Pension Systems and Investment Regulations

Analysis, Diagnosis and Recommendations

The Pension Team:

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Agenda

- **Background**
- **Chile & Mexico**
- **A Better Way**
- **Conclusions**

Background

The Pension Debate… So Far

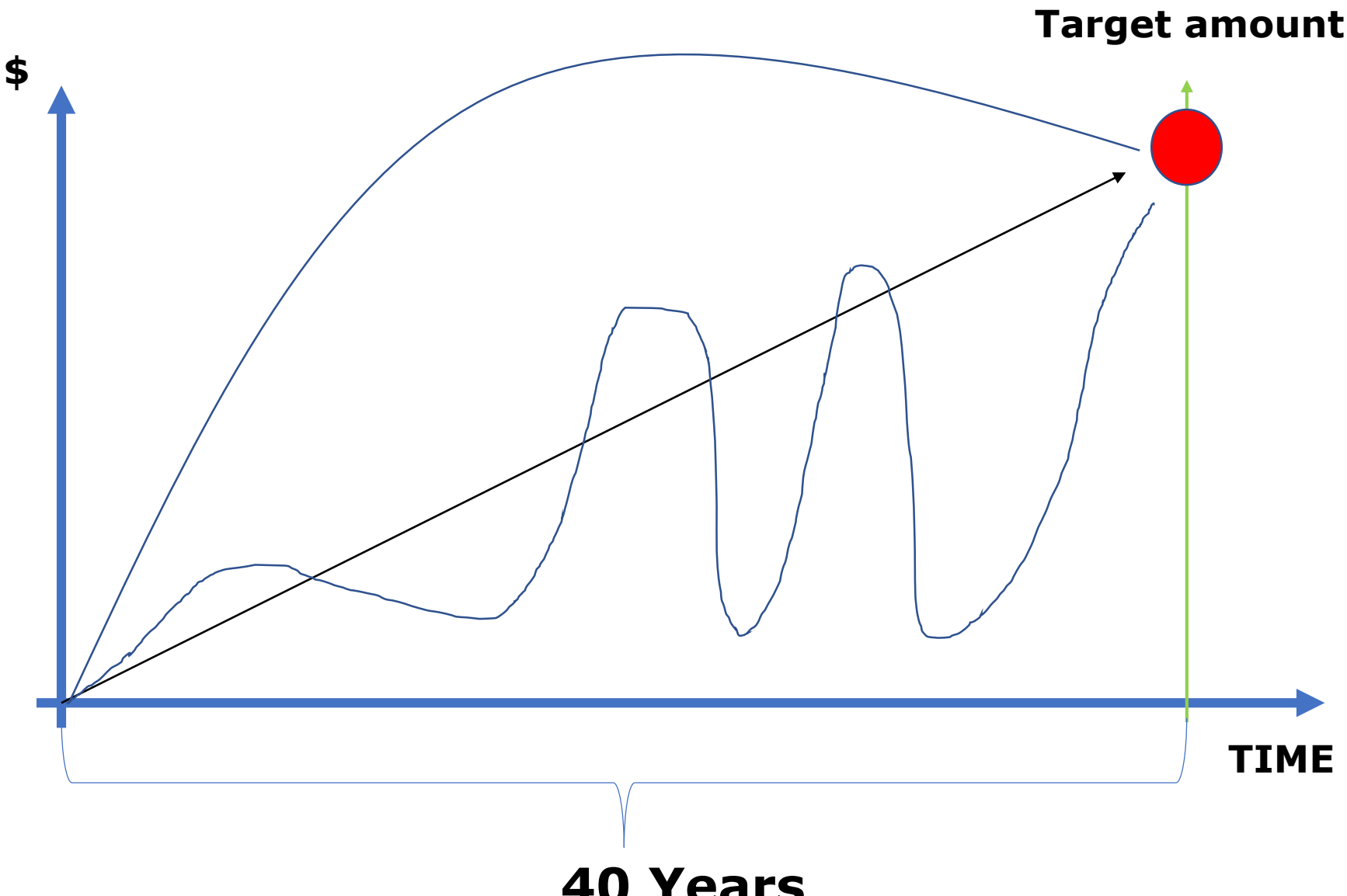
Public Policy

- Should women and men retire at the same age?
- Same mortality tables?
- Private or state-owned asset managers?
- Competition among asset managers?
- Are the management fees high?
- Can I take my money out and buy real estate?

Portfolio Management

- How should the risk be controlled?
- Is short-term volatility relevant?
- What is the role of alternative investments?
- Should there be a mandatory currency hedging?
- Use of leverage?

The Pension Game: What Really Matters…



Average Return or Cumulative Return?

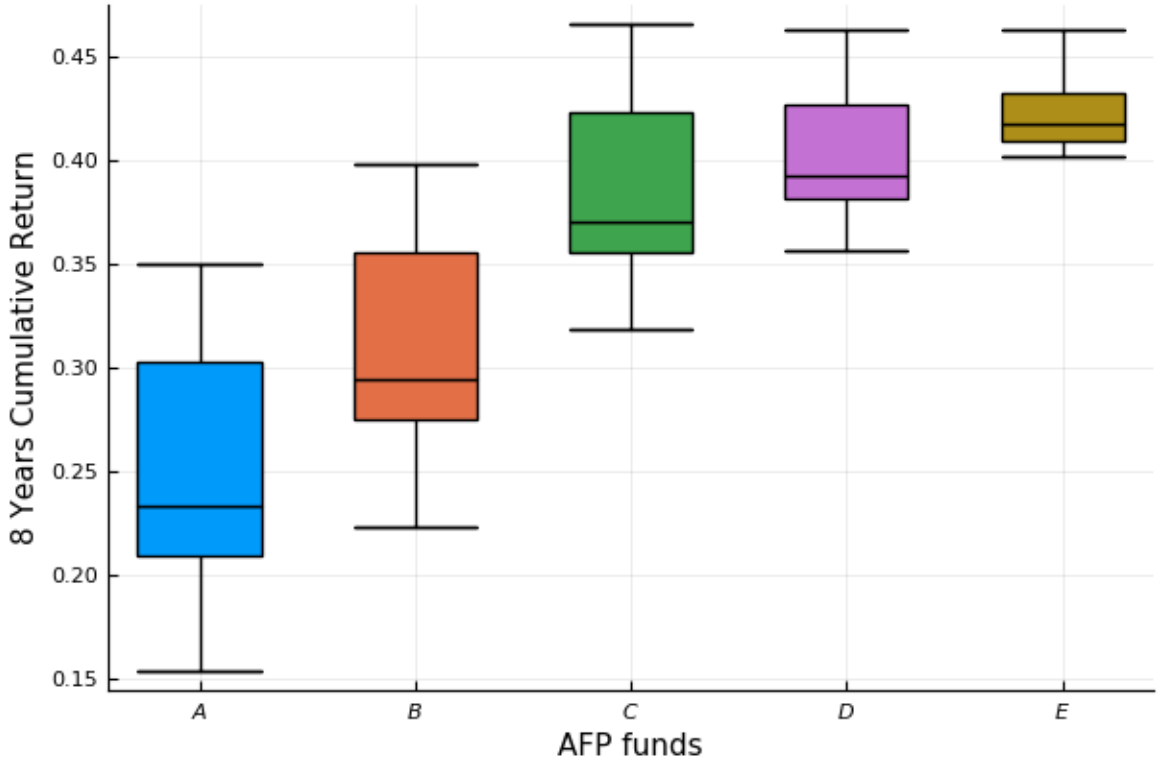
	PERIOD	return	1+ return		PERIOD	return	1+ return
	1	0.10	1.10		1	0.10	1.10
	2	0.60	1.60		2	0.10	1.10
	3	-0.29	0.71		3	0.10	1.10
average return		**0.14**				0.10	
cumulative return			0.25				**0.33**
initial balance	**100.00**					**100.00**	
final balance	**124.96**					**133.10**	

Chilean Funds, October 2002—June 2017
Inflation-Adjusted Monthly Returns

	A	B	C	D	E
Mean (%)	0.65	0.53	0.46	0.39	0.32
St. Dev. (%)	3.57	2.58	1.73	1.11	0.90
Sharpe Ratio	0.18	0.21	0.26	0.35	0.36

$$\textit{Sharpe Ratio} = \frac{E(R) - (Risk\text{–}Free\ Rate)}{St.Dev.(R)}$$

8-Year Cumulative Return-Box Plot Charts (All Windows within the Period)

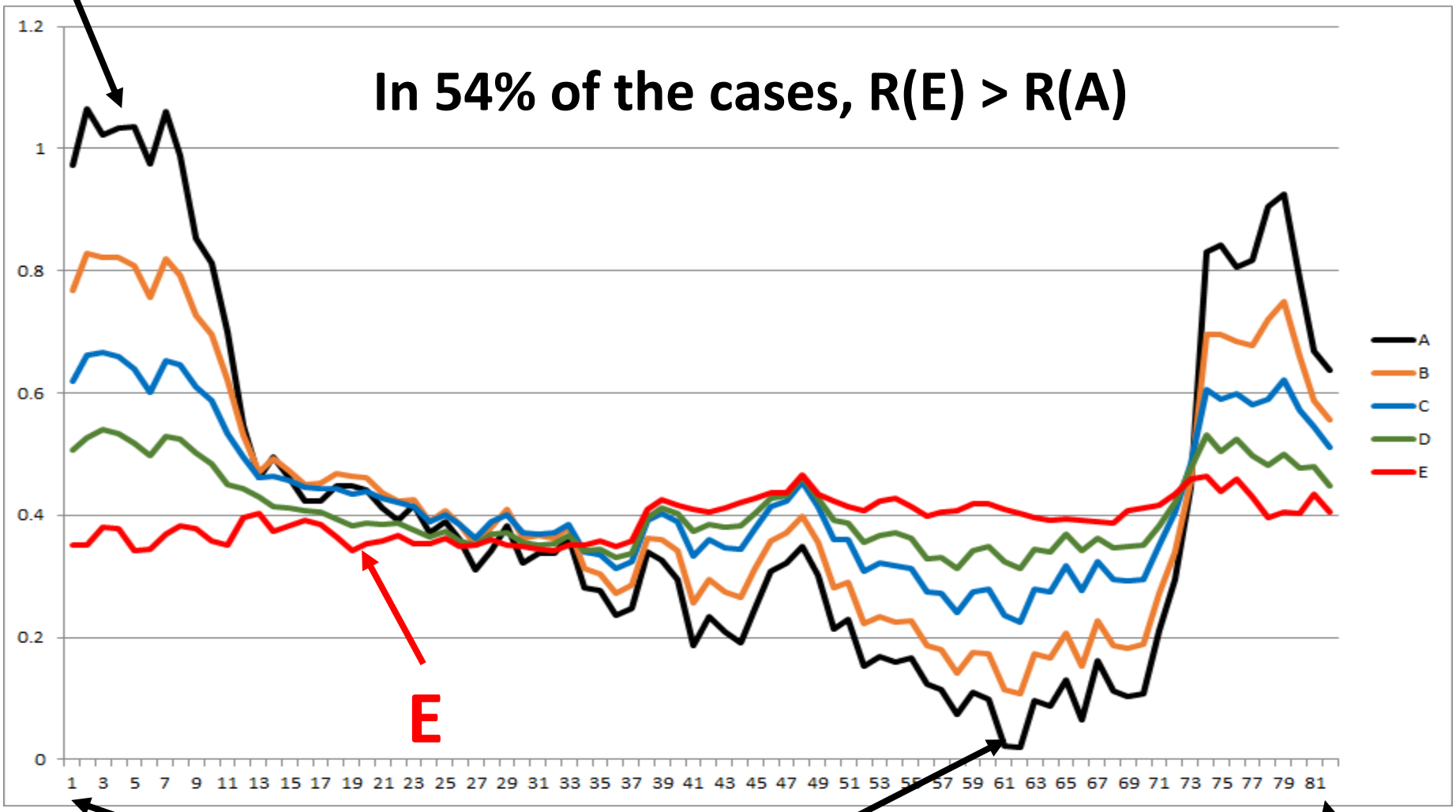


A B C D E

Period: January 2006—December 2014

8-Year Cumulative Returns; All Possible 8-Year Windows, OCT 2002—JUN-2017

A



Chile & Mexico

CHILE

Starting in 2002: Five Funds, A, B, C, D, and E

A = Riskiest (in theory)
E = Most Conservative

Lower Limit		Upper Limit
L(1)	Chilean Equities	U(1)
L(2)	Chilean Corporate Bonds	U(2)
L(3)	Chilean Sovereign Bonds	U(3)
L(4)	Chile Money Market	U(4)
L(5)	International Equities	U(5)
L(6)	International Corporate Bonds	U(6)

Penalty for underperforming: based on the last 36 months (measured against industry average)

MEXICO

Starting in 2008, Four Funds: SB1, SB2, SB3, and SB4

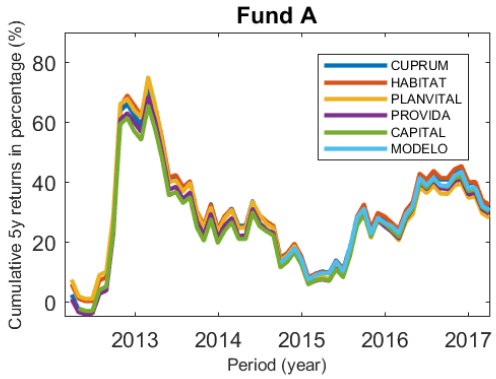
SB4 = Riskiest
SB1 = Most Conservative

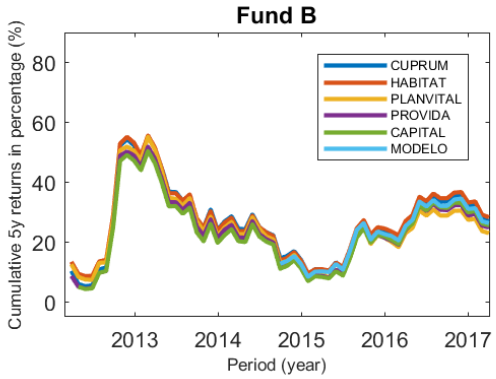
	Upper Limit
Mexican Equities	U(1)
Mexican Corporate Bonds	U(2)
Mexican Sovereign Bonds	U(3)
Alternative Assets	U(4)
International Equities	U(5)
International Corporate Bonds	U(6)

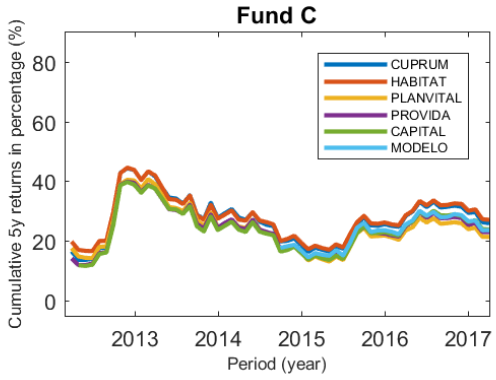
VaR Limit, (1-day VaR), based on previous 1,000 trading days

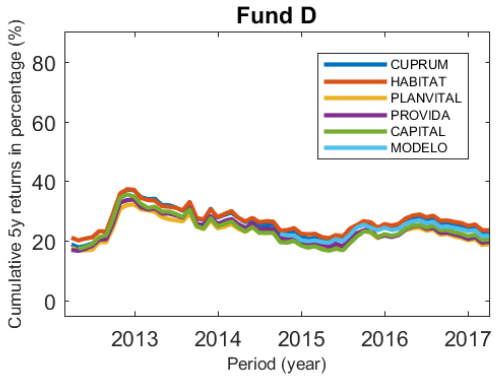
Limits: SB1 (0.70%), …, SB4 (2.10%)

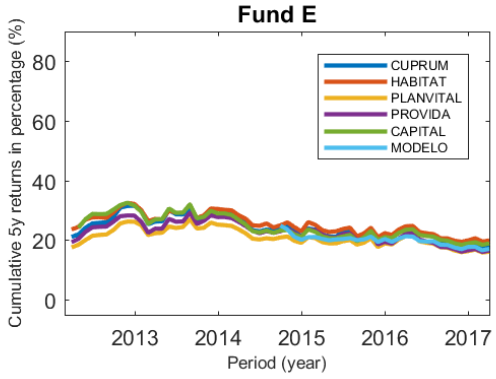
CHILE: Same Fund, Different Managers
5-Year Cumulative Returns



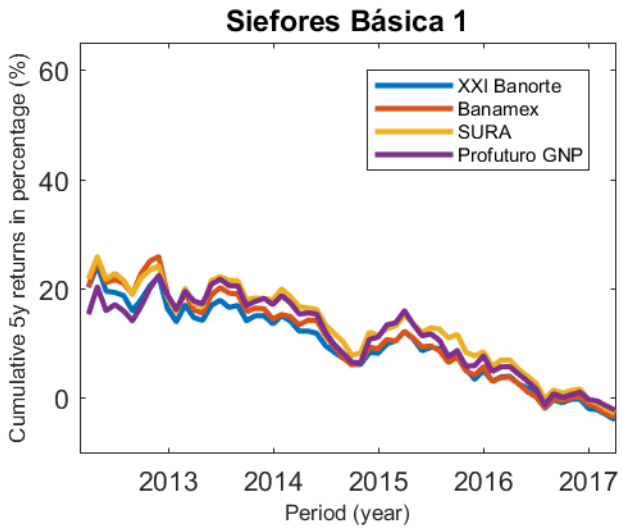


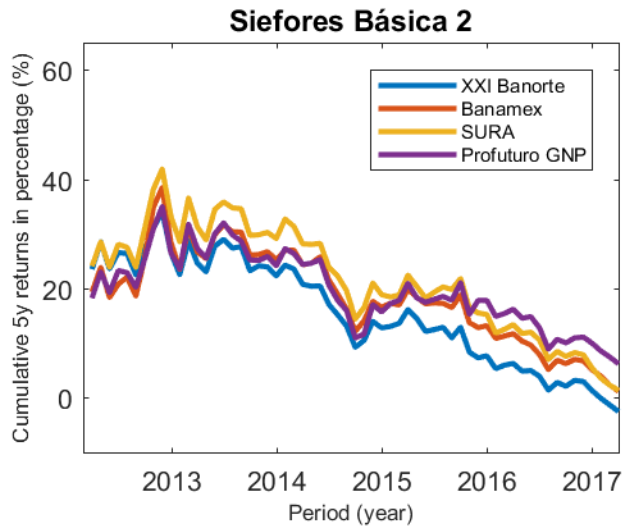


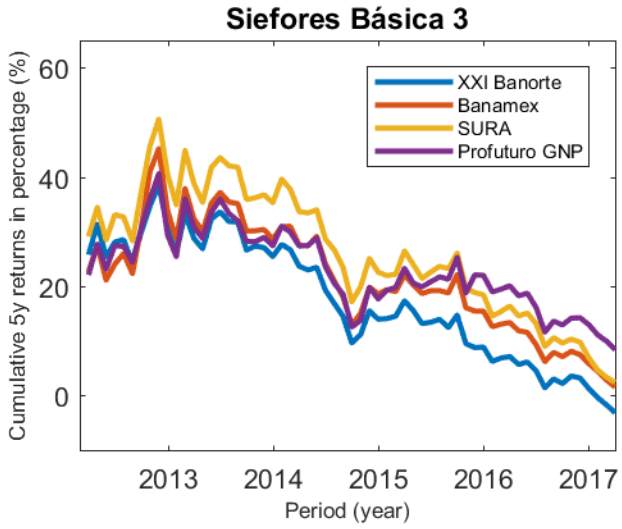


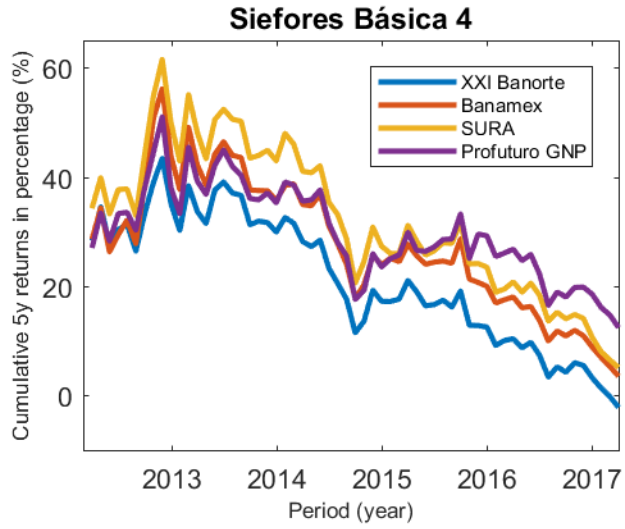


MEXICO: Same Fund, Different Managers
5-Year Cumulative Returns

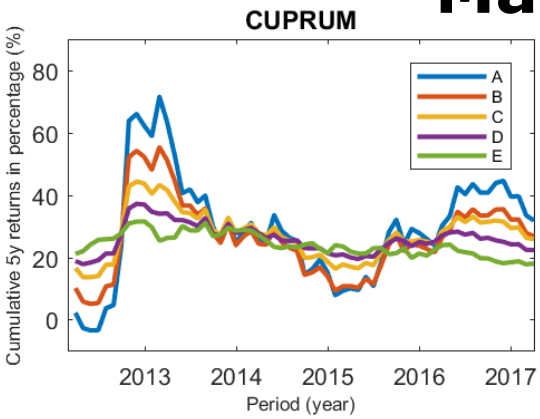


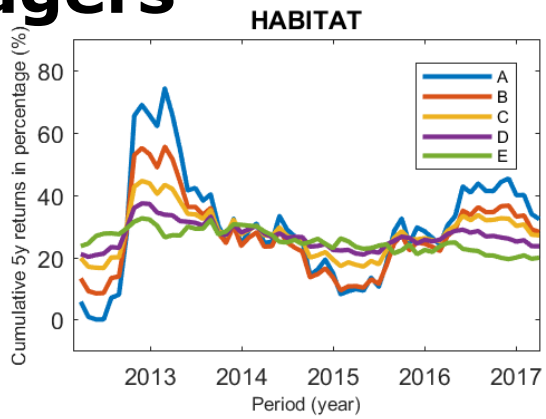


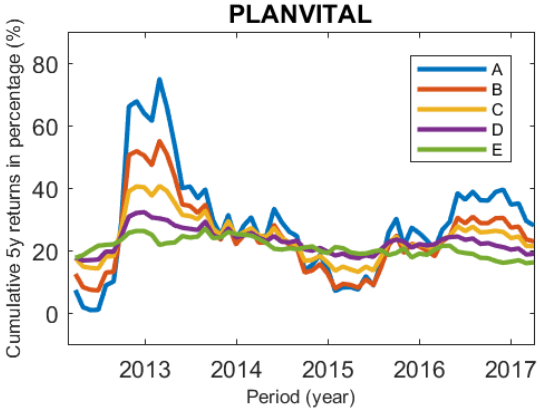


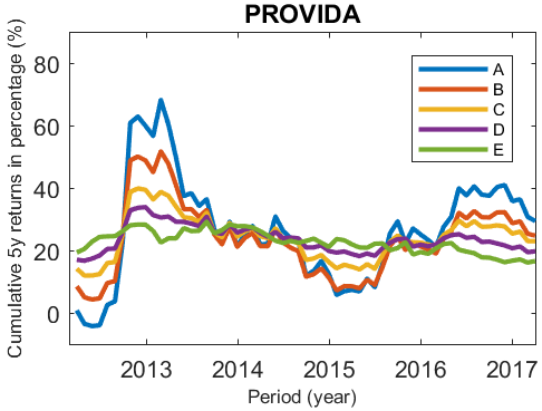


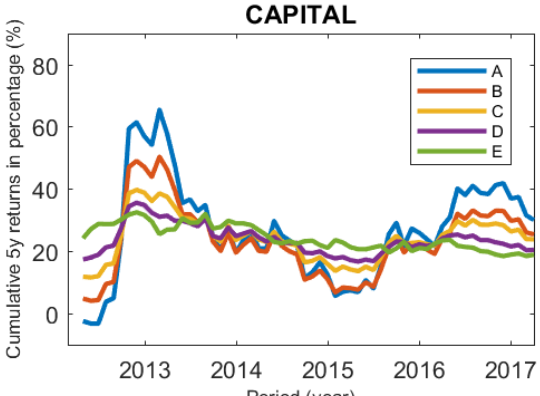
CHILE: 5-Year Cumulative Returns, Different Managers

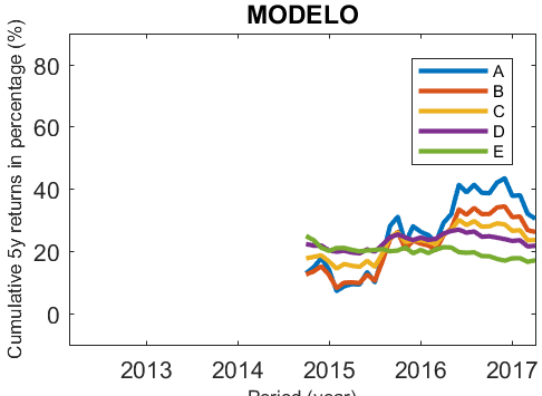




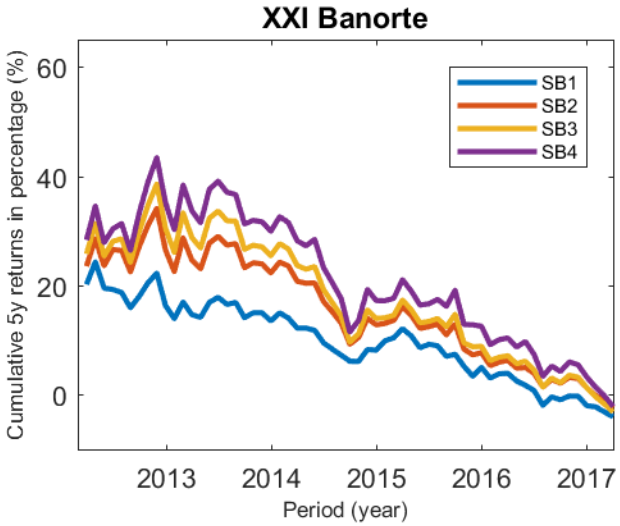


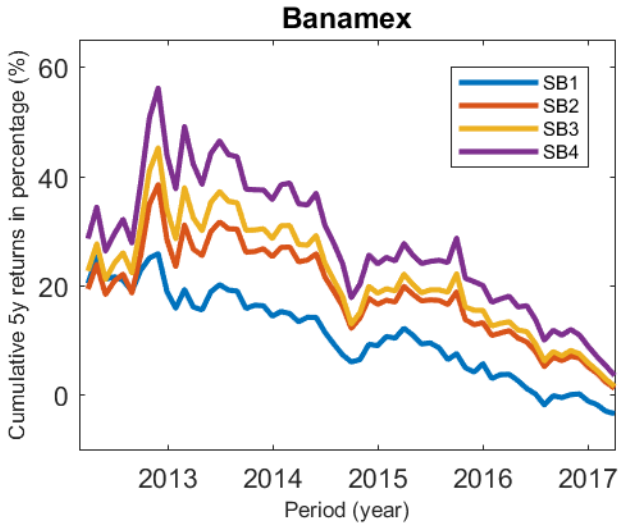


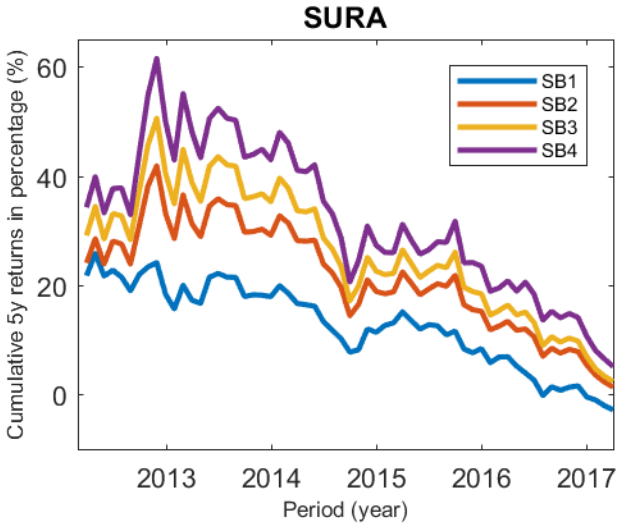


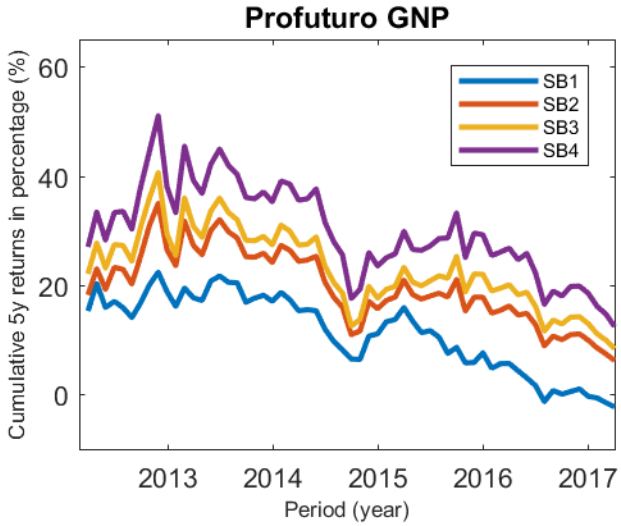


MEXICO: 5-Year Cumulative Returns, Different Managers

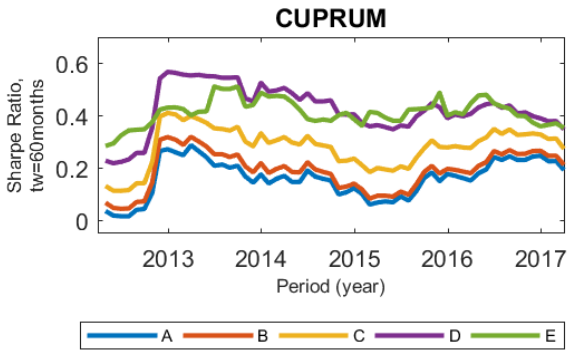


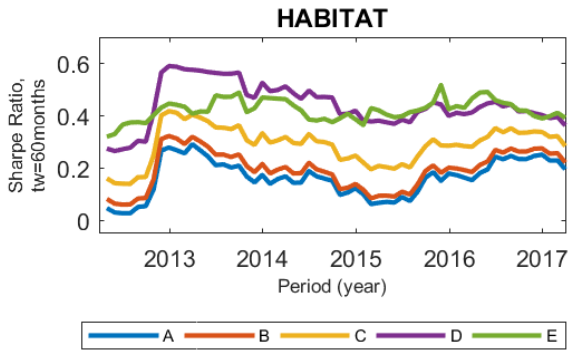


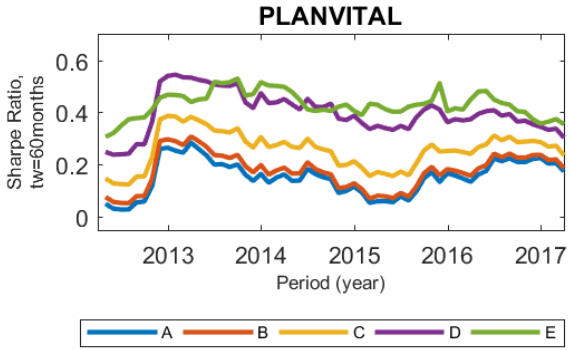


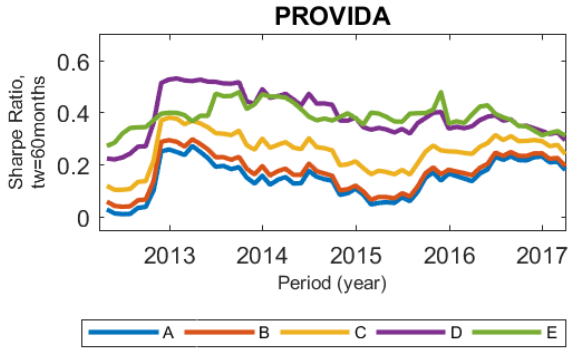


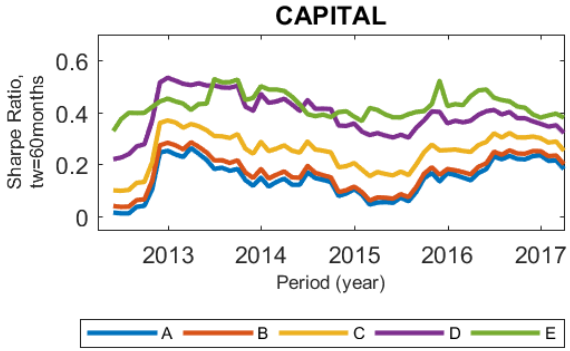
CHILE: Sharpe Ratio, Different Managers

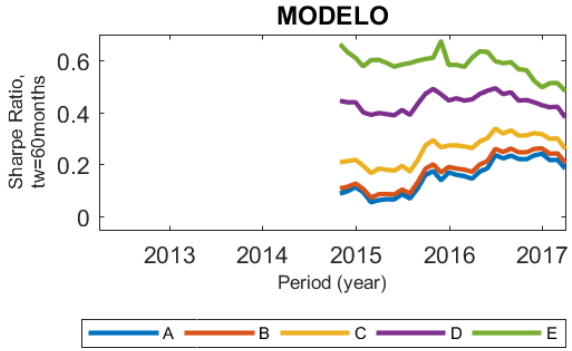




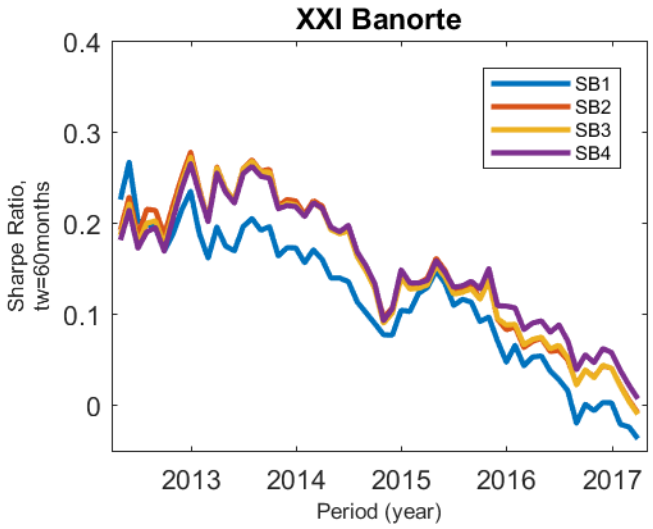


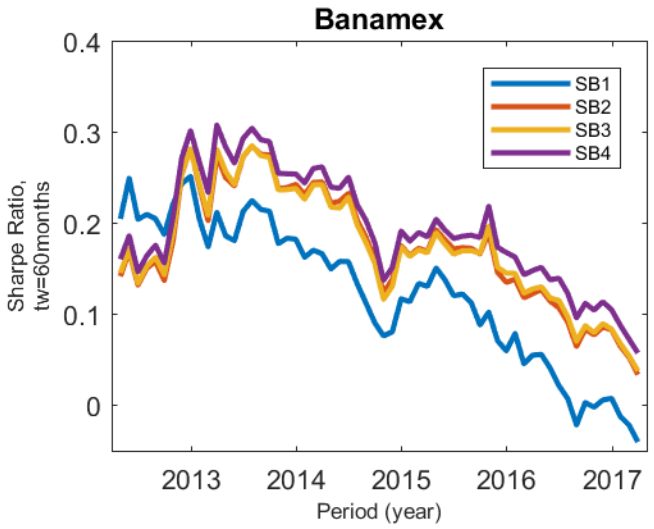


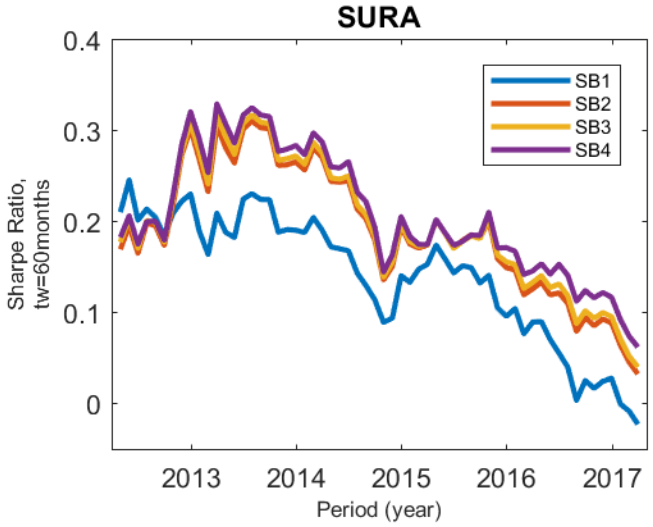


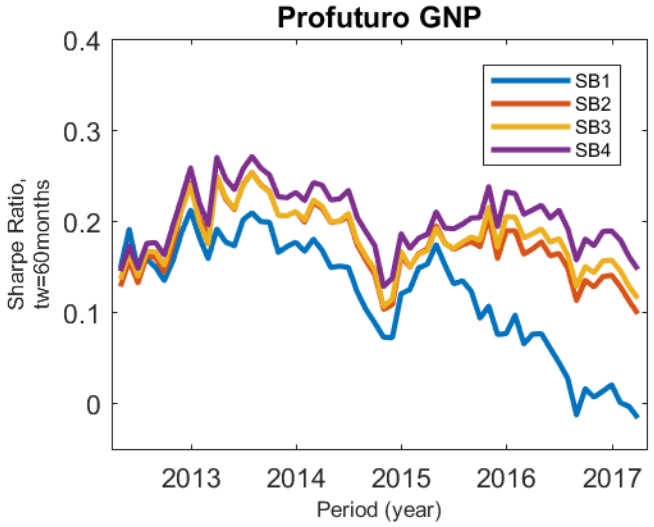


MEXICO: Sharpe Ratio, Different Managers









Rank Order Metrics

In terms of cumulative returns the funds should be ranked: 1, 2, 3, 4, (5)

(We reverse the order of the Mexican funds to run this test)

Hamming distance

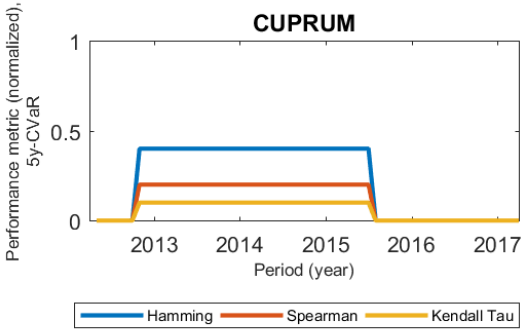
Spearman footrule

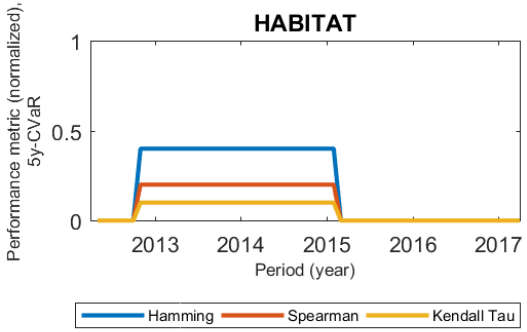
Kendall Tau rank distance

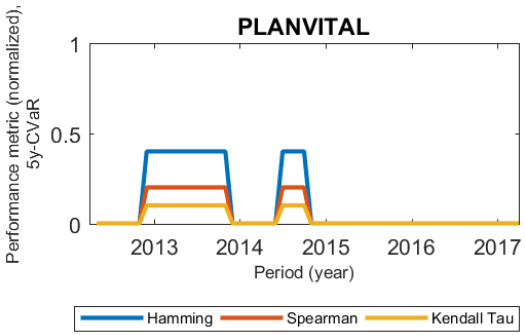
After normalization,

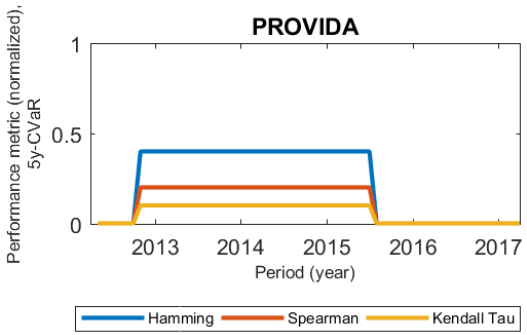
0 = perfect order = 1, 2, 3, 4, 5
1 = worst possible situation = 5, 4, 3, 2, 1

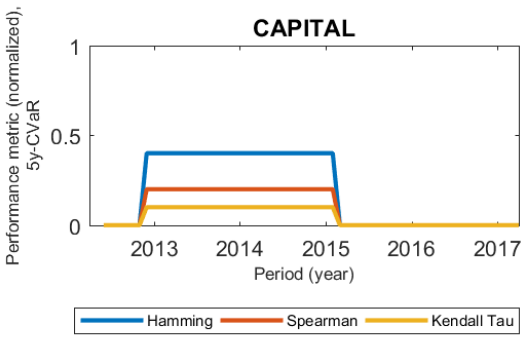
CHILE, C-VaR

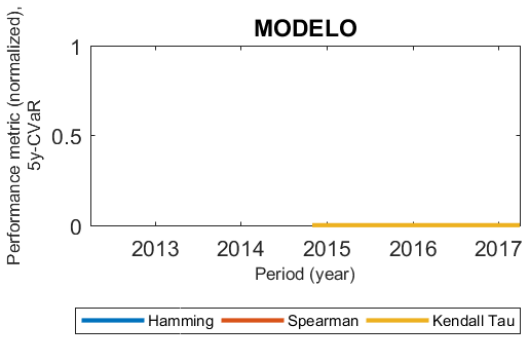

CUPRUM
Performance metric (normalized), 5y-CVaR
1
0.5
0
2013
2014
2015
2016
2017
Period (year)
Hamming
Spearman
Kendall Tau


HABITAT
Performance metric (normalized), 5y-CVaR
1
0.5
0
2013
2014
2015
2016
2017
Period (year)
Hamming
Spearman
Kendall Tau

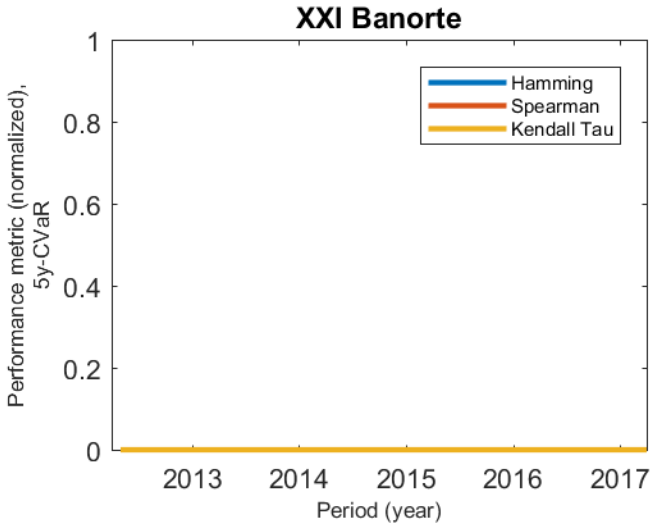

PLANVITAL
Performance metric (normalized), 5y-CVaR
1
0.5
0
2013
2014
2015
2016
2017
Period (year)
Hamming
Spearman
Kendall Tau

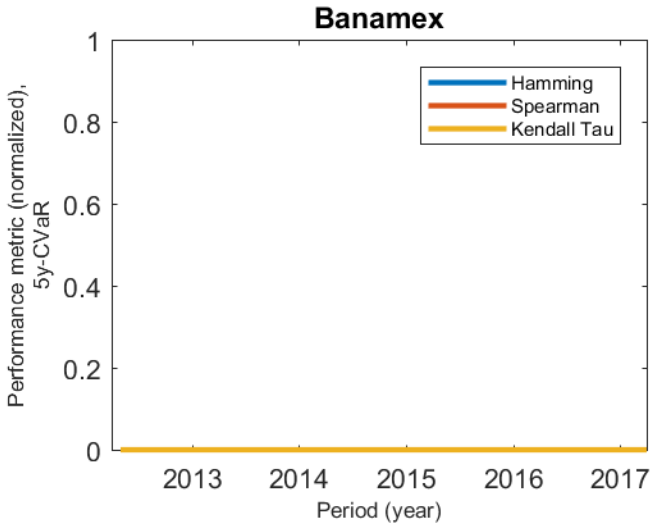

PROVIDA
Performance metric (normalized), 5y-CVaR
1
0.5
0
2013
2014
2015
2016
2017
Period (year)
Hamming
Spearman
Kendall Tau

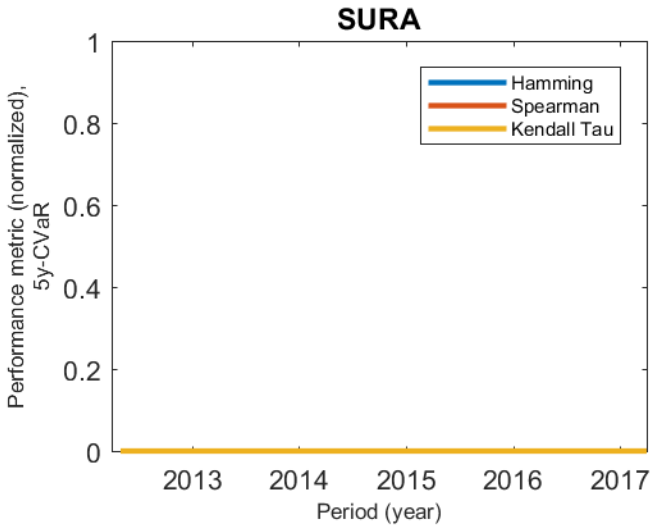

CAPITAL
Performance metric (normalized), 5y-CVaR
1
0.5
0
2013
2014
2015
2016
2017
Period (year)
Hamming
Spearman
Kendall Tau

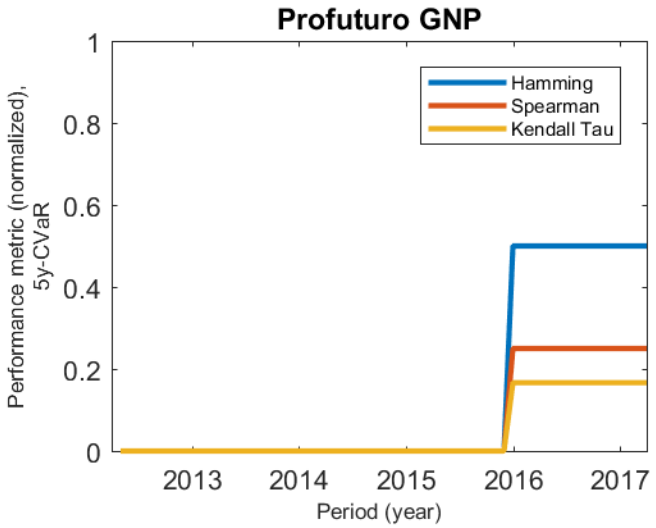

MODELO
Performance metric (normalized), 5y-CVaR
1
0.5
0
2013
2014
2015
2016
2017
Period (year)
Hamming
Spearman
Kendall Tau

MEXICO, C-VaR

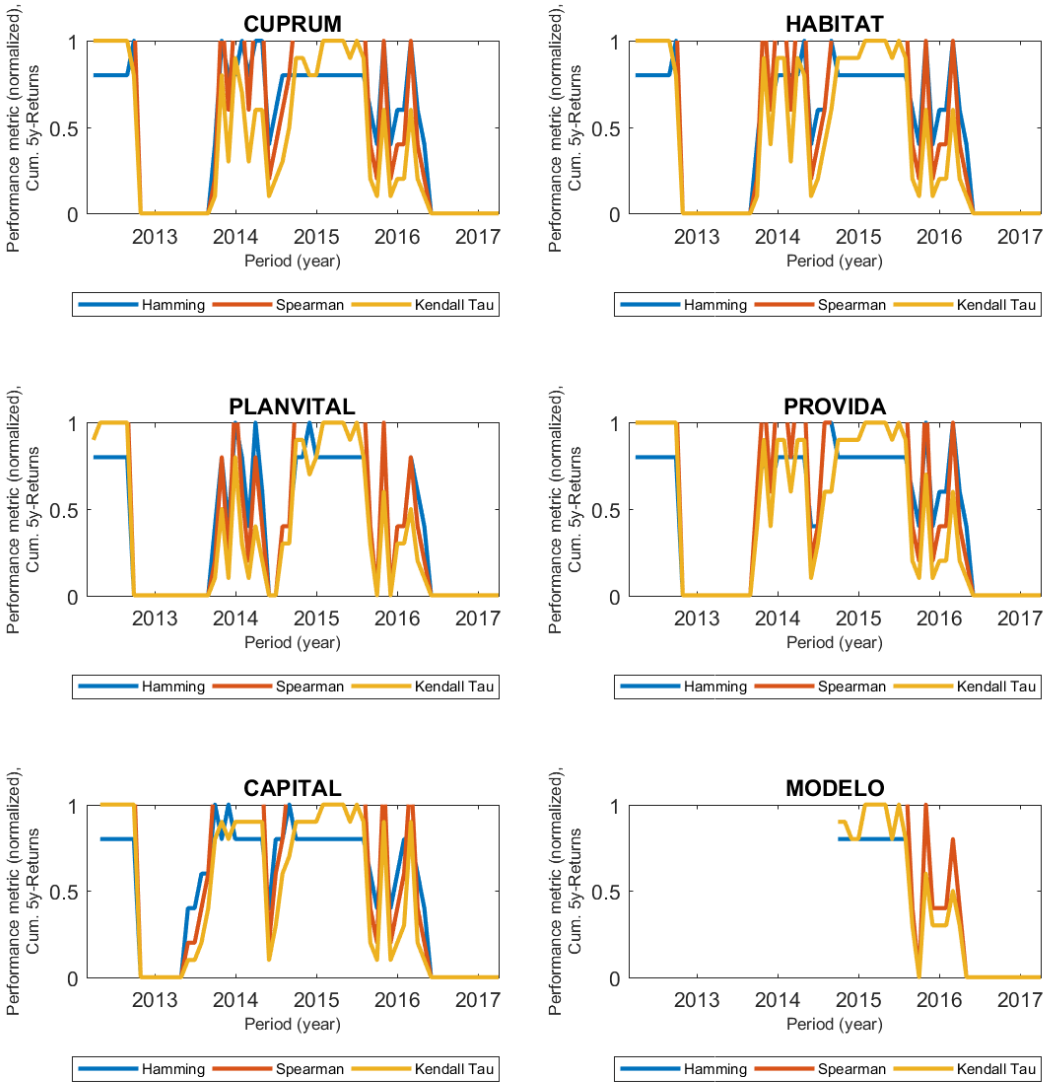

XXI Banorte
Performance metric (normalized), 5y-CVaR
Period (year)
Hamming
Spearman
Kendall Tau
0
0.2
0.4
0.6
0.8
1
2013
2014
2015
2016
2017


Banamex
Performance metric (normalized), 5y-CVaR
Period (year)
Hamming
Spearman
Kendall Tau
0
0.2
0.4
0.6
0.8
1
2013
2014
2015
2016
2017

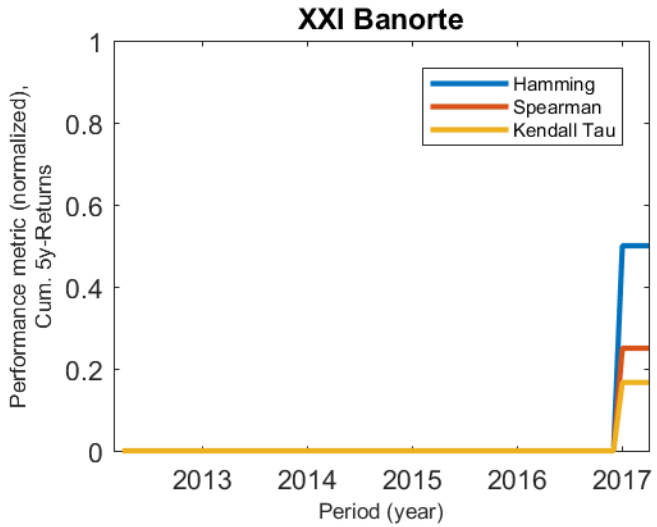

SURA
Performance metric (normalized), 5y-CVaR
Period (year)
Hamming
Spearman
Kendall Tau
0
0.2
0.4
0.6
0.8
1
2013
2014
2015
2016
2017

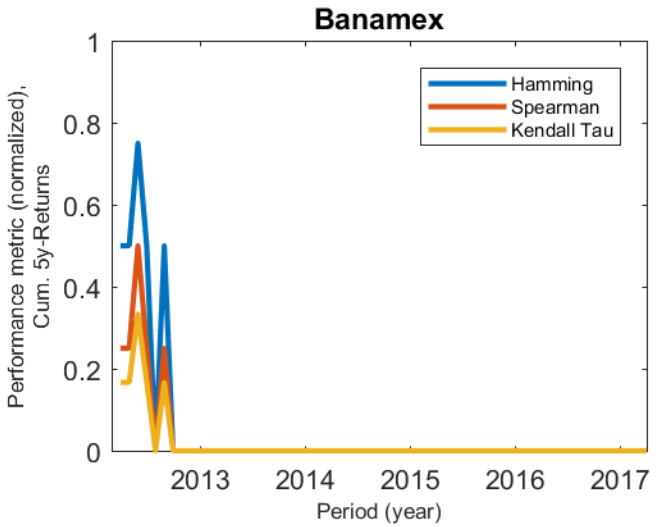

Profuturo GNP
Performance metric (normalized), 5y-CVaR
Period (year)
Hamming
Spearman
Kendall Tau
0
0.2
0.4
0.6
0.8
1
2013
2014
2015
2016
2017

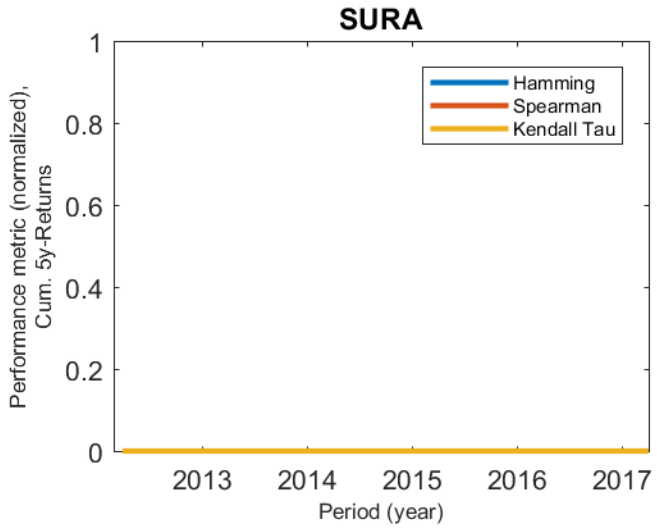
CHILE, 5-Year Cumulative Return

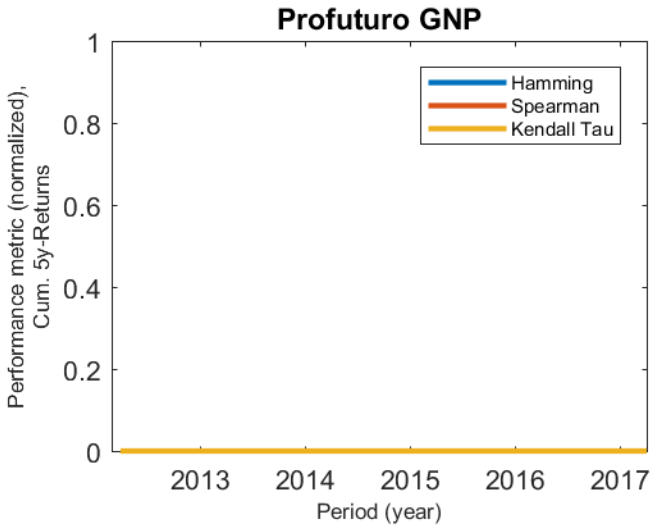


MEXICO, 5-Year Cumulative Return









A Better Way

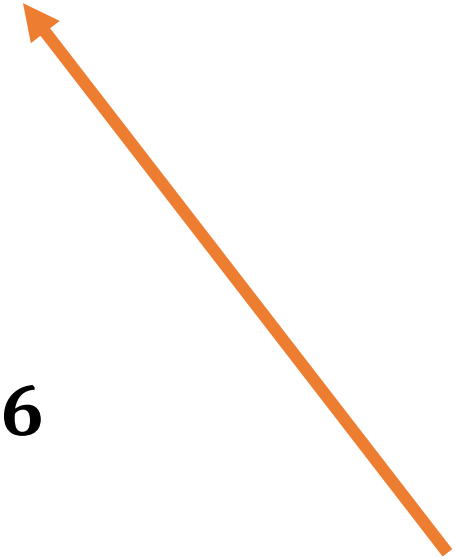
Let us consider the following six indices

1	Chilean Equities	MSCI Index
2	Chilean Corporate Bonds	DJLaTixx Chile Corporate Index
3	Chilean Sovereign Bonds	DJLaTixx Chile Government
4	Chile Money Market	LVA MM Index
5	International Equities	MSCI All Country Index
6	International Corporate Bonds	Barclays US HY Index

$$\Omega = (\omega_1, \ldots, \omega_6)^t$$

$$Return = R = \omega_1 r_1 + \ldots + \omega_6 r_6 = \Omega^t r$$

$$\underset{\Omega}{Max} \;\; \Omega^T r$$



return

Subject to

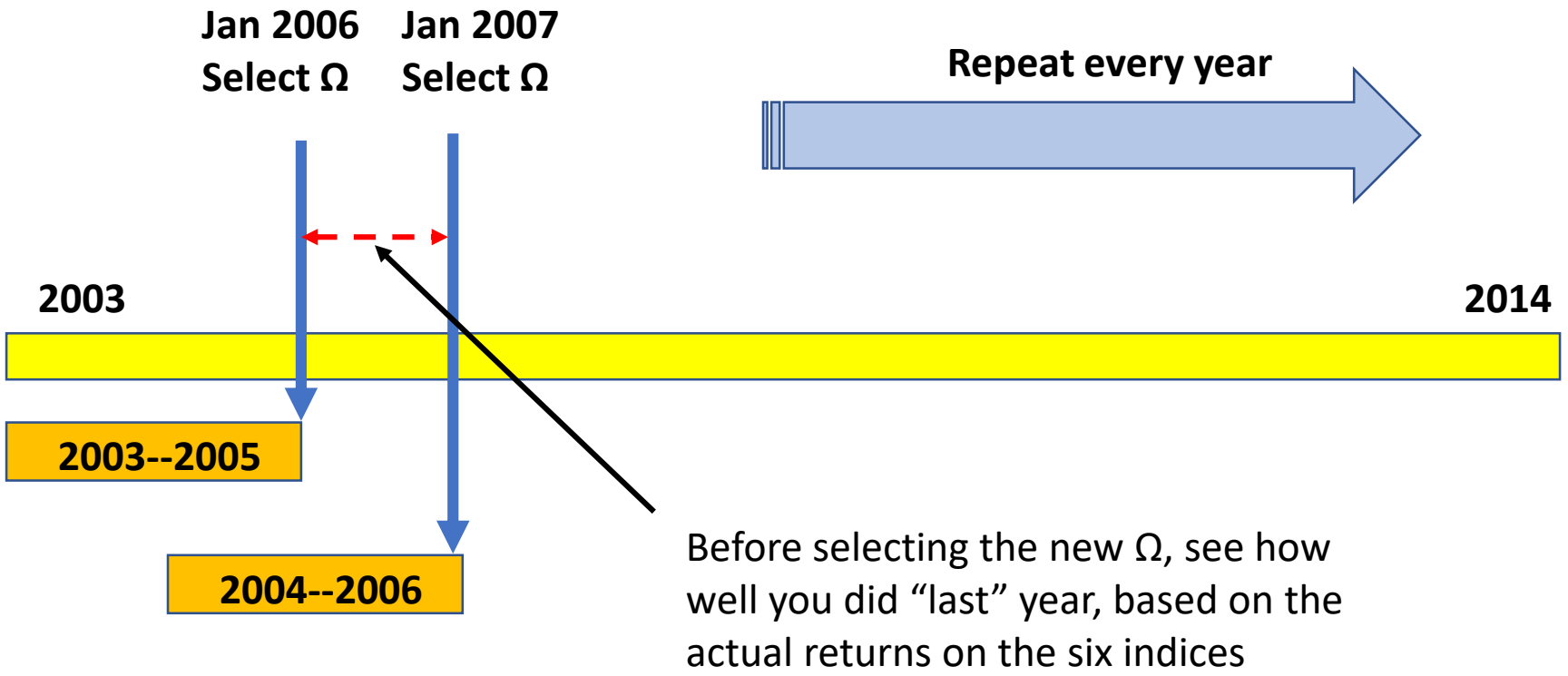
$$\omega_i \geq 0 \quad for \;\; i = 1, \ldots, 6$$

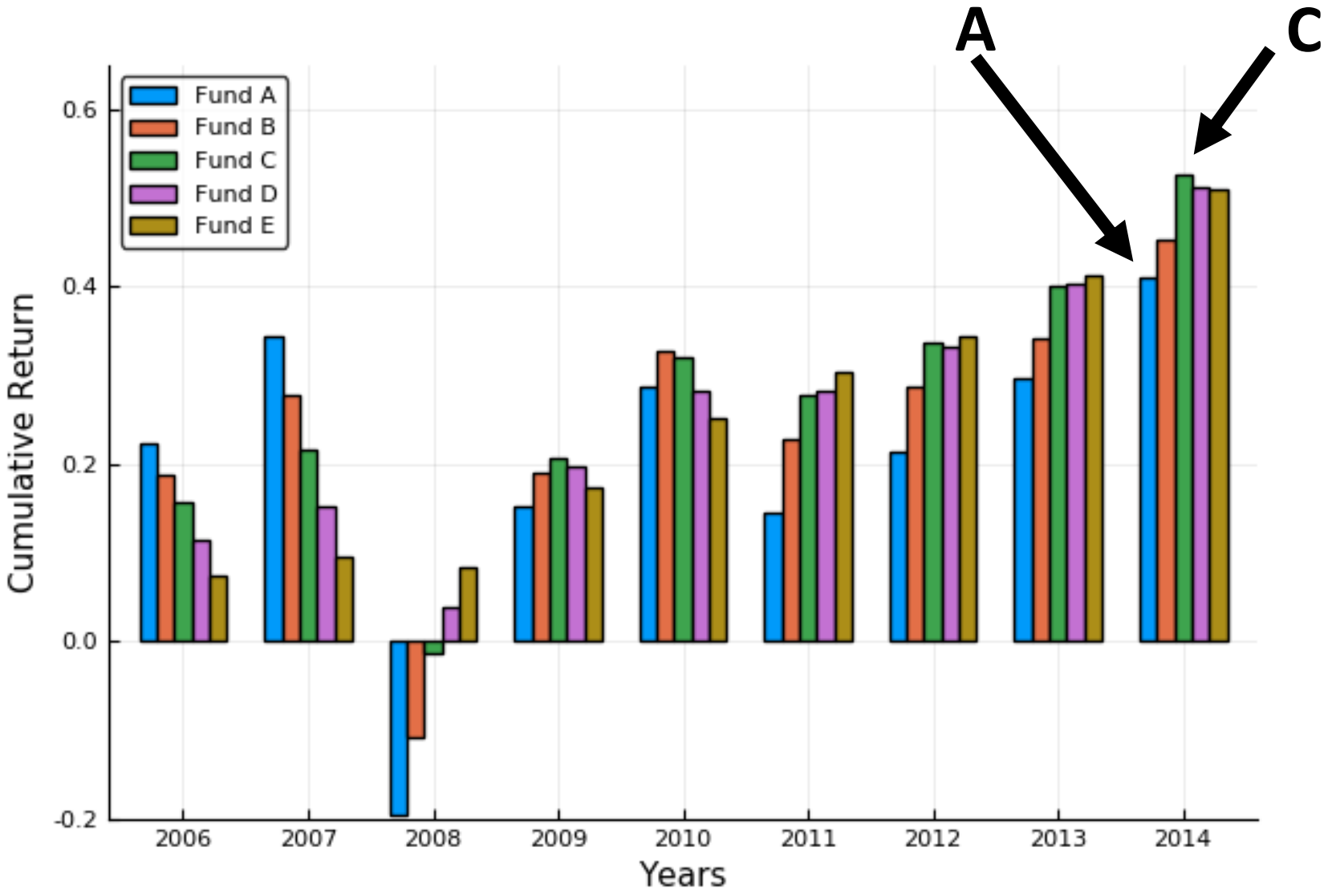
and

$$\sum_{i=1}^{6} \omega_i \;=\; 1$$

Application to the Chilean Case

We focus on the 9-year (2006-2014) period, using data from (2003-2013)





Cumulative (Actual) Returns, for windows of different sizes, for each Chilean fund

Let us use our approach now…

$$\underset{\Omega}{Max} \;\; \Omega^T r$$

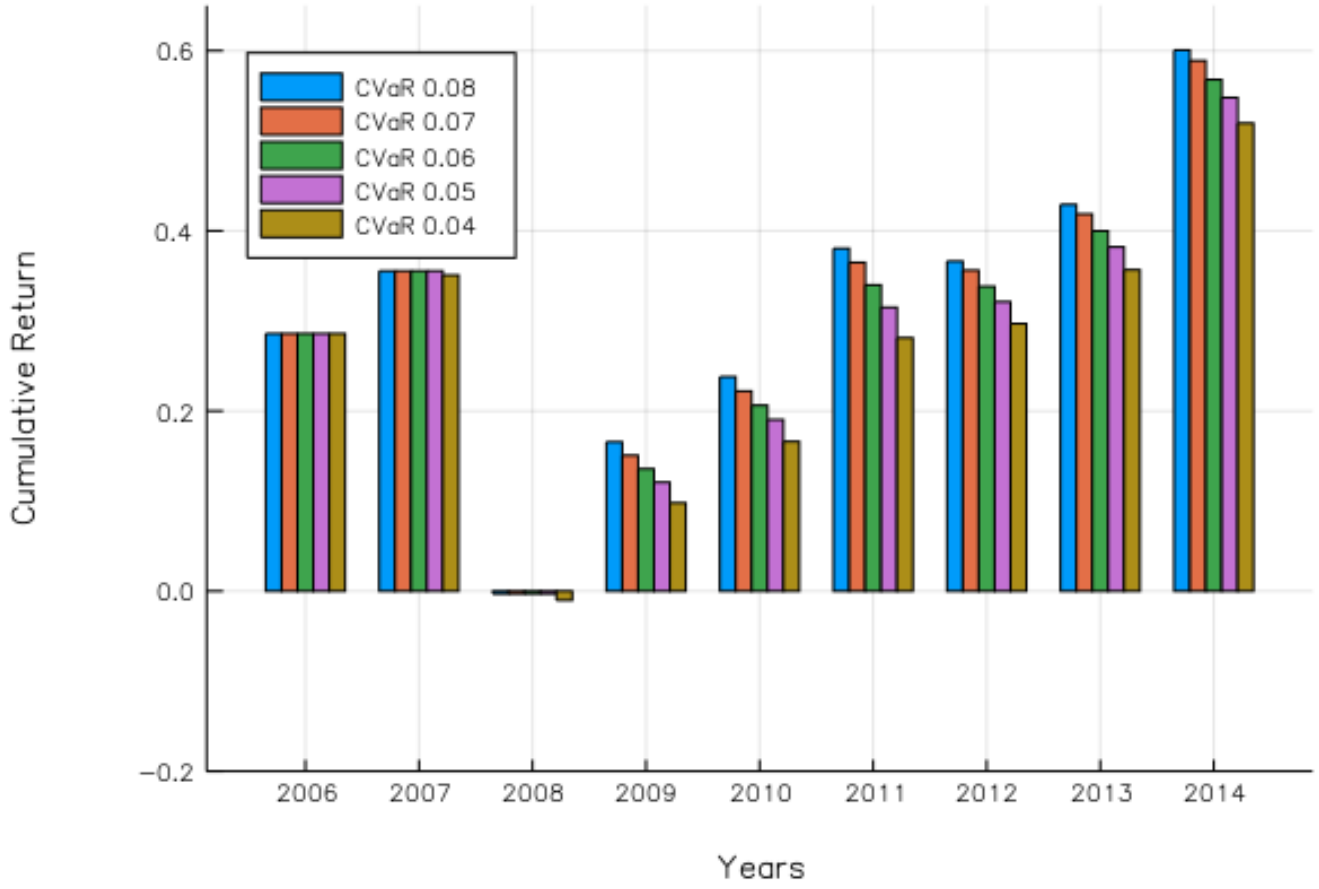
Subject to

$$CVaR_\alpha \left[\Omega^T r \; \right] \leq \gamma$$

γ ***= from 0% to 8%***

Our Proposal (Values of γ) for Each Fund:

A = 8%; B = 7%; C = 6%; D = 5 %; and E = 4 %



Let us maximize the return, subject to the Chilean regulation asset-class constraints

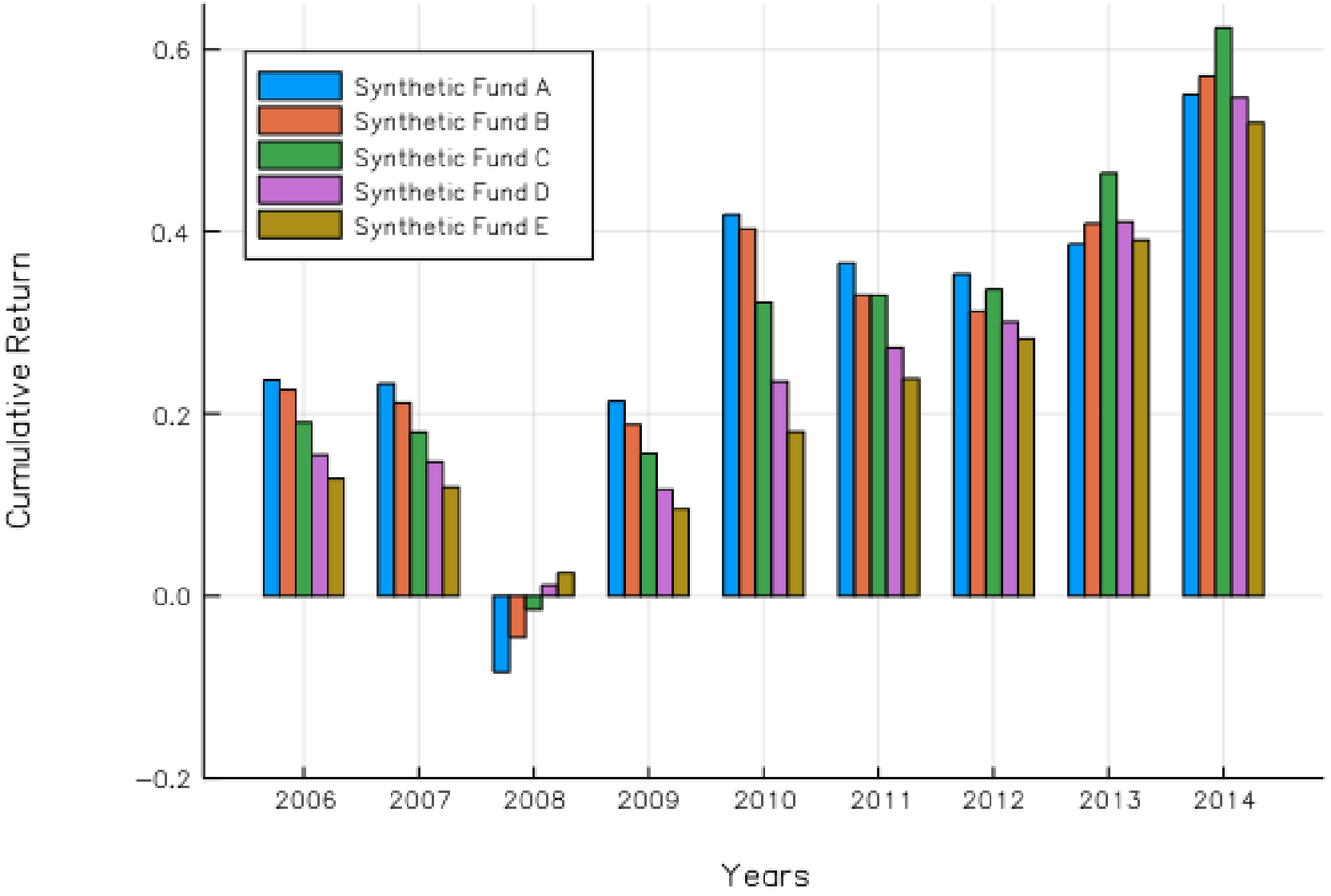
$$\underset{\Omega}{Max} \;\; \Omega^T r$$

Subject to

$$CVaR_{\alpha}\left[\Omega^T r\right] \leq \gamma$$

Add These

Lower Limit		Upper Limit
L(1)	Chilean Equities	U(1)
L(2)	Chilean Corporate Bonds	U(2)
L(3)	Chilean Sovereign Bonds	U(3)
L(4)	Chile Money Market	U(4)
L(5)	International Equities	U(5)
L(6)	International Corporate Bonds	U(6)


Synthetic Fund A
Synthetic Fund B
Synthetic Fund C
Synthetic Fund D
Synthetic Fund E
0.6
0.4
0.2
0.0
−0.2
Cumulative Return
2006
2007
2008
2009
2010
2011
2012
2013
2014
Years

Conclusions

- ✓ **Mexican funds are ranked correctly in terms of risk, cumulative return, and risk-adjusted return almost always. In short, they exhibit the desired risk-return profiles**

- ✓ **Chilean funds exhibit <u>erratic risk-return profiles</u>**

  In terms of risk-adjusted returns they are always ranked in a sequence which is the exact opposite of what it was intended

  And in terms of cumulative returns, more than half of the time they are ranked, again, in the "reverse" order

- ✓ **BOTTOM LINE: The Mexican regulation is working; the Chilean regulation is NOT working as intended**

- ✓ **Min/Max constraints by asset class do not work**
- ✓ **Min constraints are very dangerous (more than Max)**
- ✓ **Portfolio-level risk constraints work much better**
- ✓ **Our idea (CVaR-based) proposal is very promising**
- ✓ **In light of our results, it is obvious that the Chilean pension debate is (and has been) missing a critical issue**

The Discussion To have NOW !!!

The Discussion To have NOW:

How to Implement a Portfolio-Level Risk-Based Investment Regulation...

- ❑ VaR, C-VaR, other metrics/combinations?
- ❑ Computation-related Issues, Time-Frame?
- ❑ Risk Limits?
- ❑ Transition Regime?

Appendix -- References

"A Two-Step Hybrid Investment Strategy for Pension Funds" In **The North American Journal of Economics and Finance** (2017), 42 (November 2017): 574-583; Pagnoncelli, Cifuentes & Denis

"Can asset allocation limits determine portfolio risk–return profiles in DC pension schemes?" In **Insurance Mathematics and Economics**, Vol. 86, May 2019, Pages 134-144; Gutierrez, Pagnoncelli, Valladao & Cifuentes

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"Pension Funds in Mexico and Chile: A Risk-Reward Comparison", Clapes, April, 2019; Schlechter, Pagnoncelli & Cifuentes