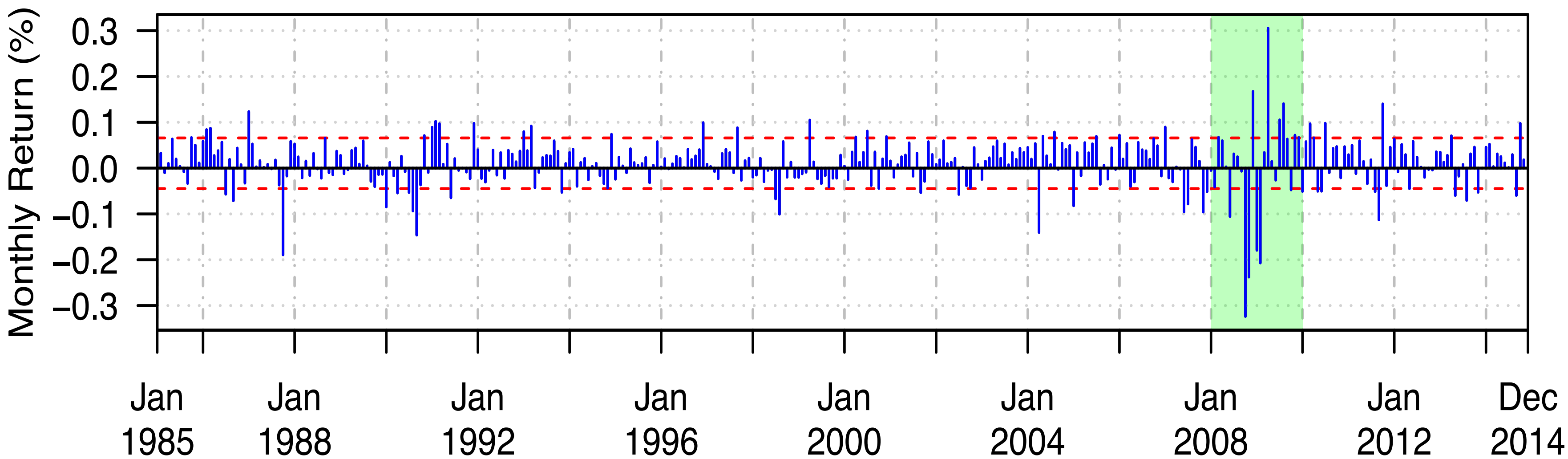


Fig. 7: National – Alphas of rolling Regressions (p. 30)

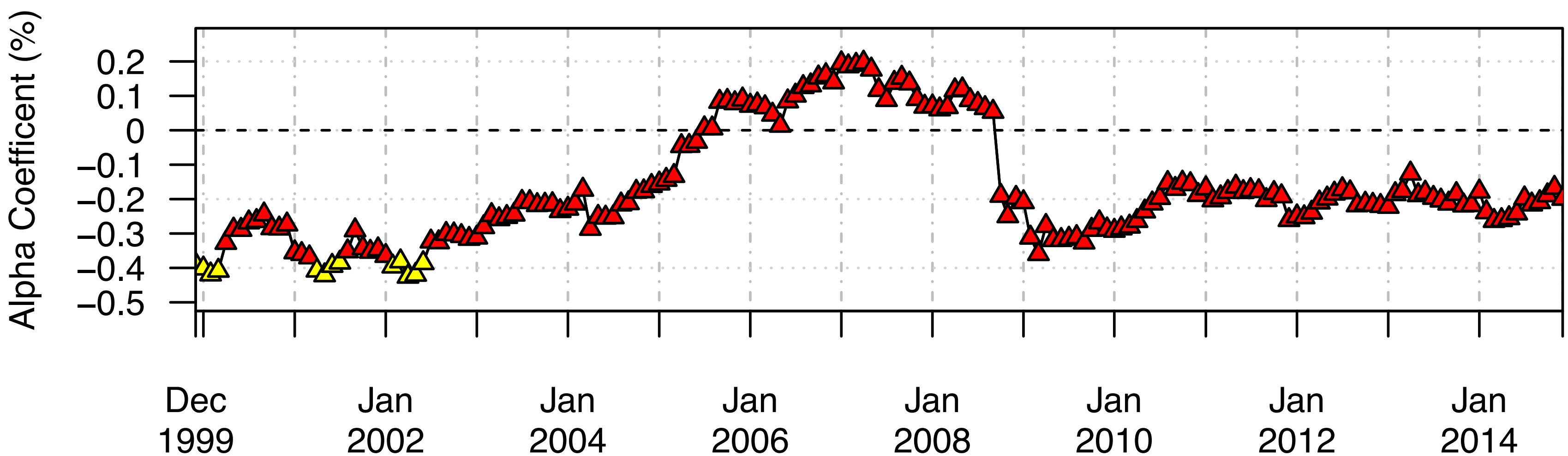


Fig. 8: National – Time-Varying Mean Returns (p.31)

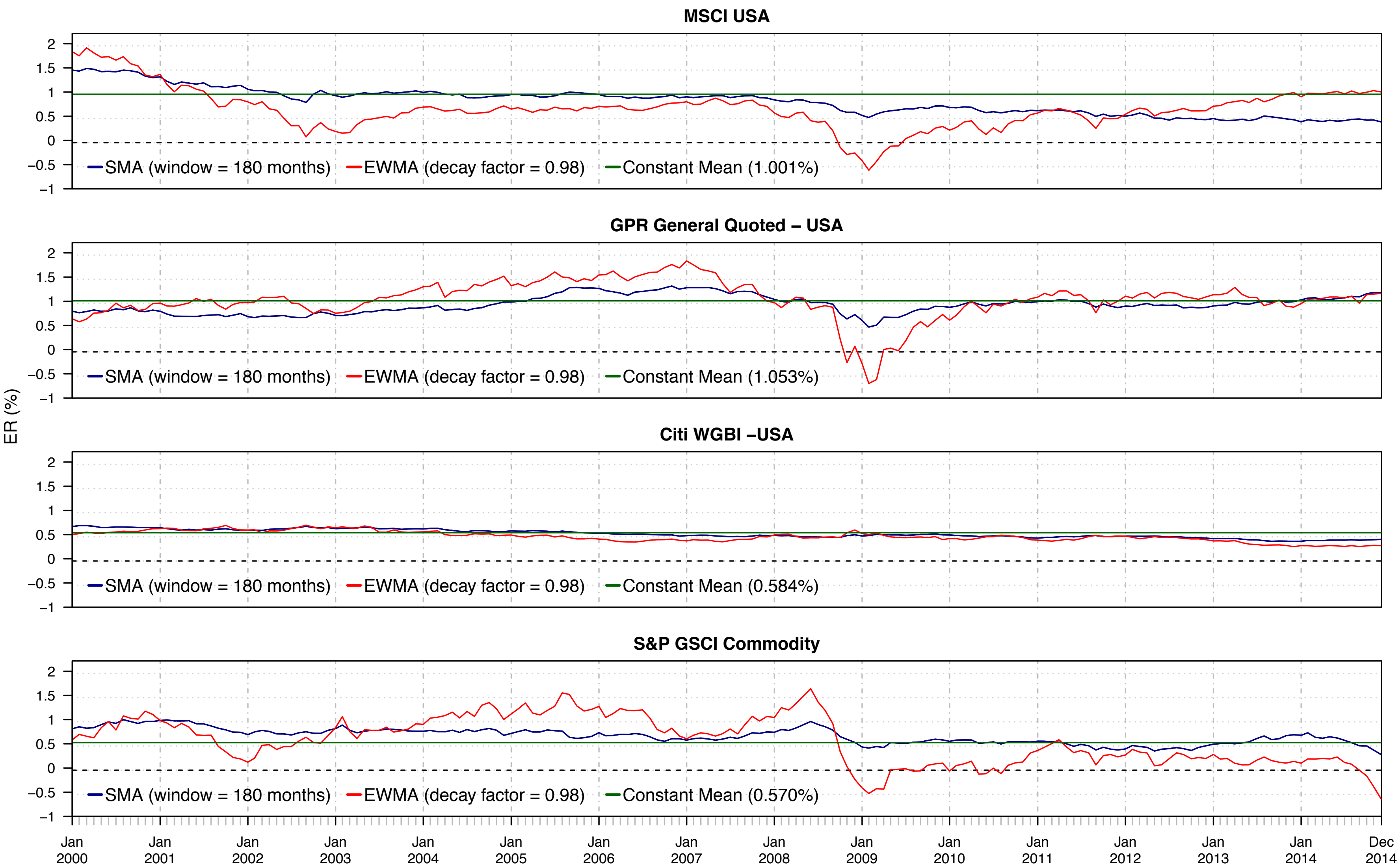


Fig. 9: National – Term Structure of Risk (p. 33)

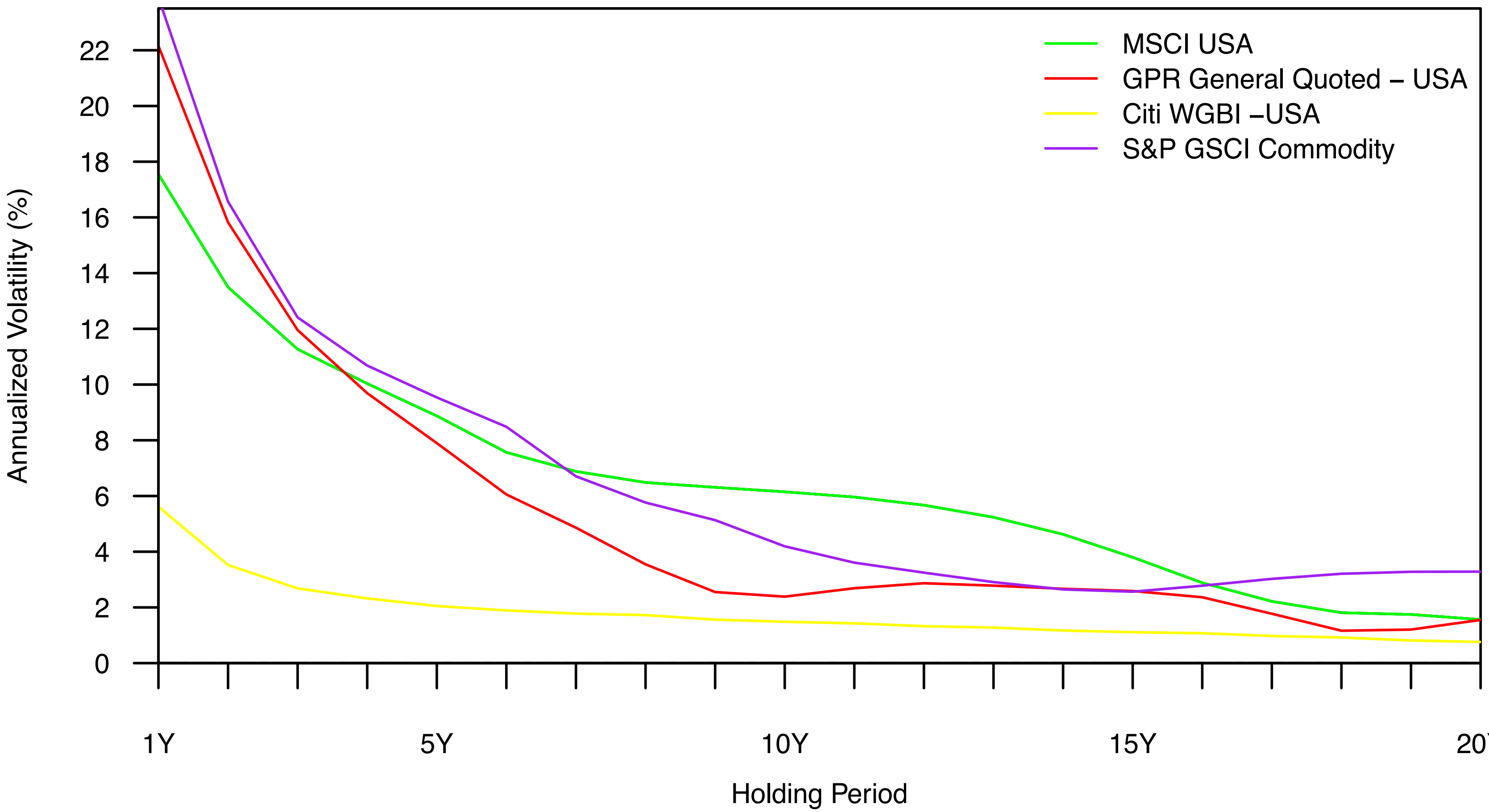


Fig. 10: National – Correlations with Real Estate (p. 34)

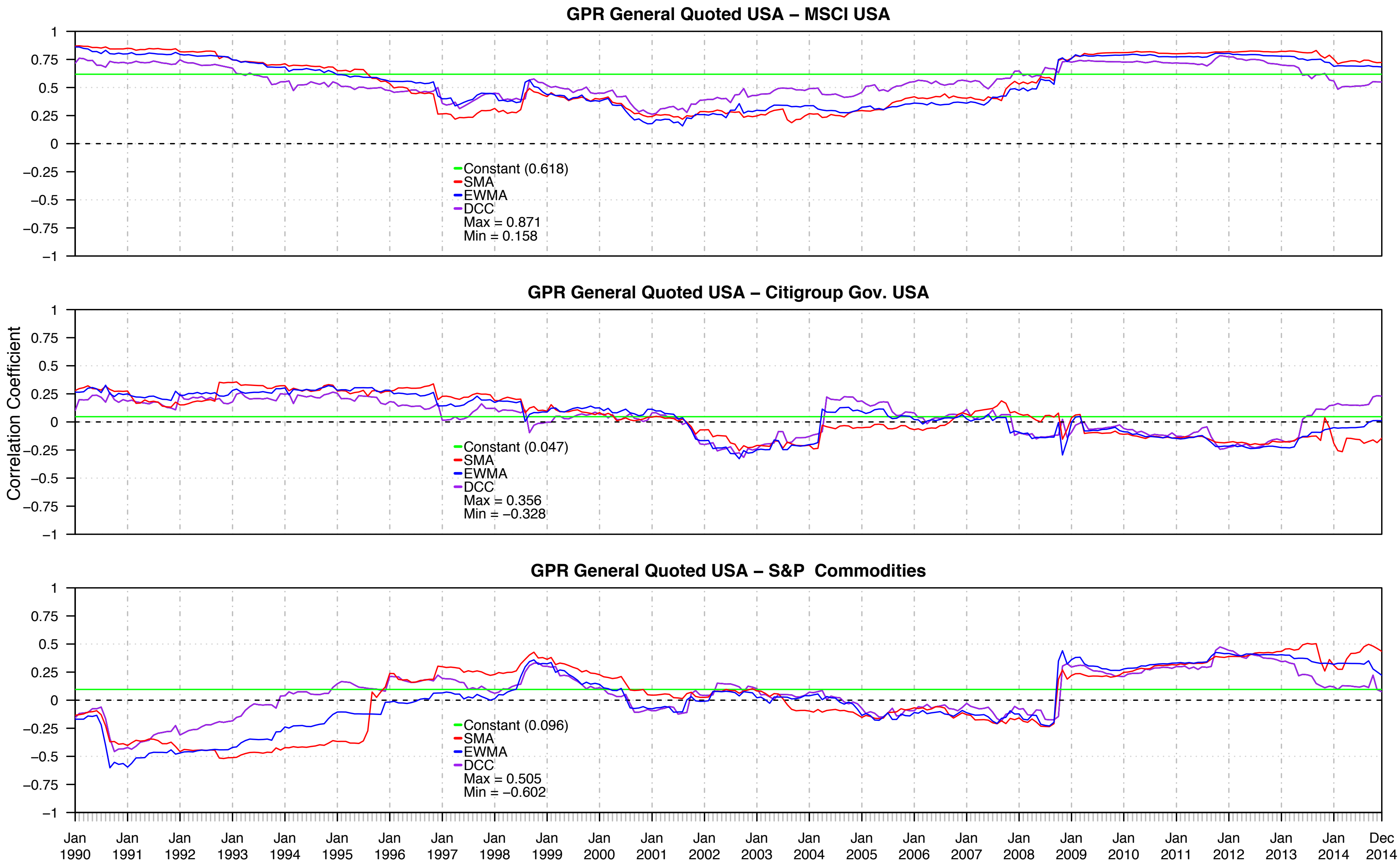


Fig. 11: National – Minimum annualized returns depending on the holding period (p. 35)

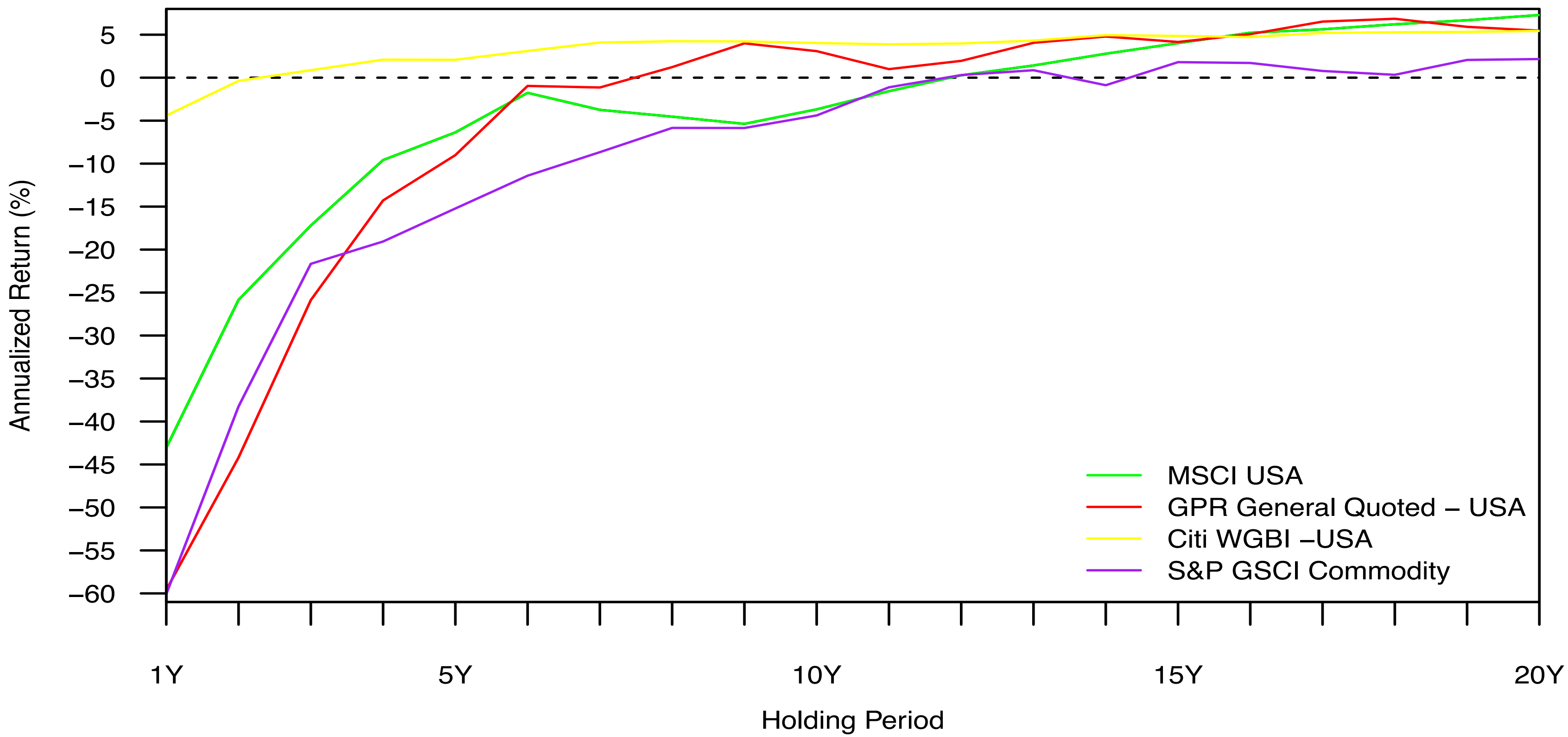
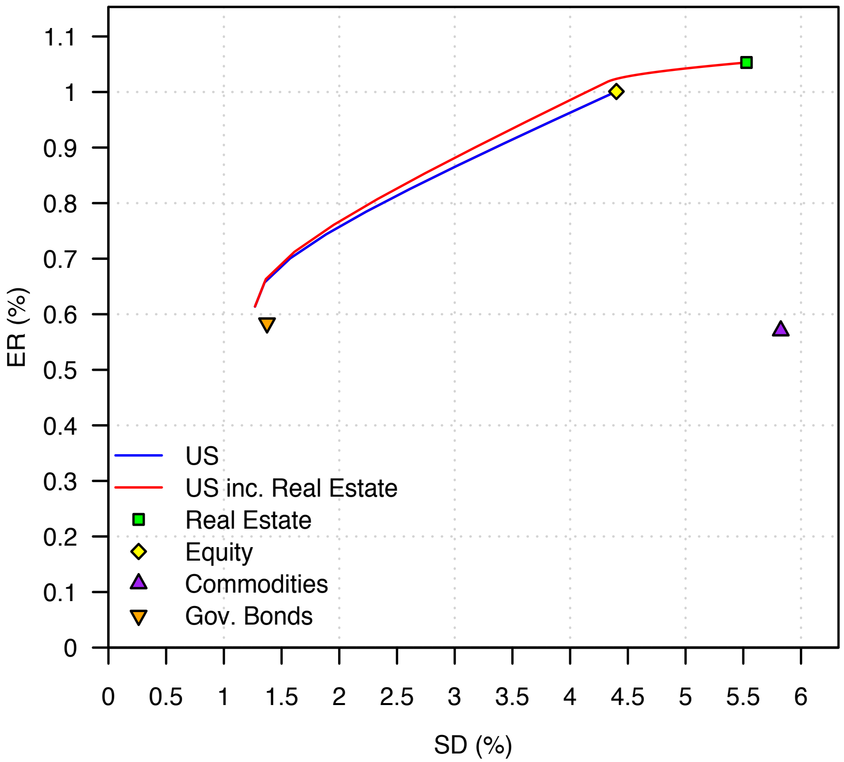


Fig. 12: National – Efficient Frontiers (p. 36)



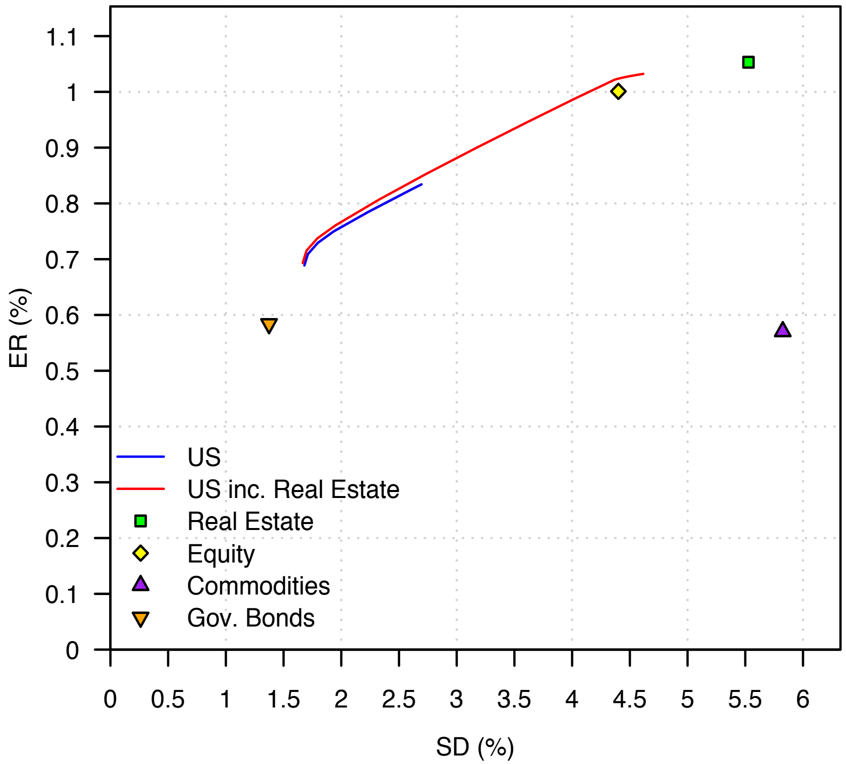


Fig. 13: National – Optimal Weights (p. 37)

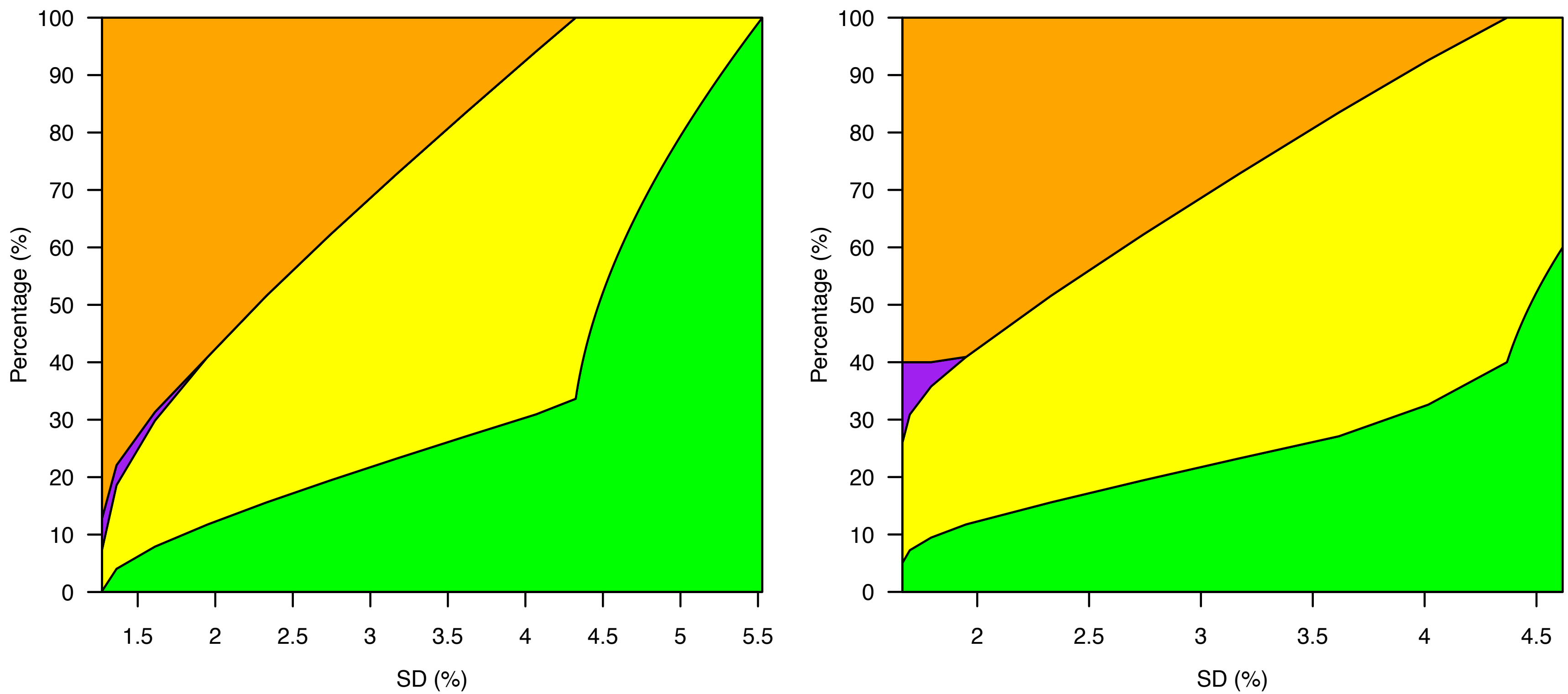


Fig. 14: National – Time-Varying M Squared (p. 38)

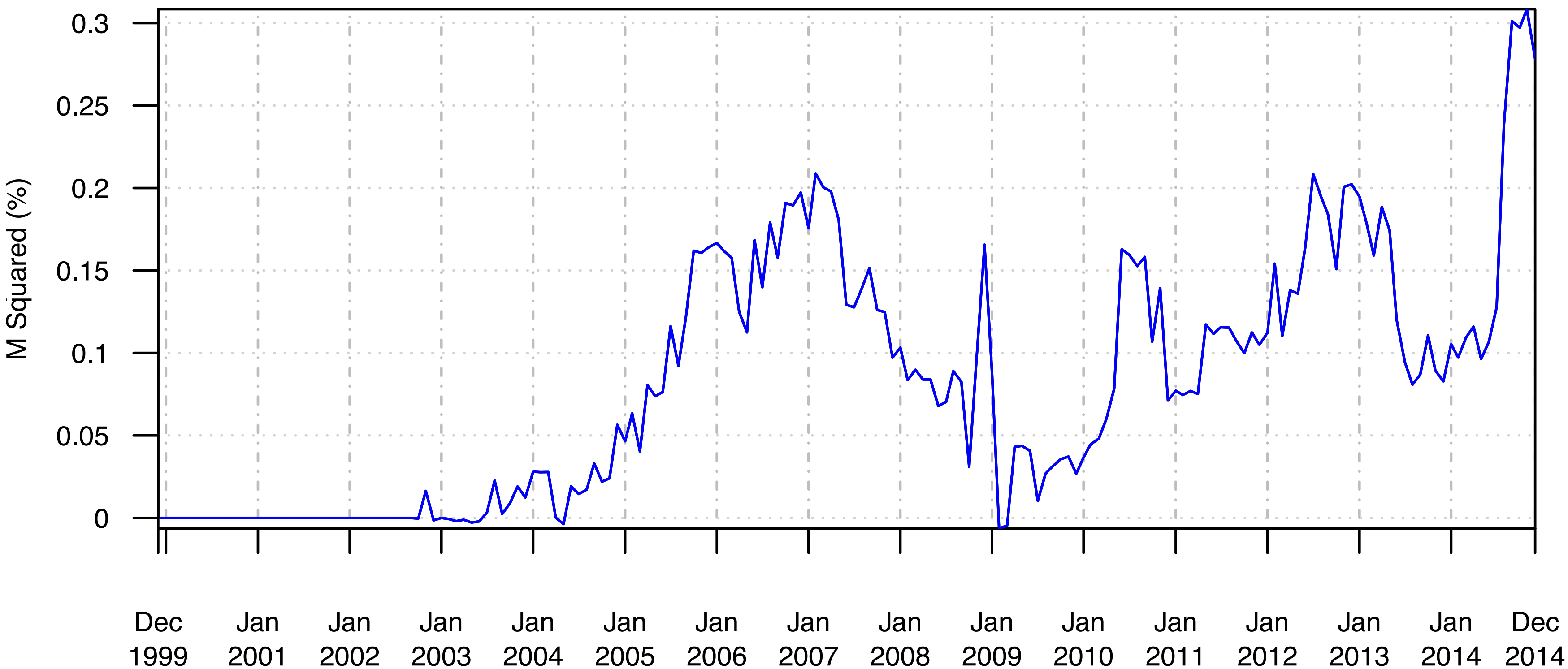


Fig. 15: National – Cumulative Returns of optimized Portfolios (Fixed Window) (p. 39)

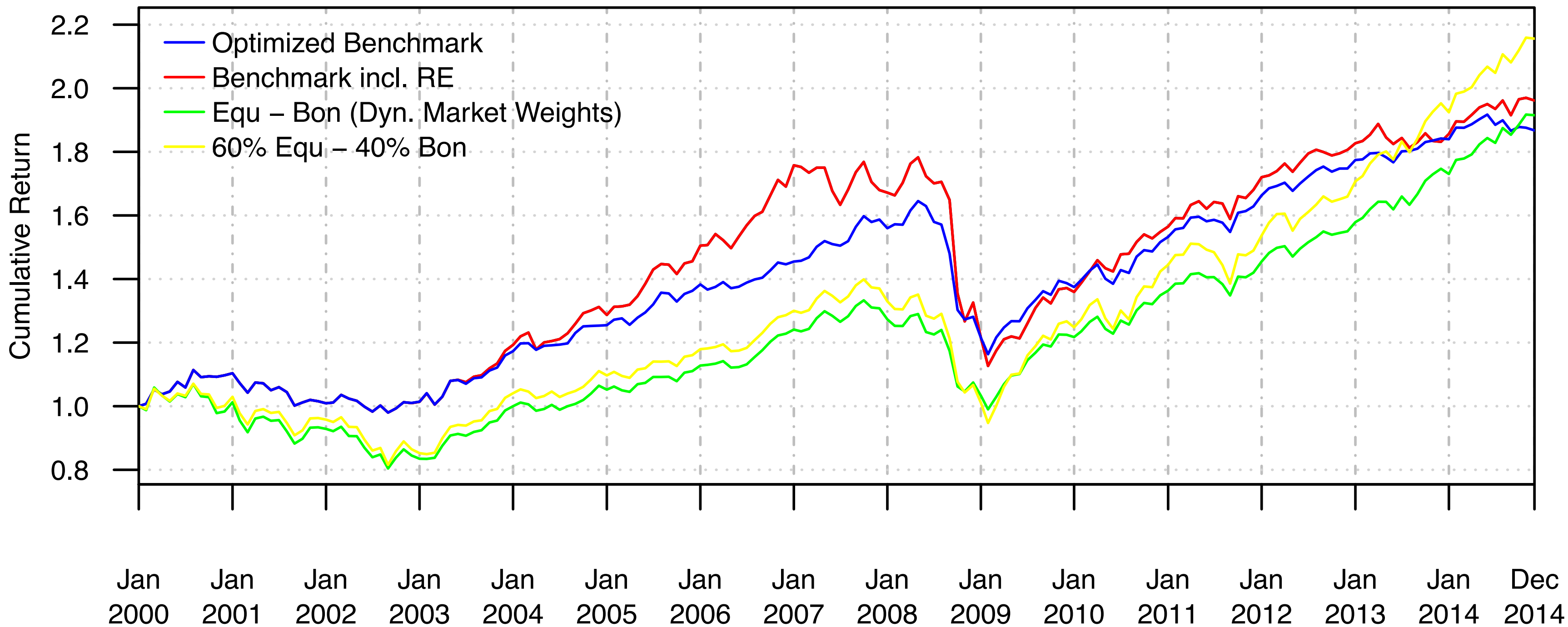


Fig. 16: National – Cumulative Returns of optimized Portfolios (Recursive) (p. 40)

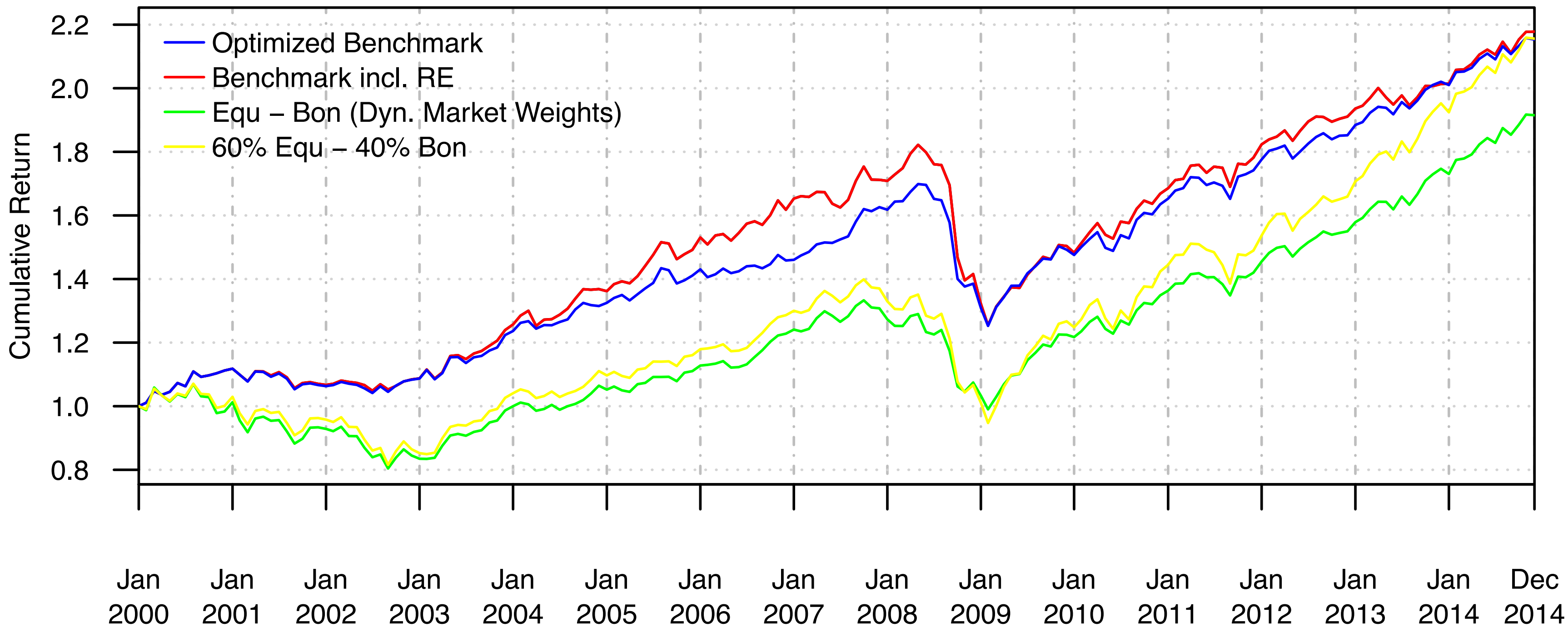


Fig. 17: National – Coefficients of expected Inflation from rolling Regressions (p. 43)

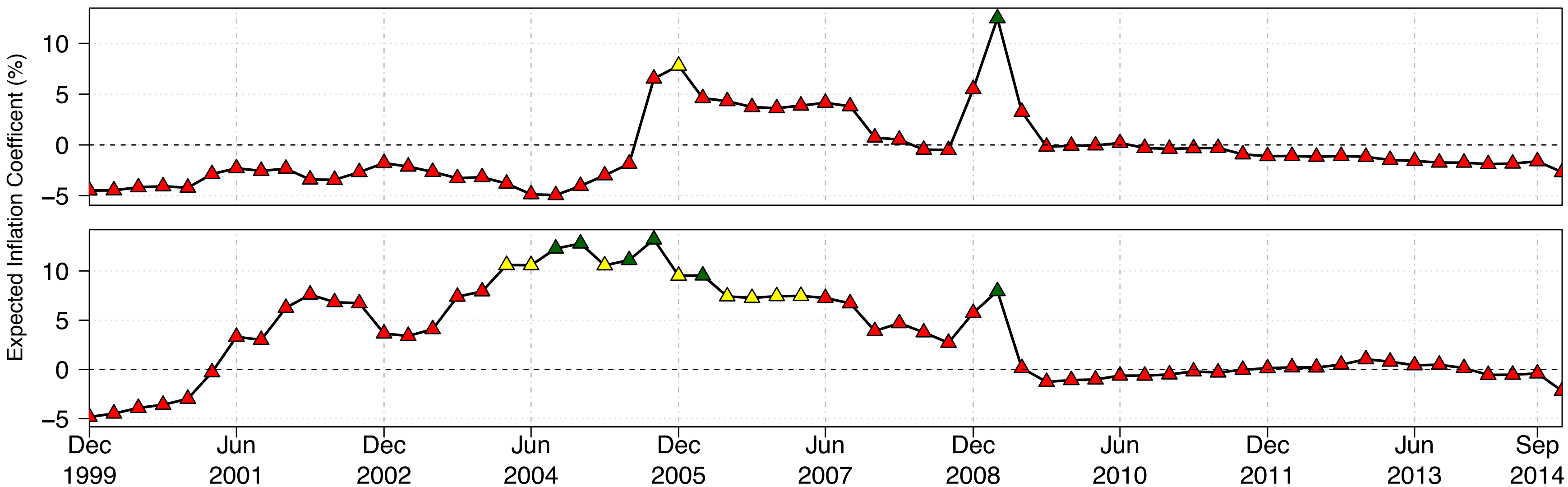


Fig. 18: Global – Cumulative Returns of global Indices (p. 47)

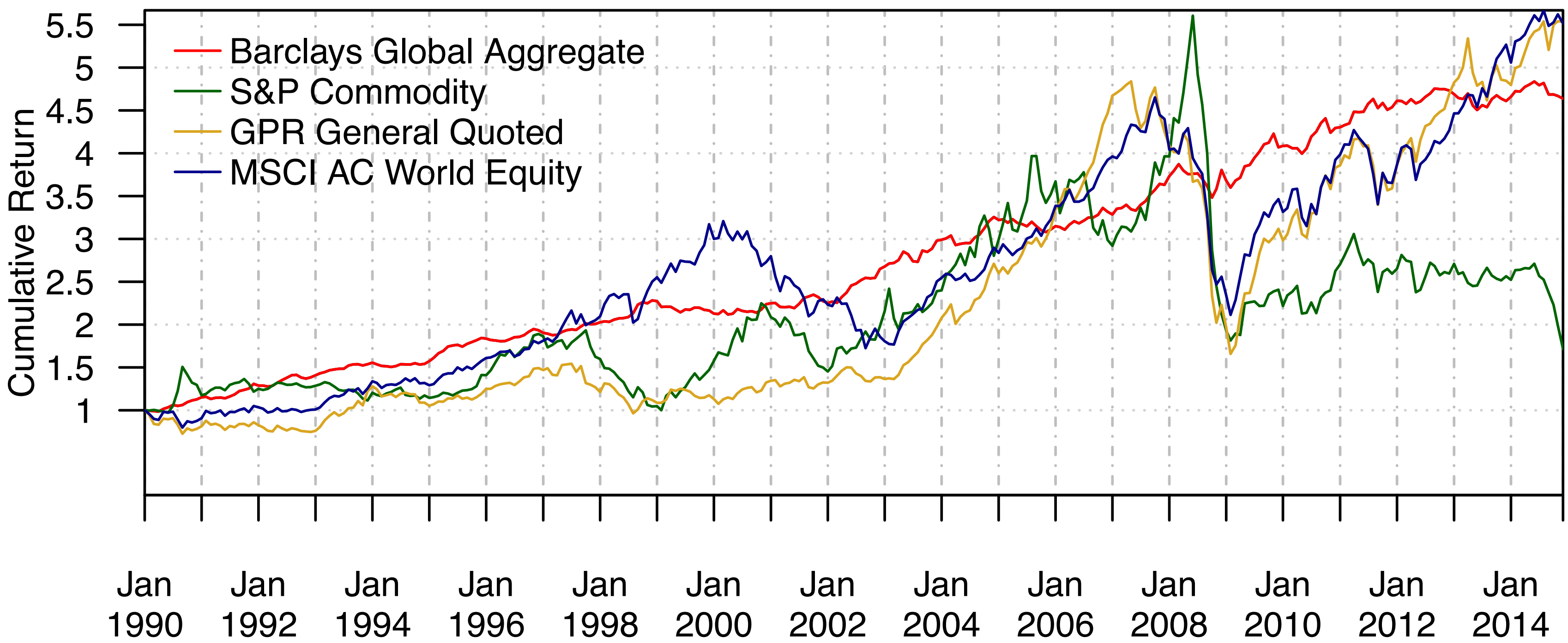


Fig. 19: Global – Alphas from rolling Regressions (p. 49)

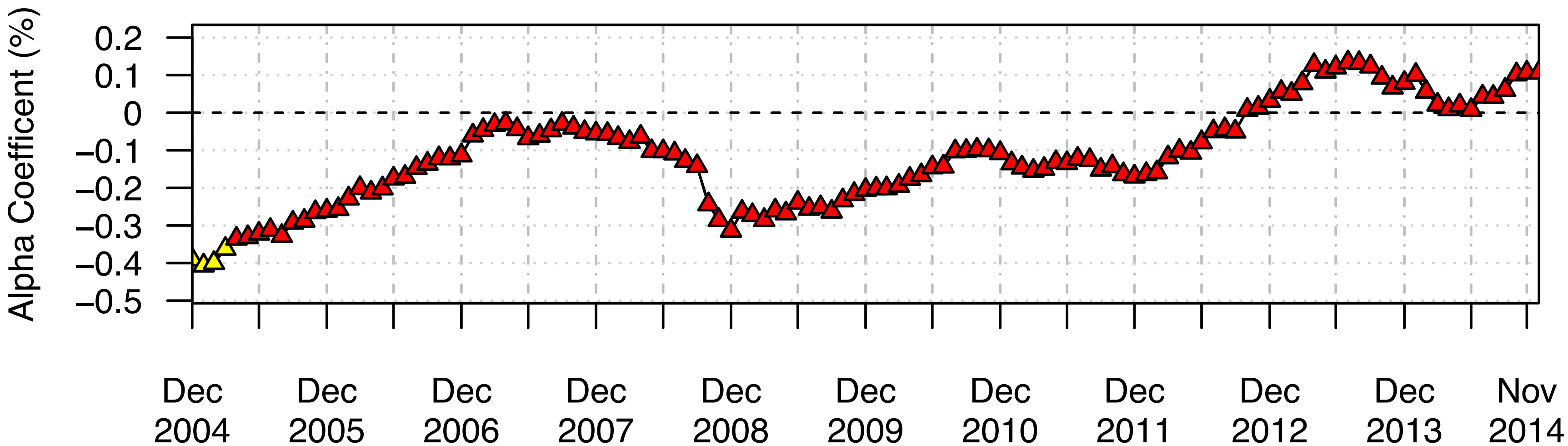


Fig. 20: Global – Histograms of Indices (p. 49)

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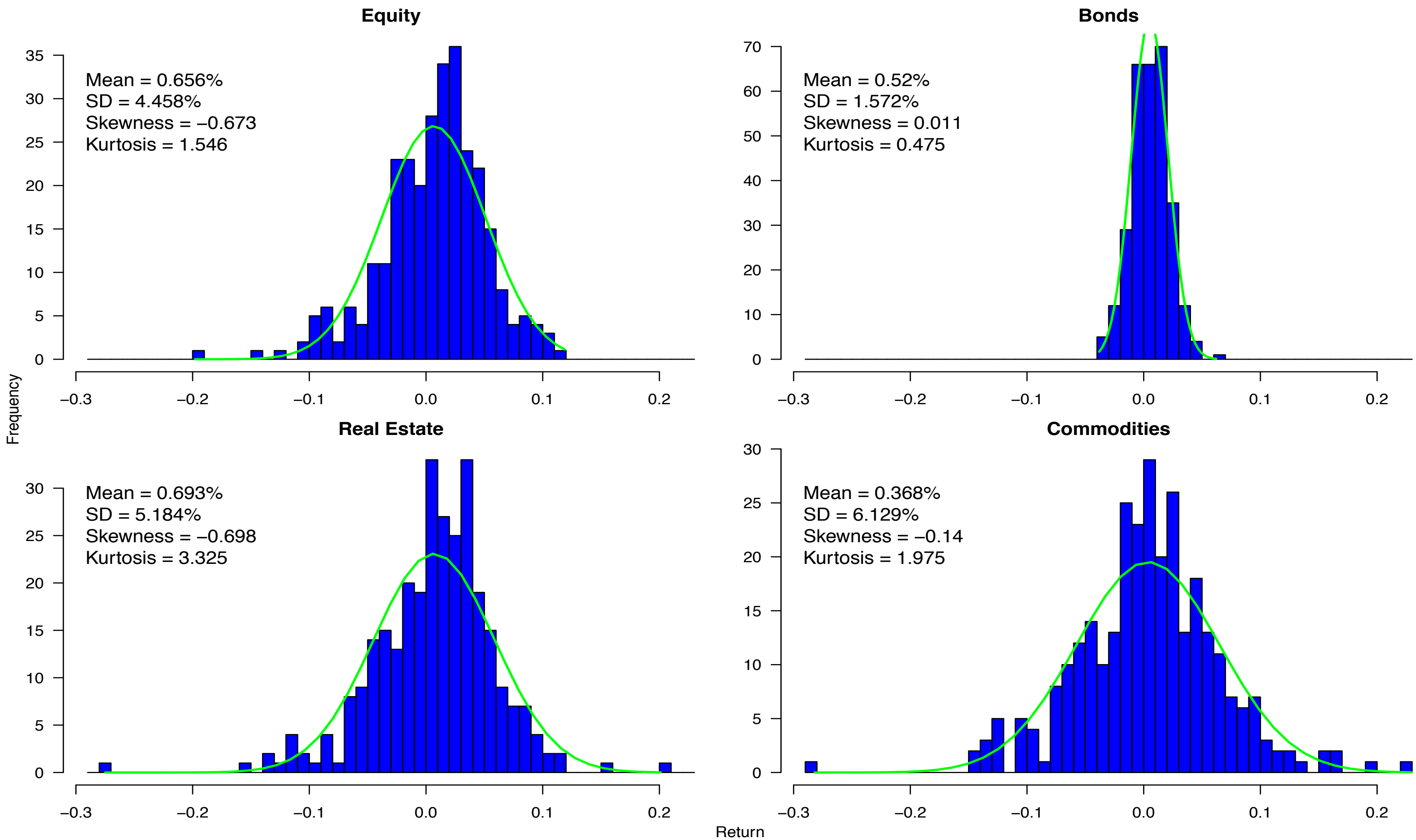

Fig. 21: Global – Correlations between Real Estate and Equity within Countries (p. 52)

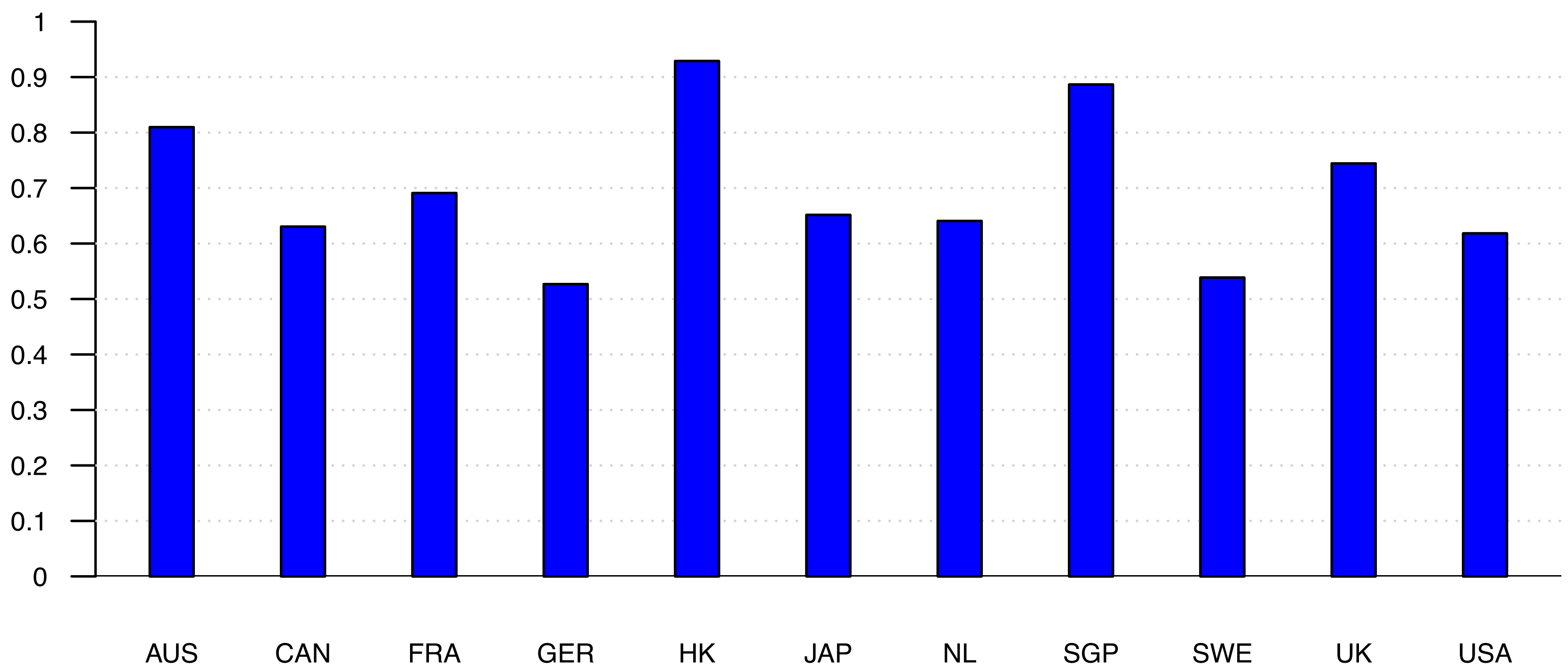

Fig. 22: Global – Correlations with Real Estate (p. 53)

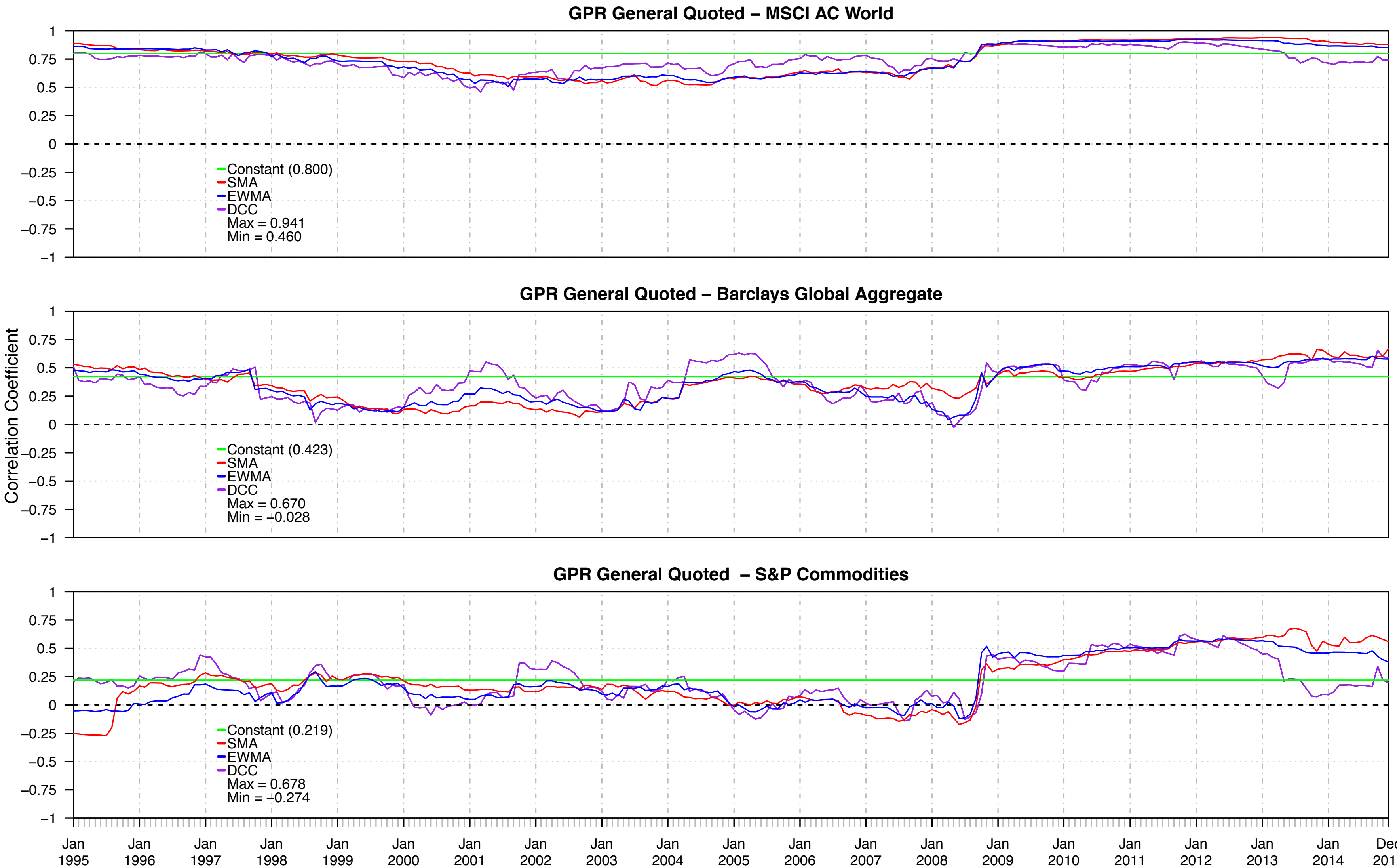

Fig. 23: Global – Term Structure of Risk (p. 55)

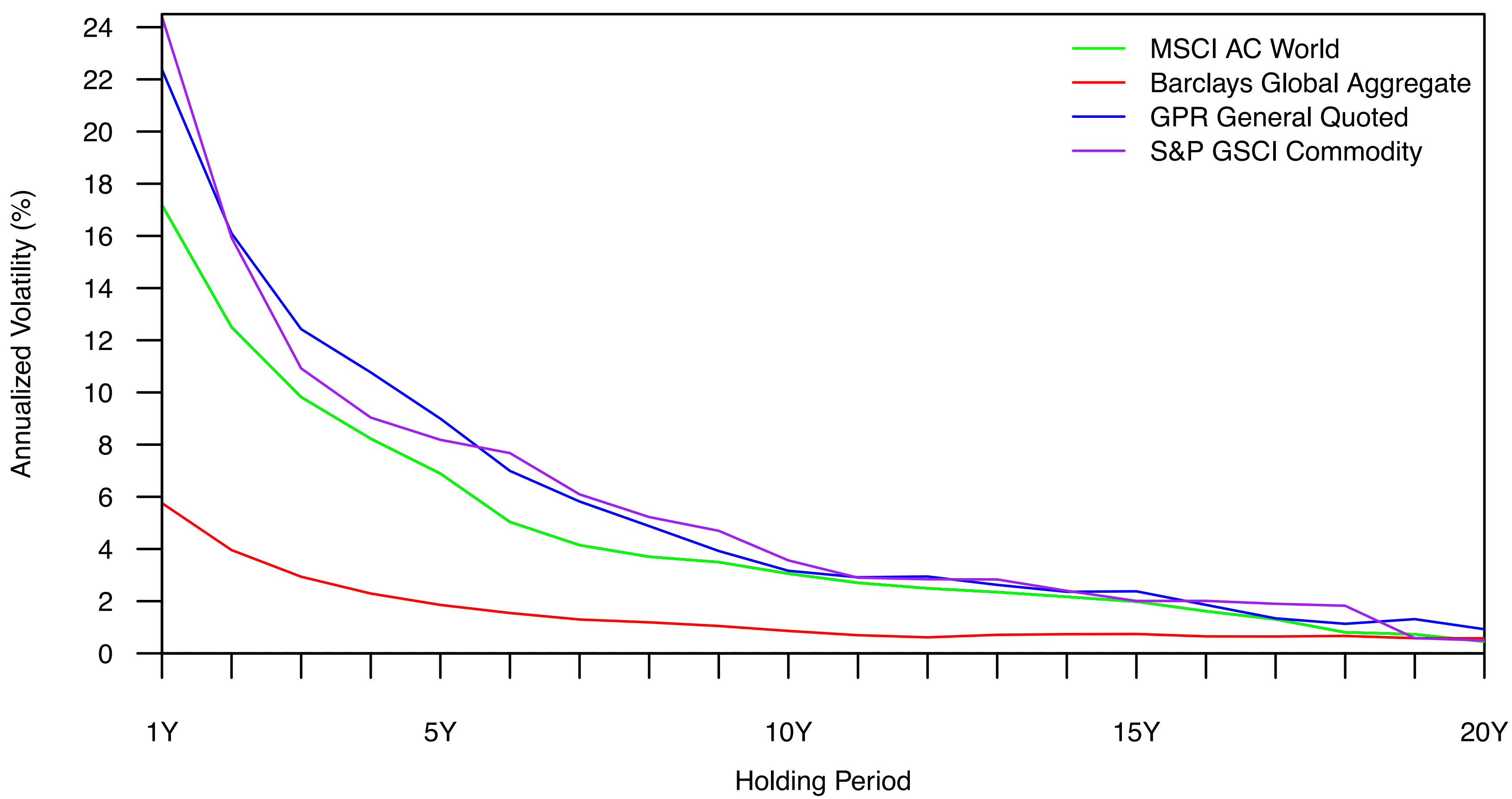

Fig. 24: Global – Minimum annualized Return depending on the Holding Period (p. 56)

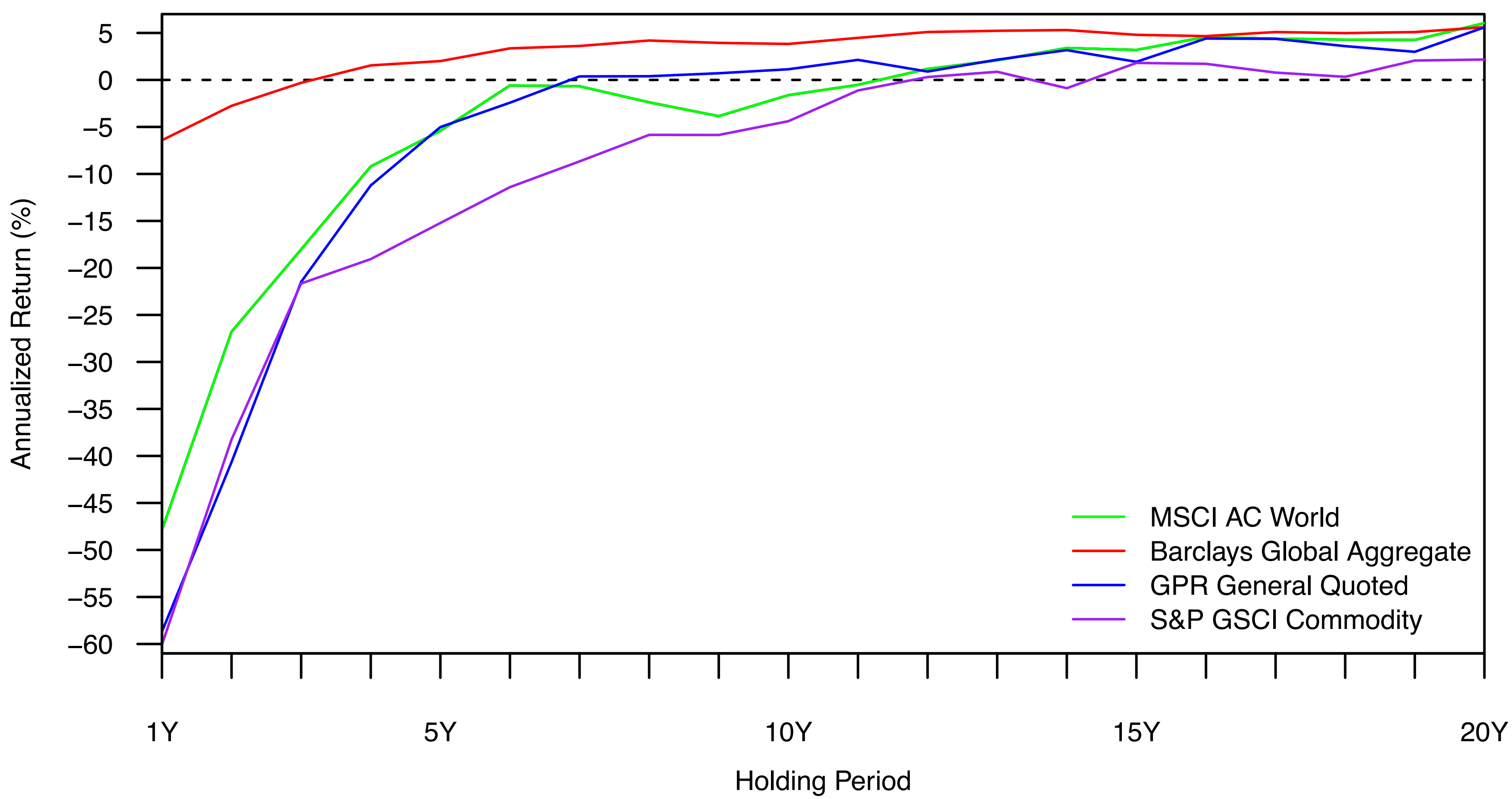

Fig. 25: Global – Efficient Frontiers for broad Indices (p. 57)

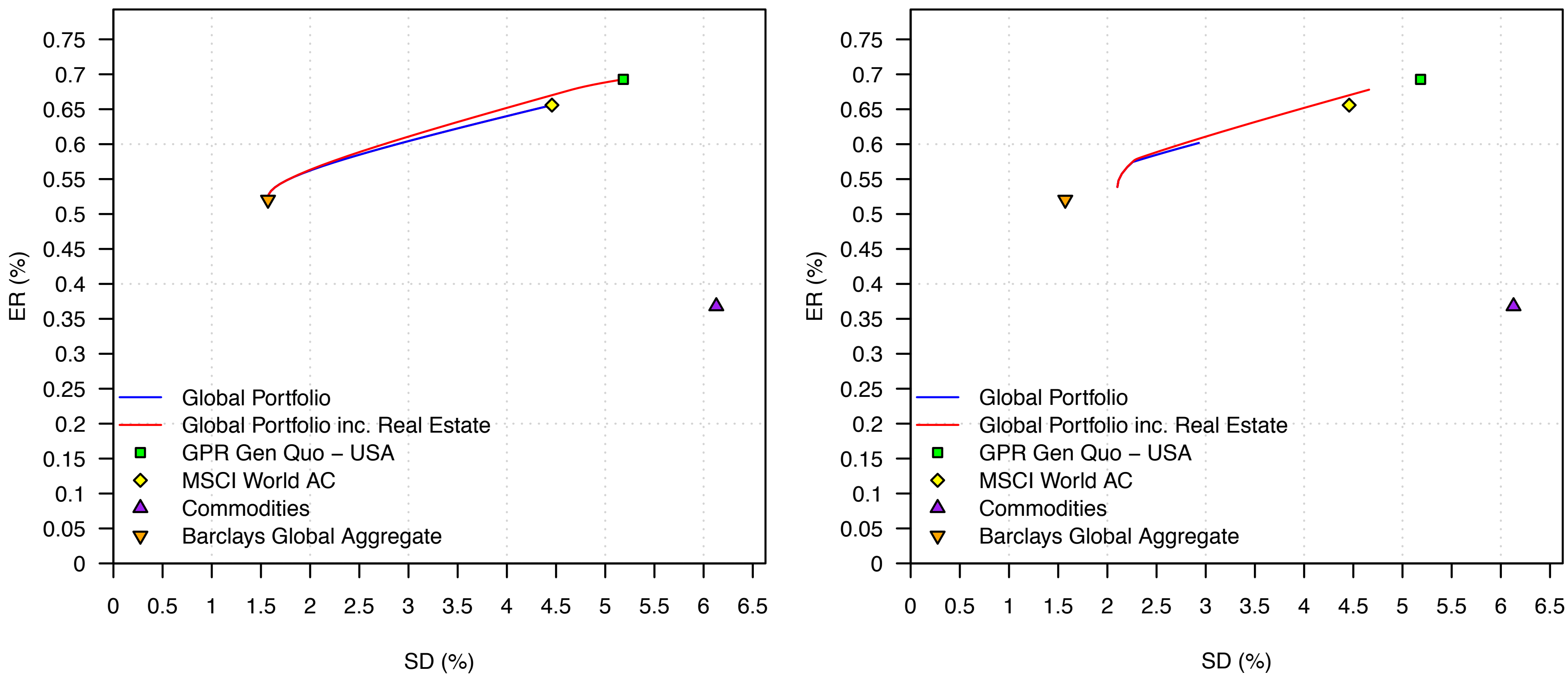

Fig. 26: Global – Optimal Weights for broad Indices (p. 58)

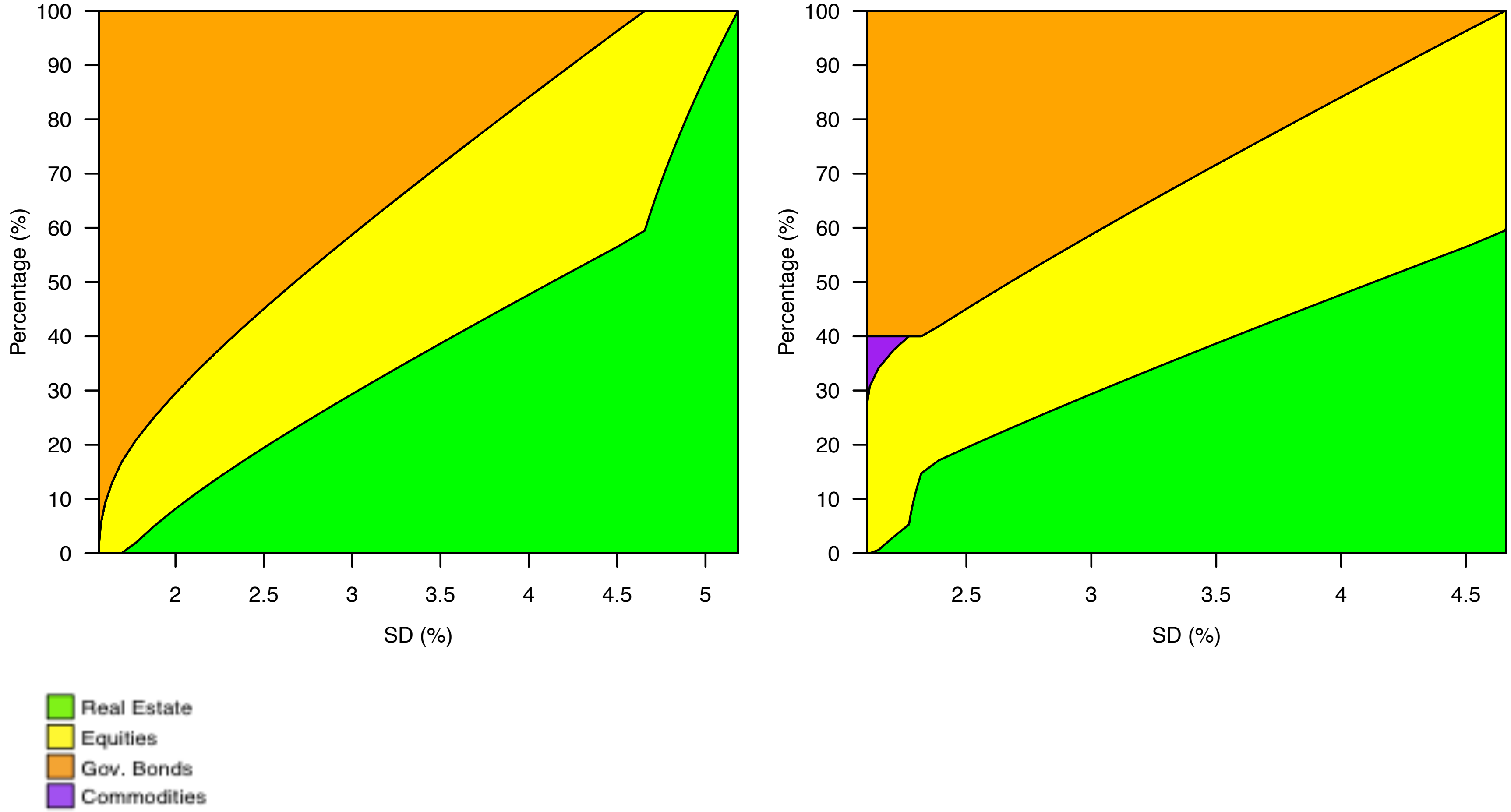

Fig. 27: Global – Efficient Frontiers for Country Indices (A) (p. 58)

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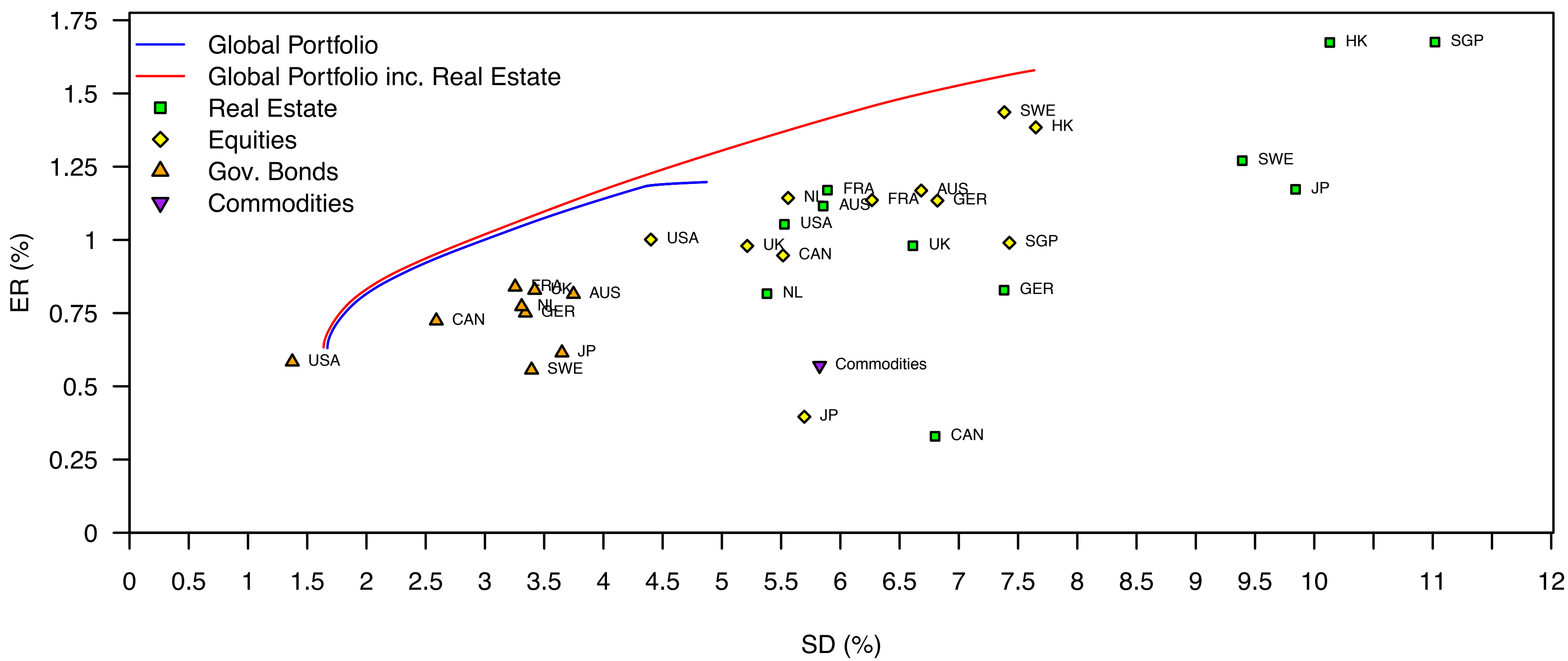


Fig. 28: Global – Optimal Asset Class Weights for Country Indices (p. 59)

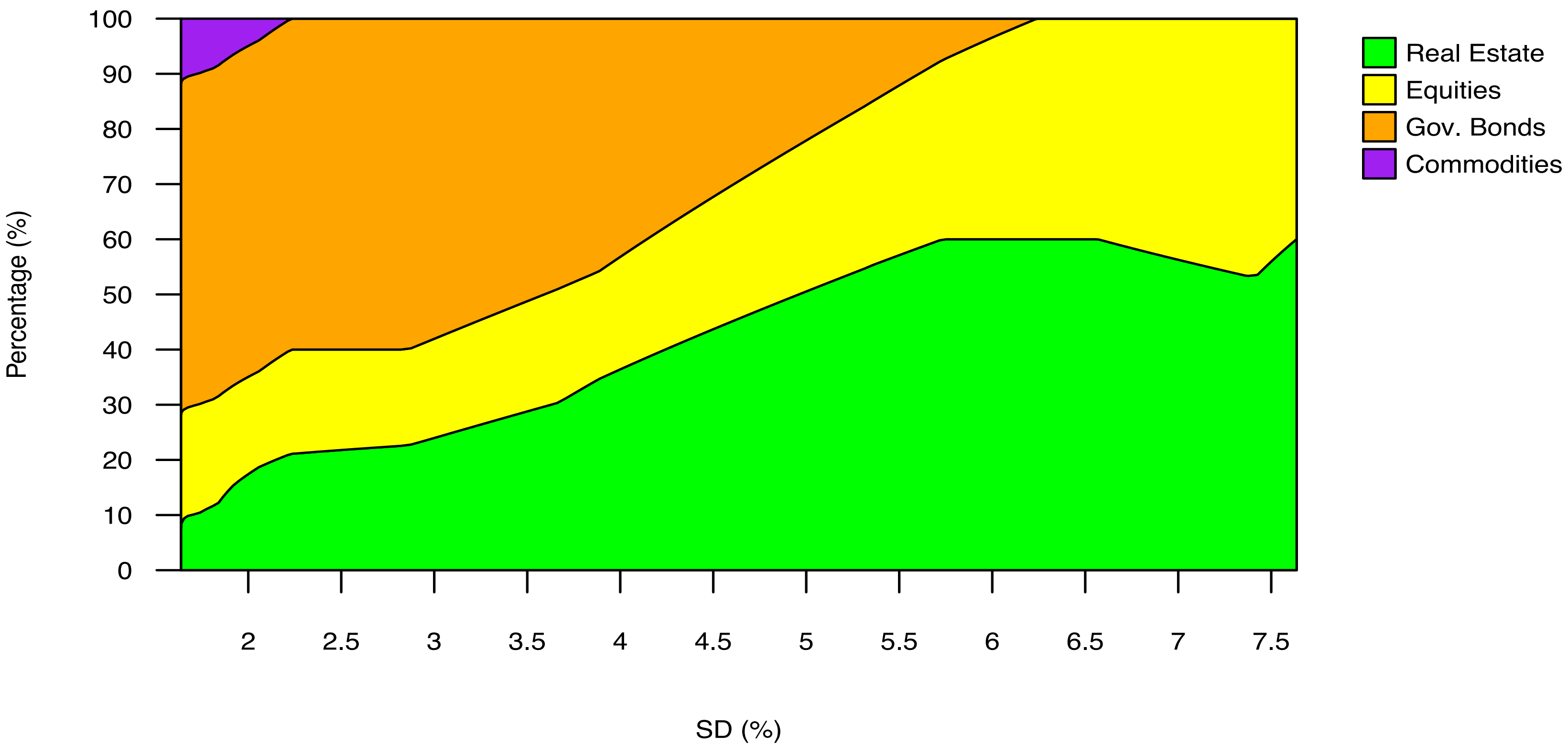


Fig. 29: Global – Optimal Country Weights of the Real Estate Portfolio (p. 60)

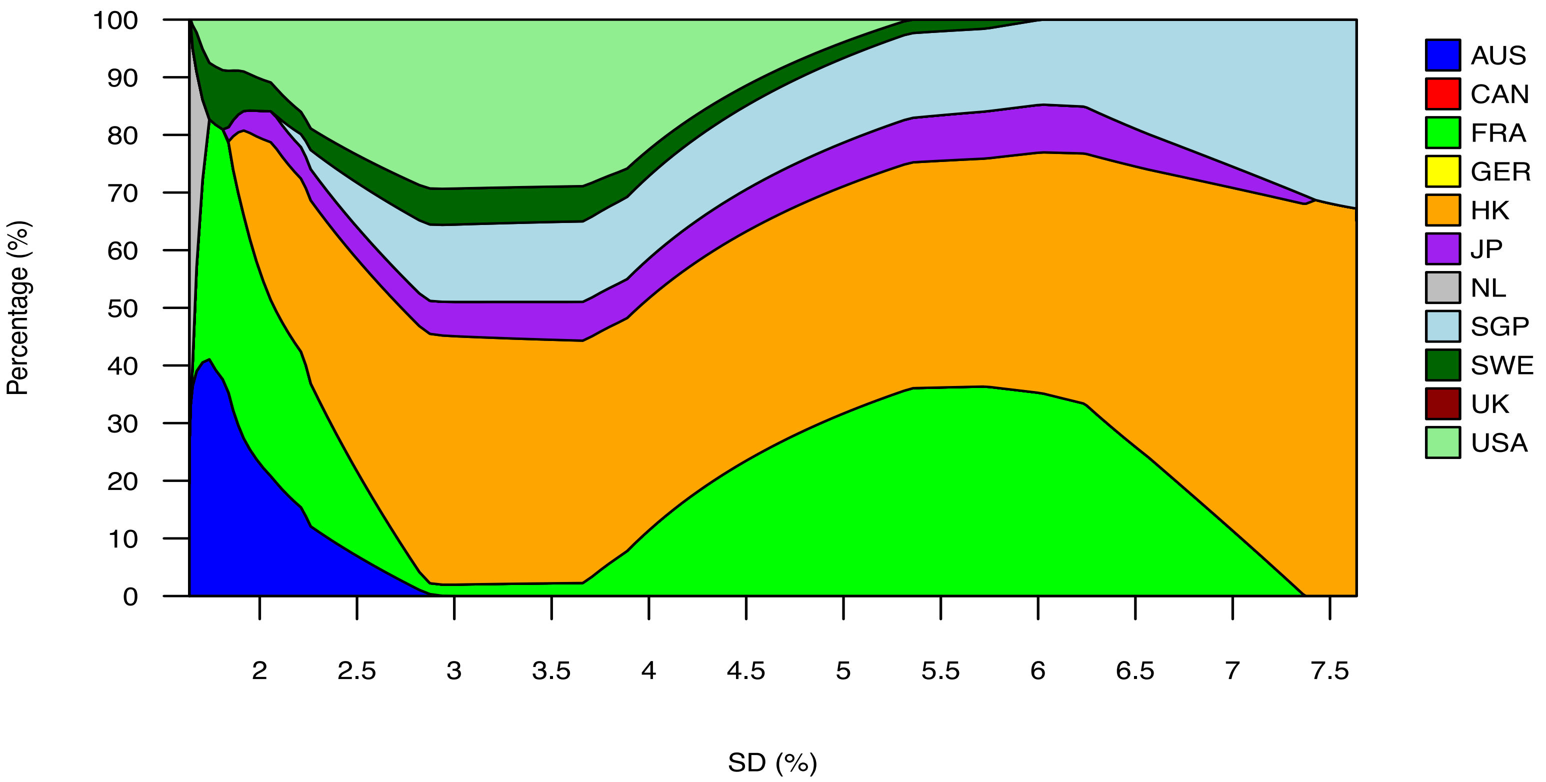


Fig. 30: Global – Time-Varying M Squared (A) (p. 61)

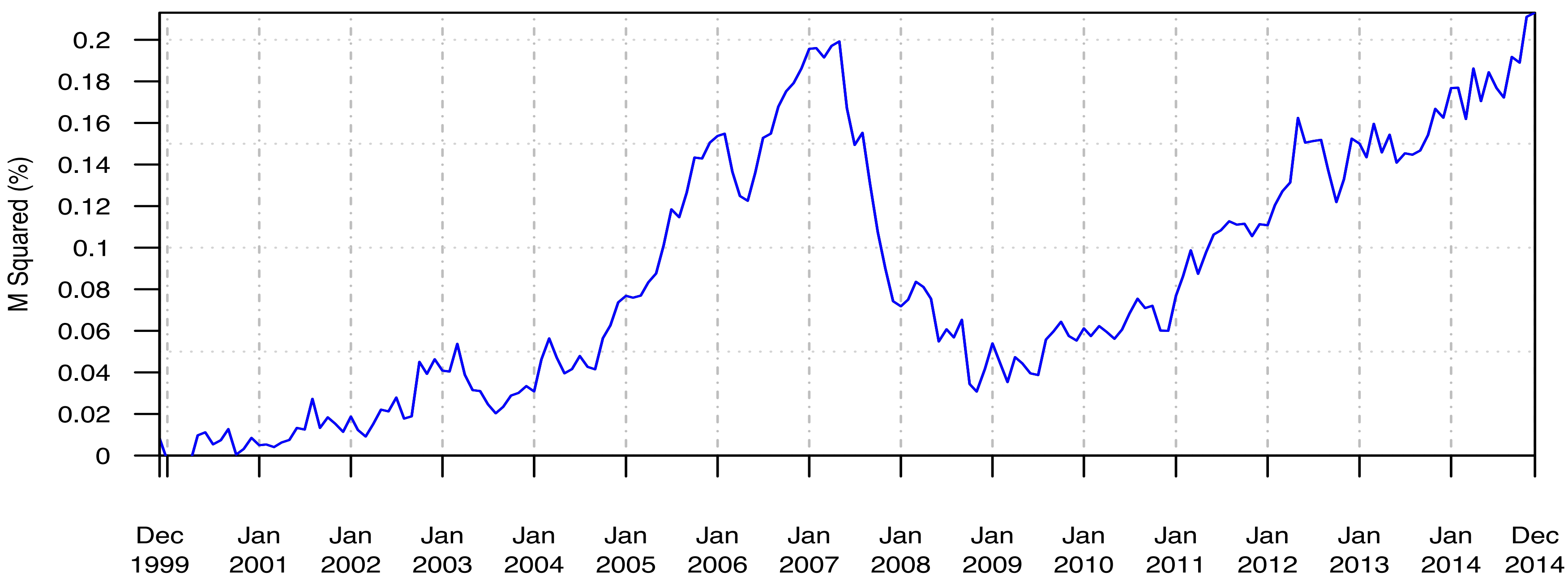


Fig. 31: Global – Cumulative Returns of Optimized Portfolios (Fixed Window) (p. 62)

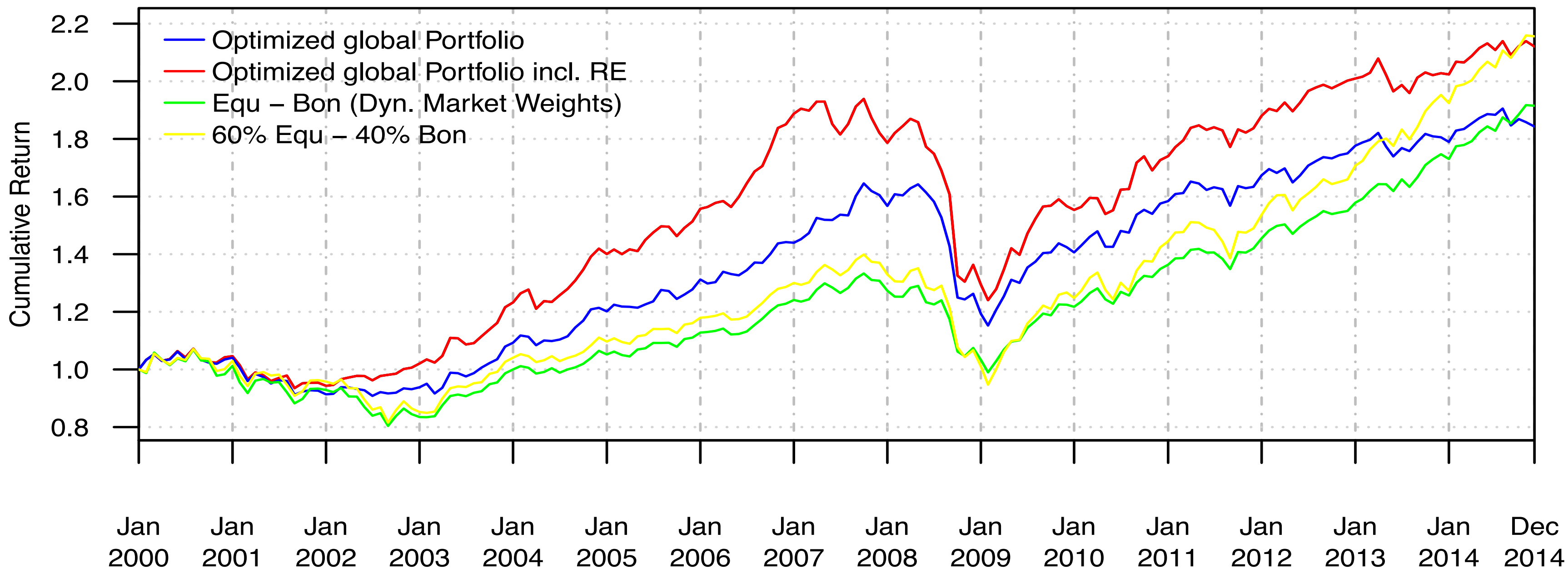


Fig. 32: Global – Cumulative Returns of Optimized Portfolios (Recursive) (p. 62)

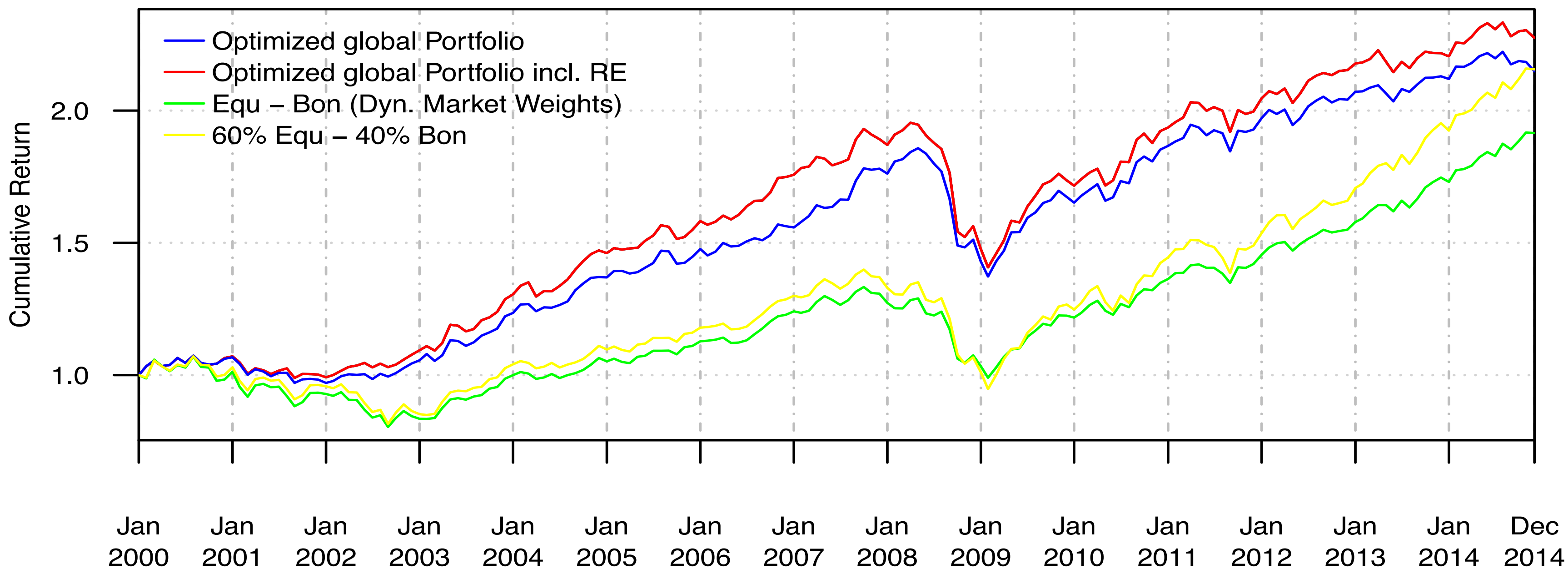


Fig. 33: Global – Efficient Frontiers for Country Indices (B) (p. 63)

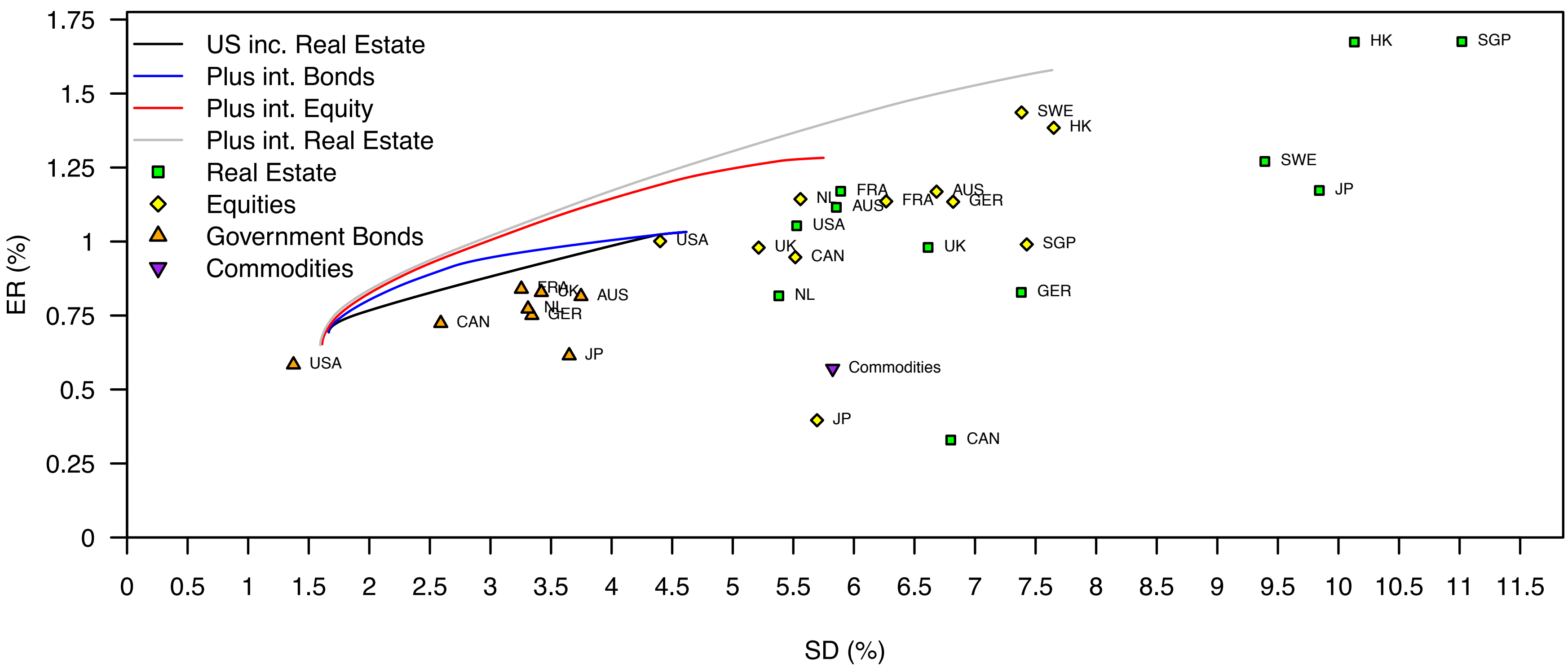
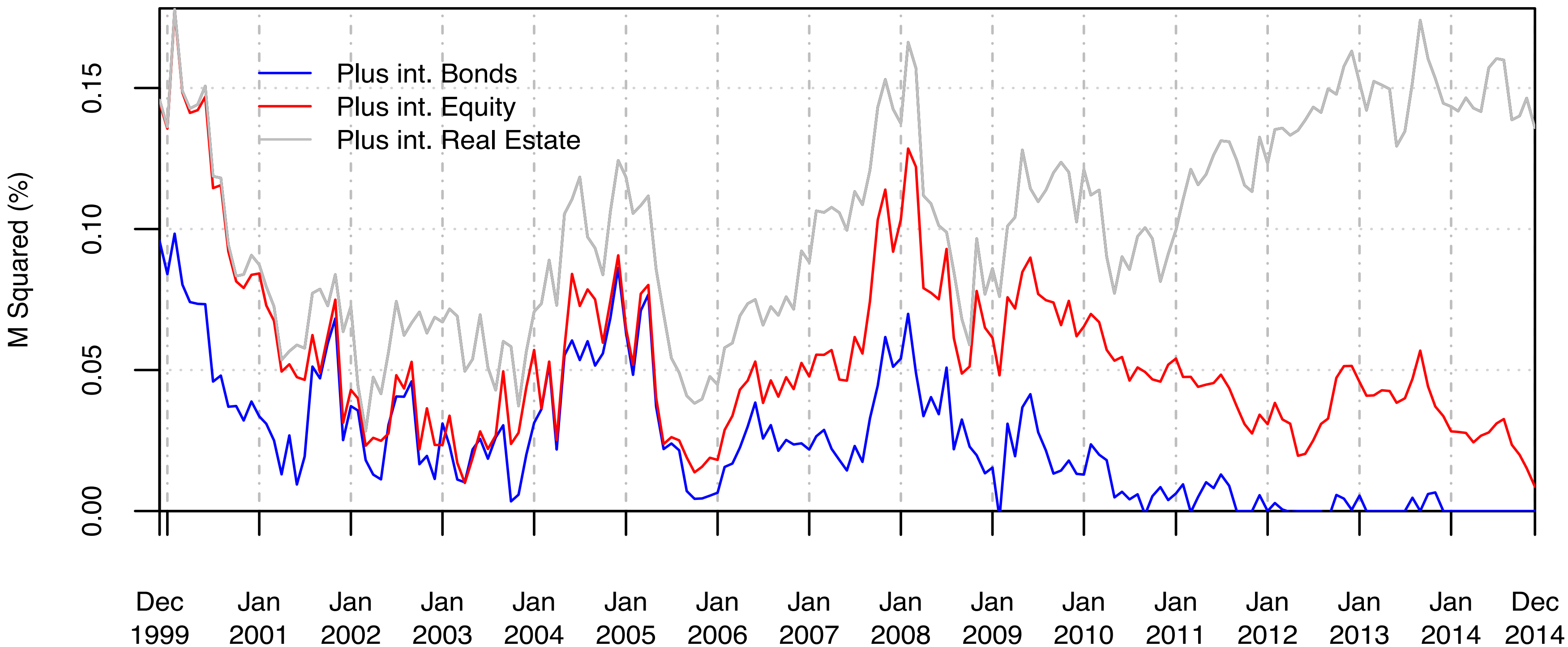
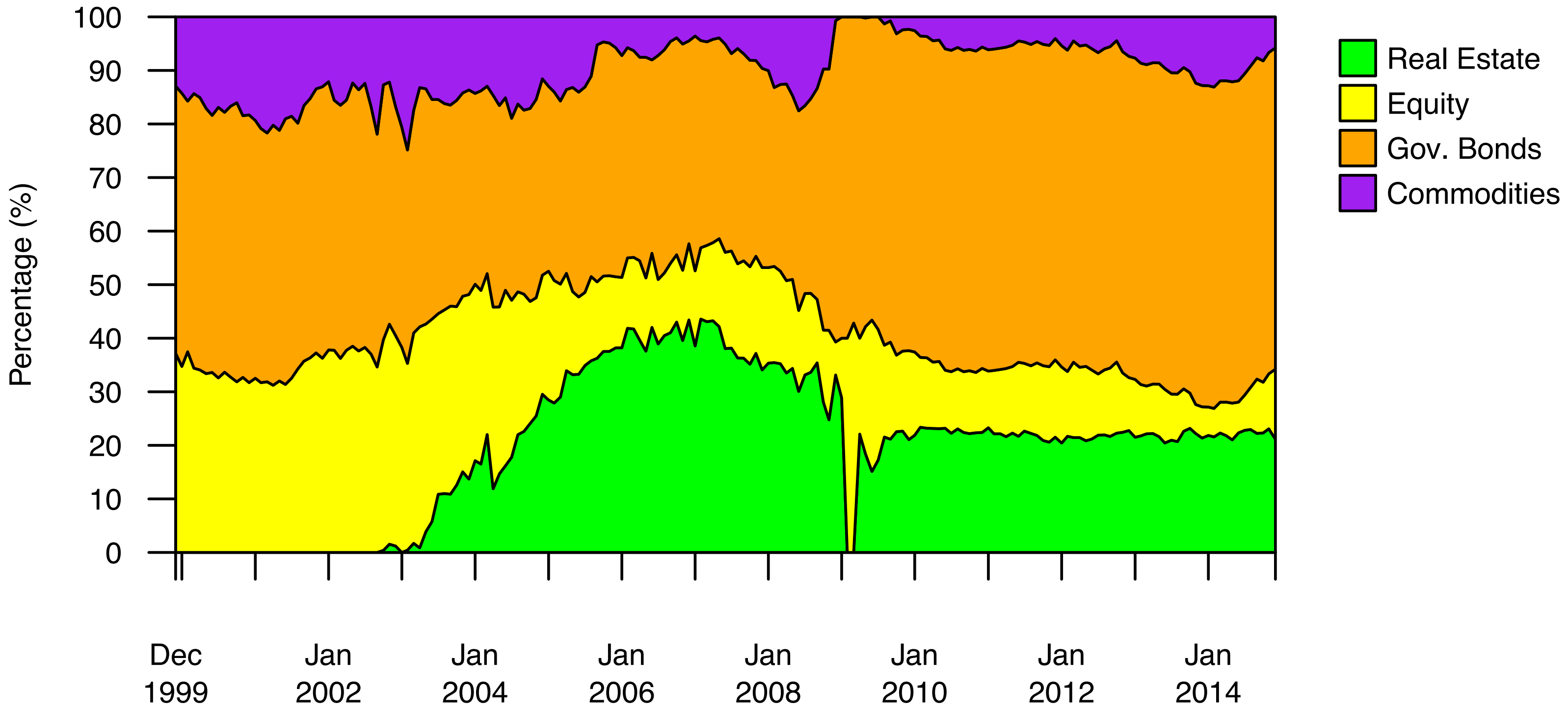


Fig. 34: Global – Time-Varying M Squared (B) (p. 64)



Appendix B (p. 70)

Fig. A: National – Weights of optimized Portfolios (Fixed Window)



Appendix B (p. 70)

Fig. B: National – Weights of optimized Portfolios (Expanding Window)

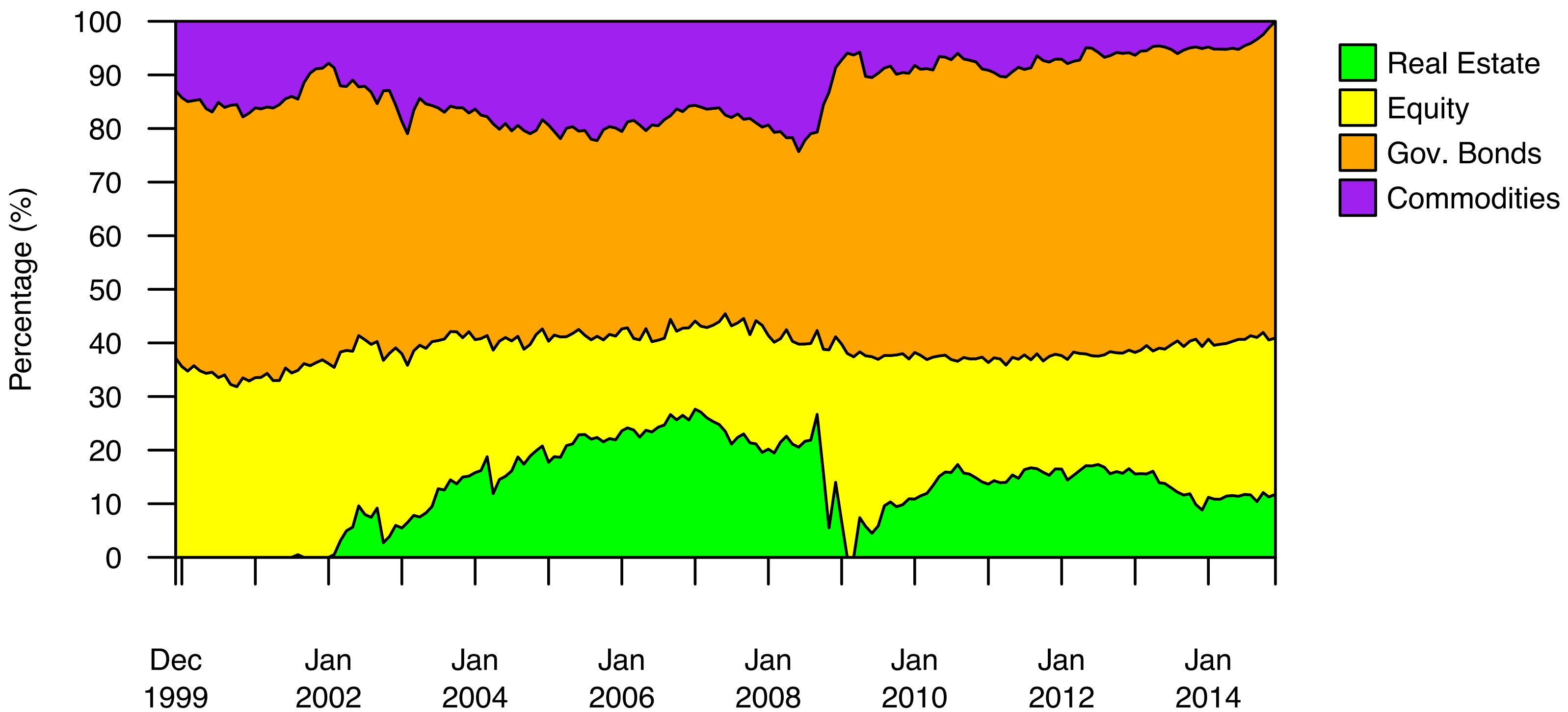


Fig. A: Total Inflation Hedging – Rolling Regression

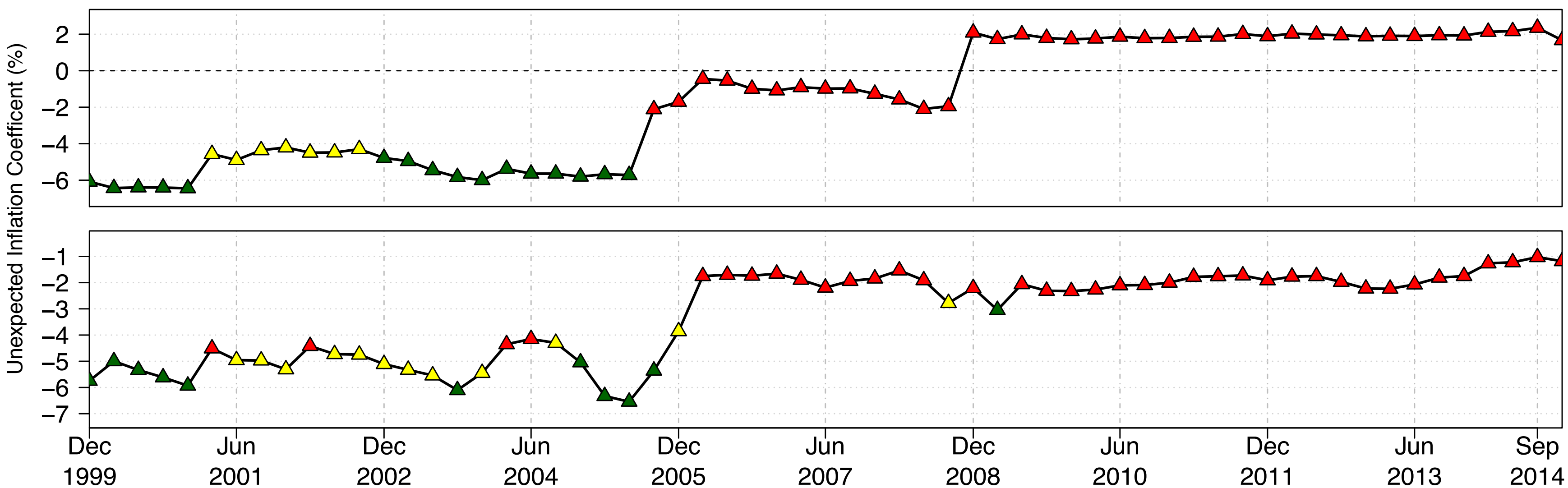


Fig. B: Unexpected Inflation Hedging – Rolling Regression

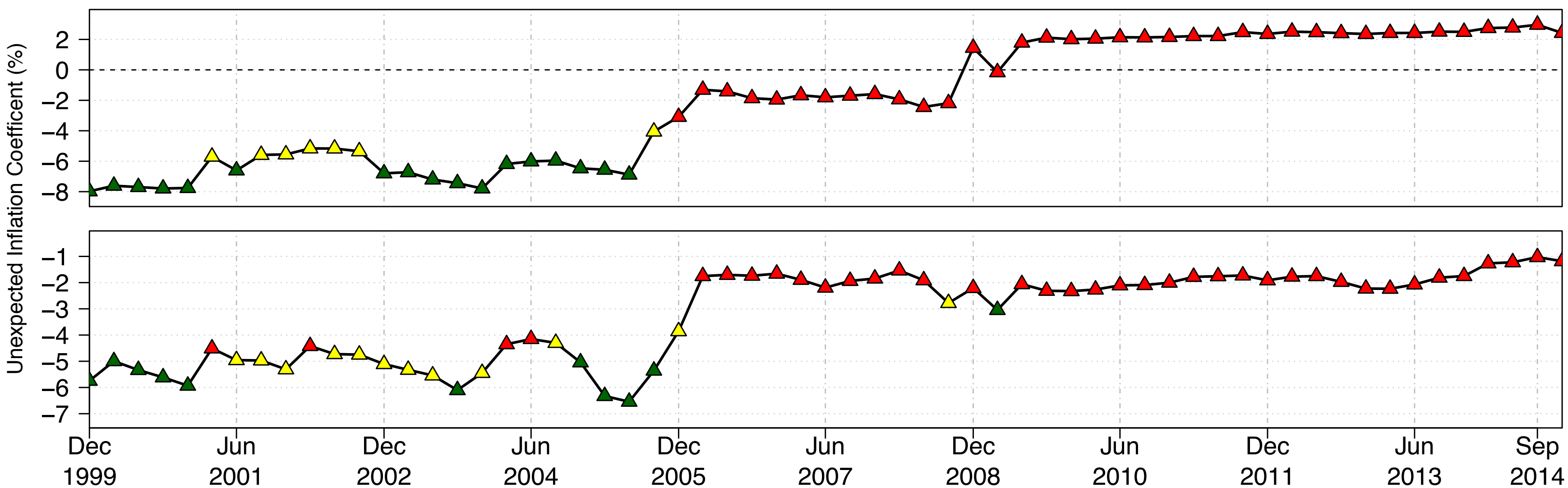


Fig. A: Correlations between national Indices

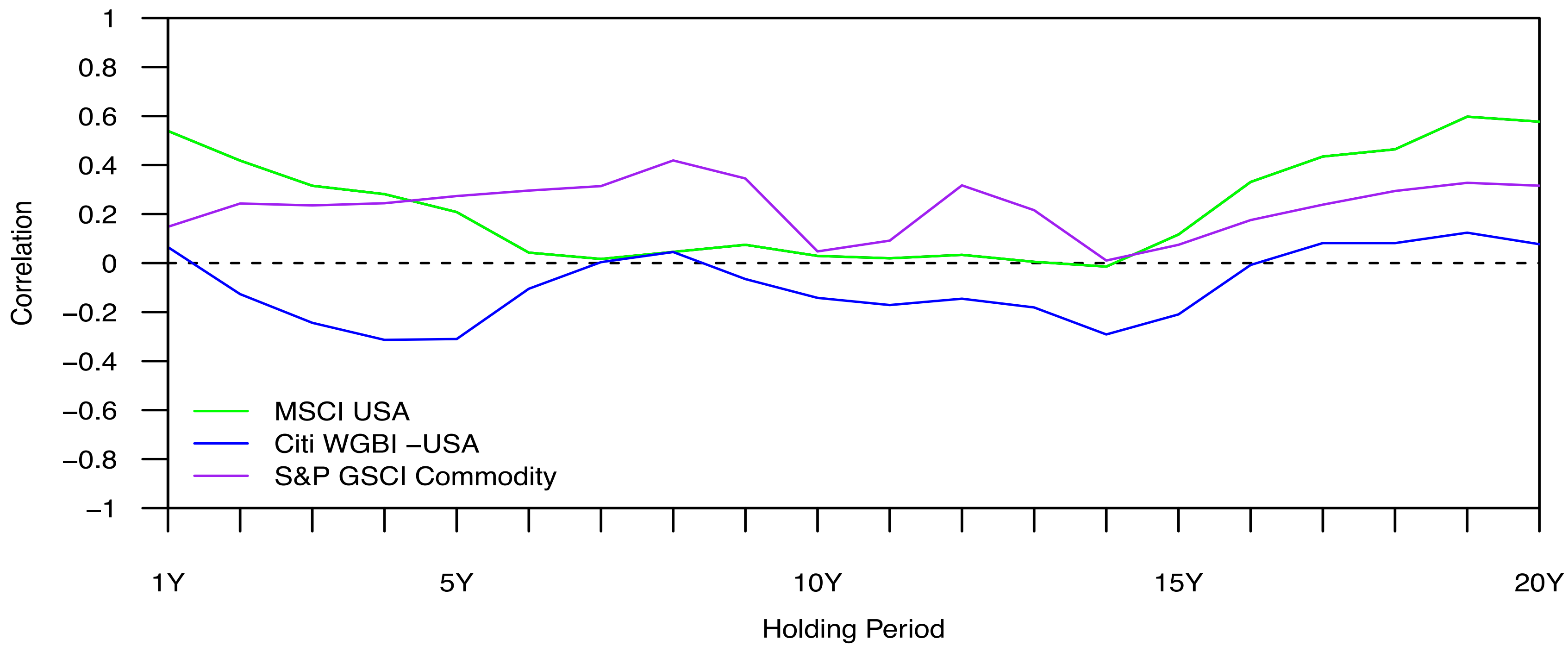
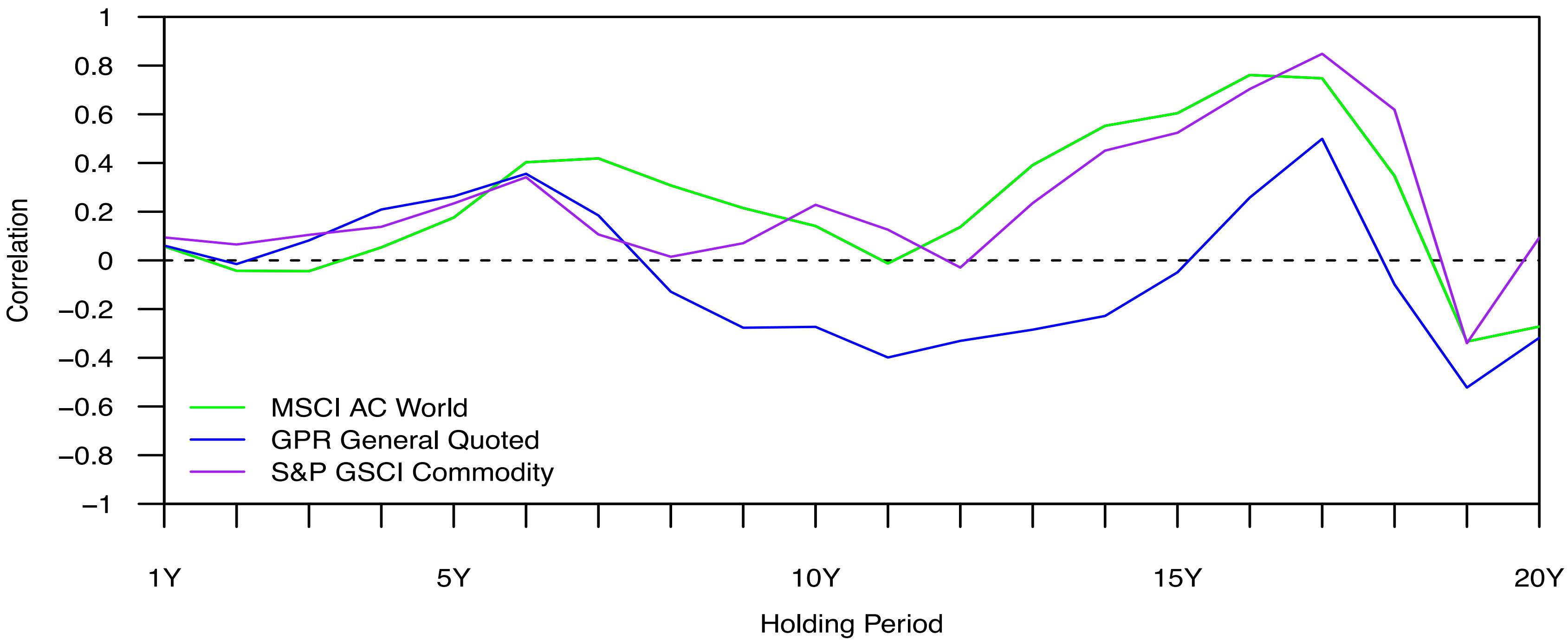
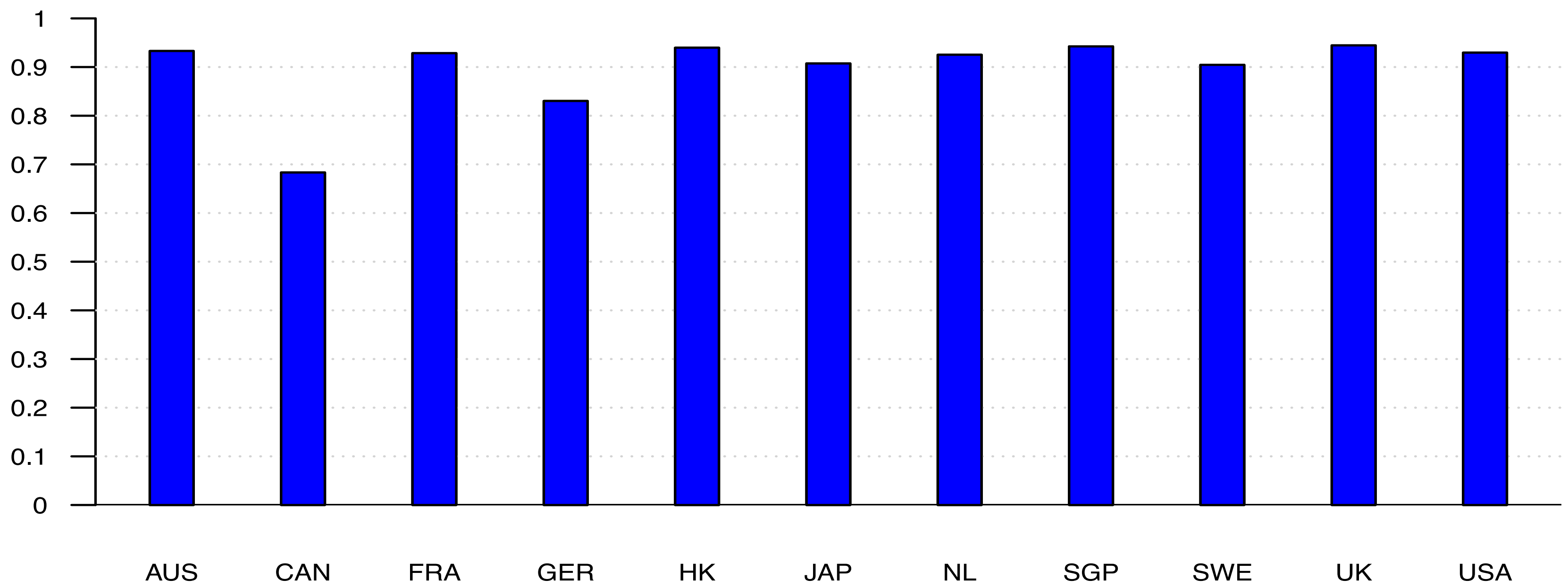


Fig. B: Correlations between broad global Indices



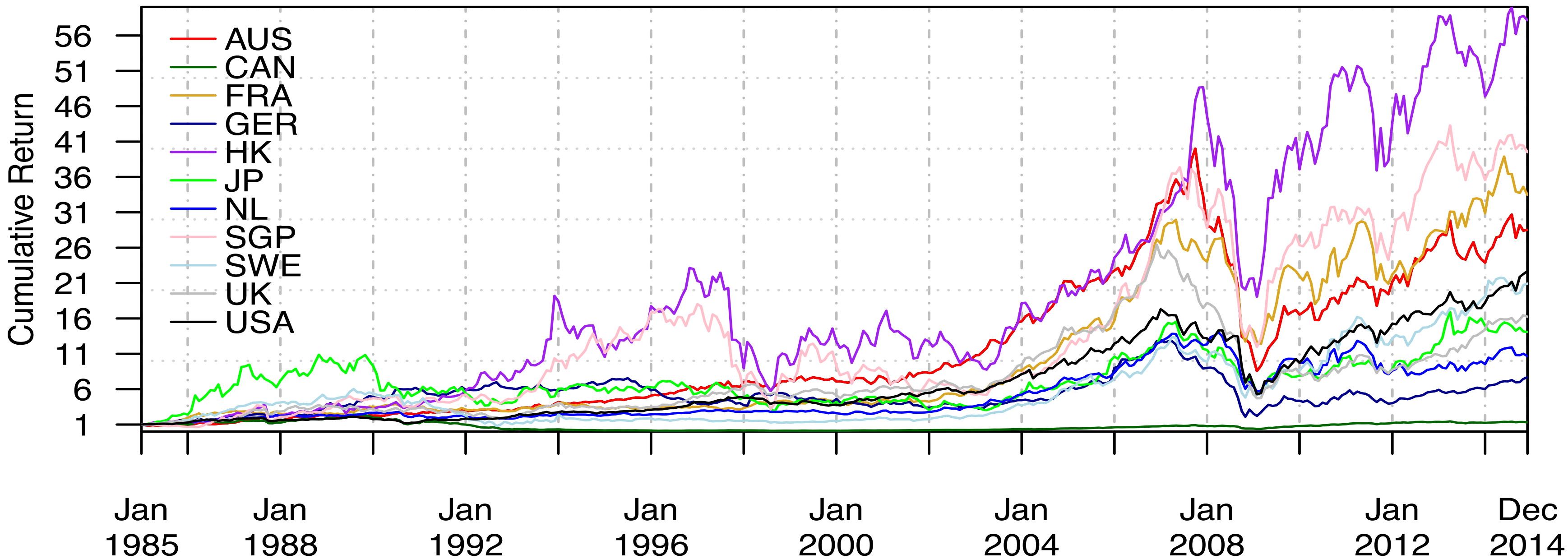
Appendix G (p. 75)

Fig. A: Constant Correlations between Country Indices



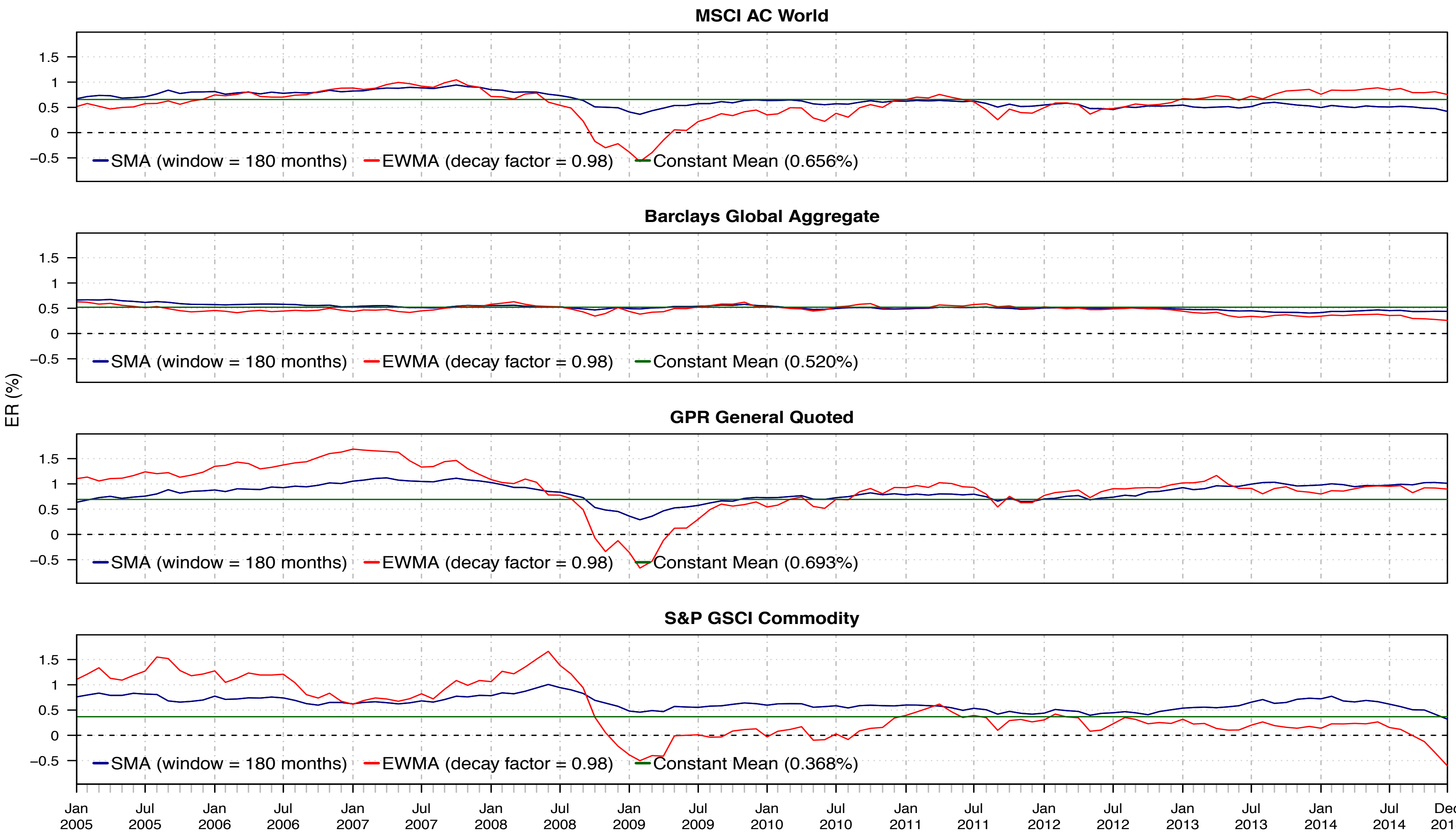
Appendix H (p. 76)

Fig A: Global – Cumulative Returns of the GPR General Quoted Country Indices

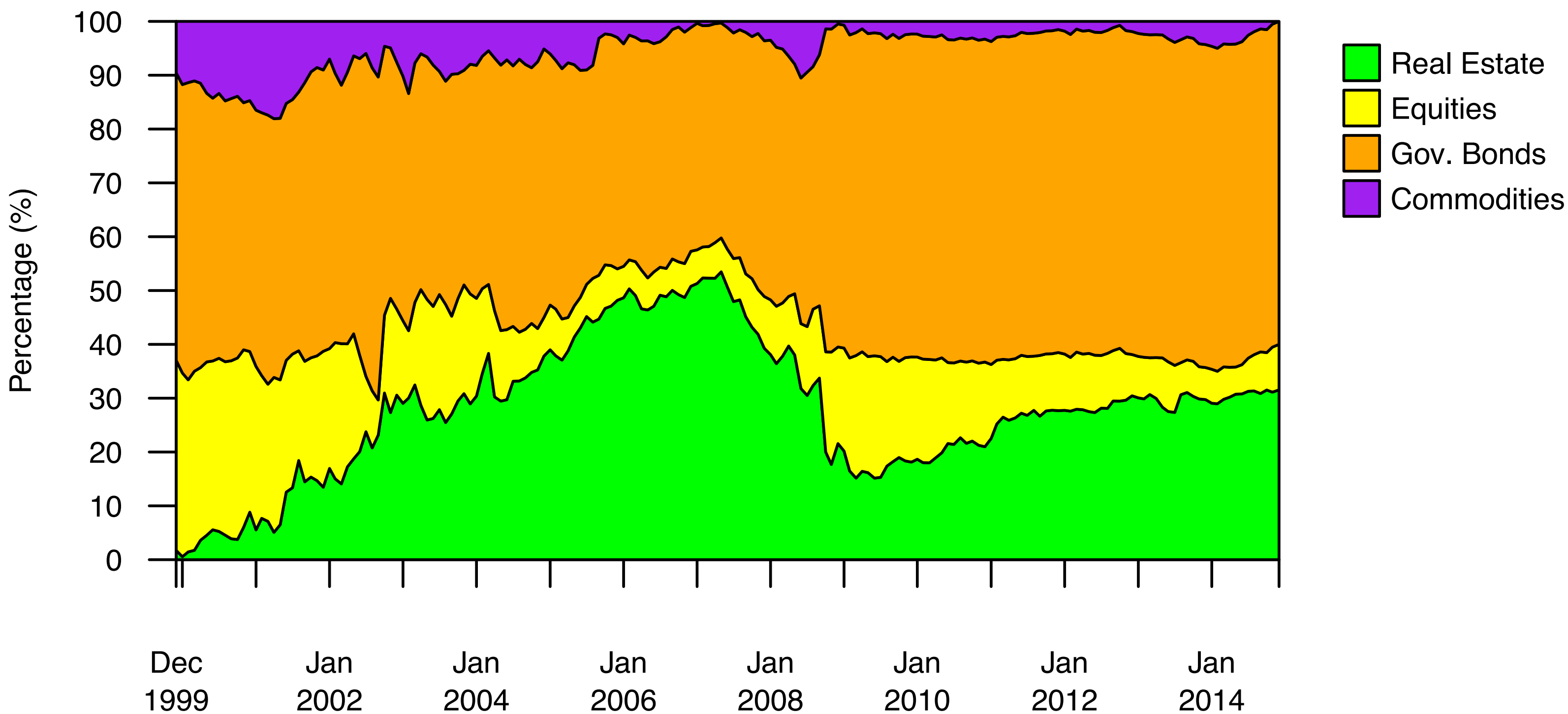


Appendix I (p. 77)

Fig. A: Time-varying means of global indices



Appendix K (p. 79)
Fig. A: Global –Weights of optimized Portfolios (Fixed Window)



Appendix K (p. 79)

Fig. A: Global –Weights of optimized Portfolios (Expanding Window)