Australian Investment Performance 1959 to 2017 (and Investment Assumptions for Stochastic Models)

Colin Grenfell and **Thomas Sneddon**

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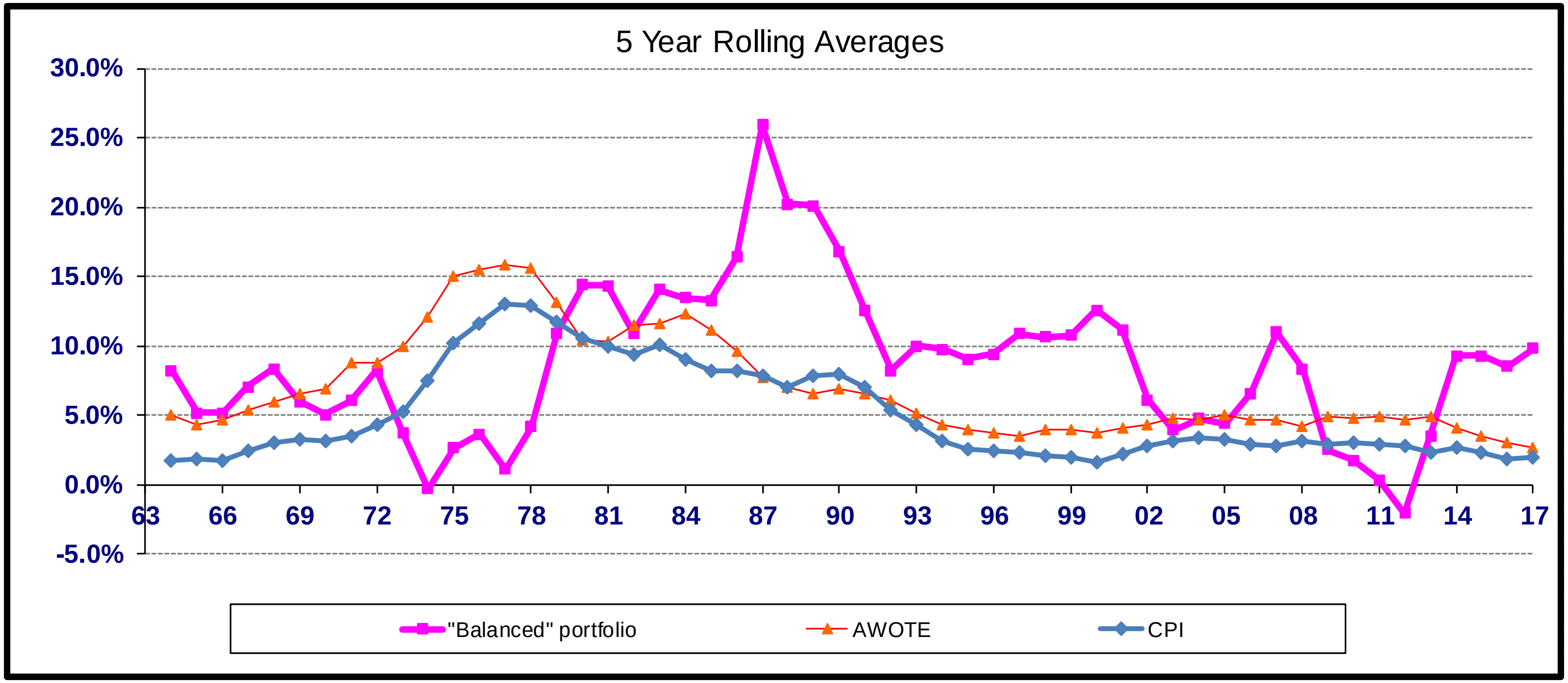
Australian Investment Performance 1959 to 2017 (and Investment Assumptions for Stochastic Models)

1959 to 2017



Historical 5-year (ending 30/6/64 to 30/6/17) compound average annual returns and rates

Source: *Austmod,* net of tax and fees

Presentation

Why?

What?

How? … briefly

Results … some of the 82 charts

… just 2 of 30 tables

(with focus on features and concepts, rather than values)

Acknowledgments

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Why?

Demand versus supply gap

- in Australia
- for many sectors
- often for commercial reasons
- particularly, data for long term assumptions

and

- little documented assumption methodology

Demand "pull"

- Actuaries use investment assumptions in all practice areas
- For premium or contribution rate calculations
- For valuations, capital assessments, investment strategy calculations, etc
- For benefit and other projections

Supply "push"

Valuable 58-year database:

- EFG investment system (1965 to 2009)
- Published indices and rates (8-58 years)

We're keen to see Australian actuaries make greater use of:

- Stochastic models
- Historical simulations
- Auto-correlations
- Economic cycles

What content ?

(1) Australian investment performance
30 June 1959 to 30 June 2017
(annual data, quarterly intervals)

(2) Investment assumptions (realistic) for
stochastic (and deterministic) models

What sectors?

GROWTH SECURITIES

S	Australian shares
I	International shares (unhedged)
H	International shares (hedged)
Q	Property trusts
P	Direct property

INTEREST INCOME

F	Australian fixed interest
J	International fixed interest (hedged)
G	Government semis (0 to 3 yrs)
N	Inflation-linked bonds (0 + yrs)
L	Loans (floating rate) / Credit
C	Cash

FINANCIAL INDICATORS

X	CPInde<u>x</u> (annual increase)
W	A<u>W</u>OTE (annual increase)
B	90-day <u>b</u>ill rates (<u>mid-year</u>)
D	10-year bon<u>d</u> rate (<u>mid-year</u>)

Section 3 details
Section 4 backdating

What results?

- Risk margins (over 10-year bond rates)
- Coefficients of variation (of rates)
- Skewness (of forces)
- Kurtosis (of forces)
- Cross-correlations (of forces)
  rank <u>and</u> standard
- Auto-correlations (of forces)

- **Arithmetic means (44 years)**
- **Compound means (44 and 40 yrs)**
- **Standard deviations (44 years)**
- **“Balanced” and “Capital stable”**
- **Gross/net of superannuation tax**
- **Gross/net of wholesale passive fees**

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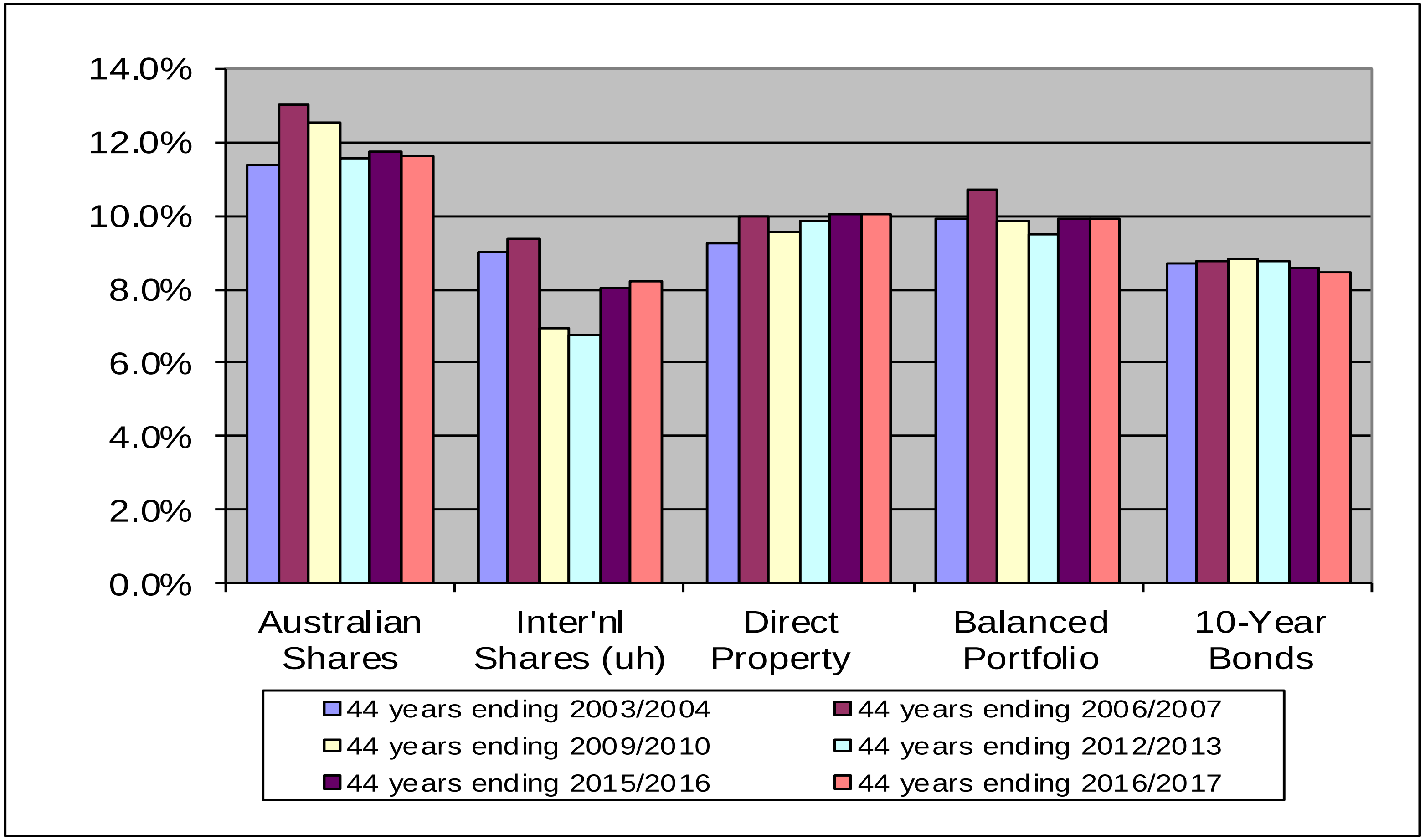
44-year Average (compound) Returns pa



2003/2004 (for example) indicates average of yrs. ending 30/9/03, 31/12/03, 31/3/04 & 30/6/04

Figure 8.1, before tax and fees

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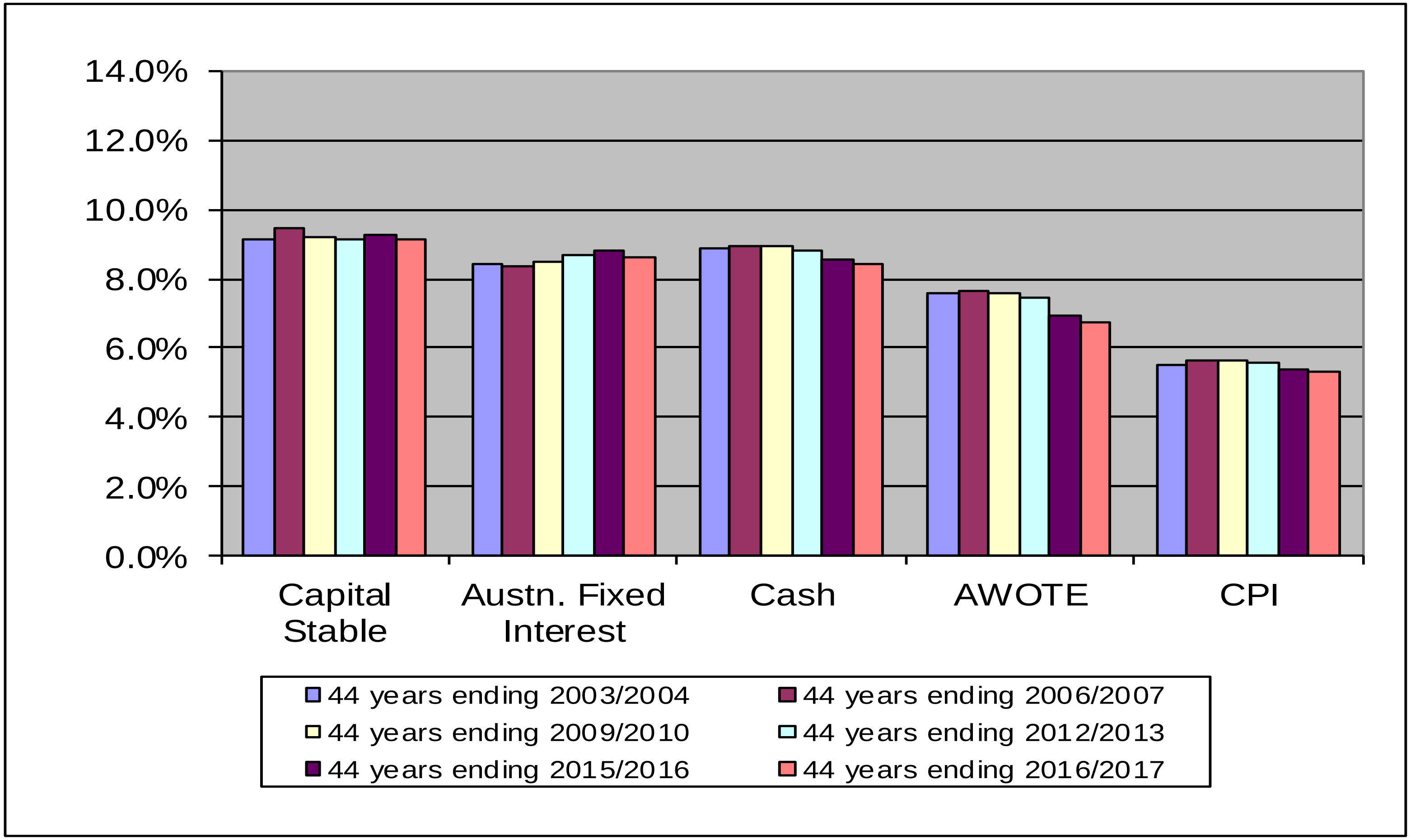
44-year Average (compound) Returns pa



2003/2004 (for example) indicates average of yrs. ending 30/9/03, 31/12/03, 31/3/04 & 30/6/04

Figure 8.1, before tax and fees

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Impact of GFC on Balanced Portfolio

Figure 9.1

Unit price, before tax and fees

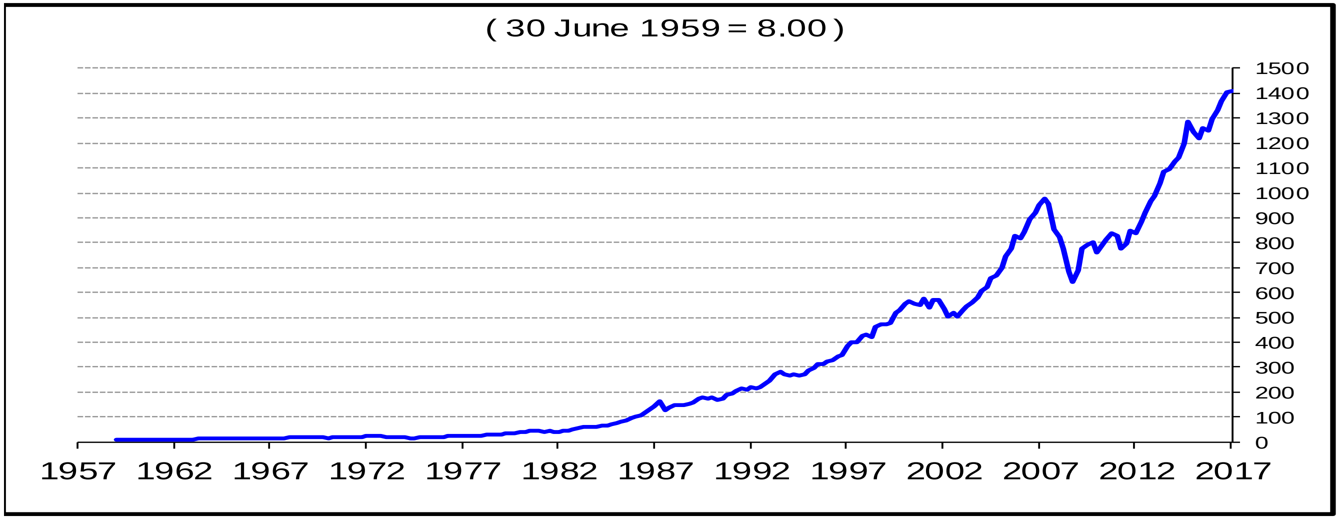
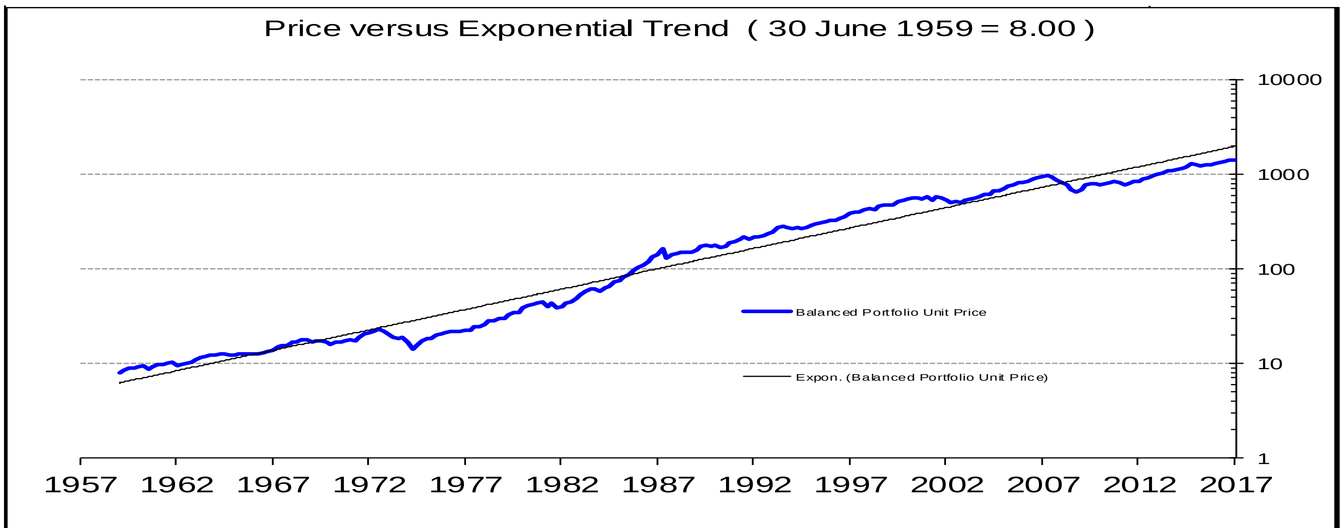


Figure 9.2



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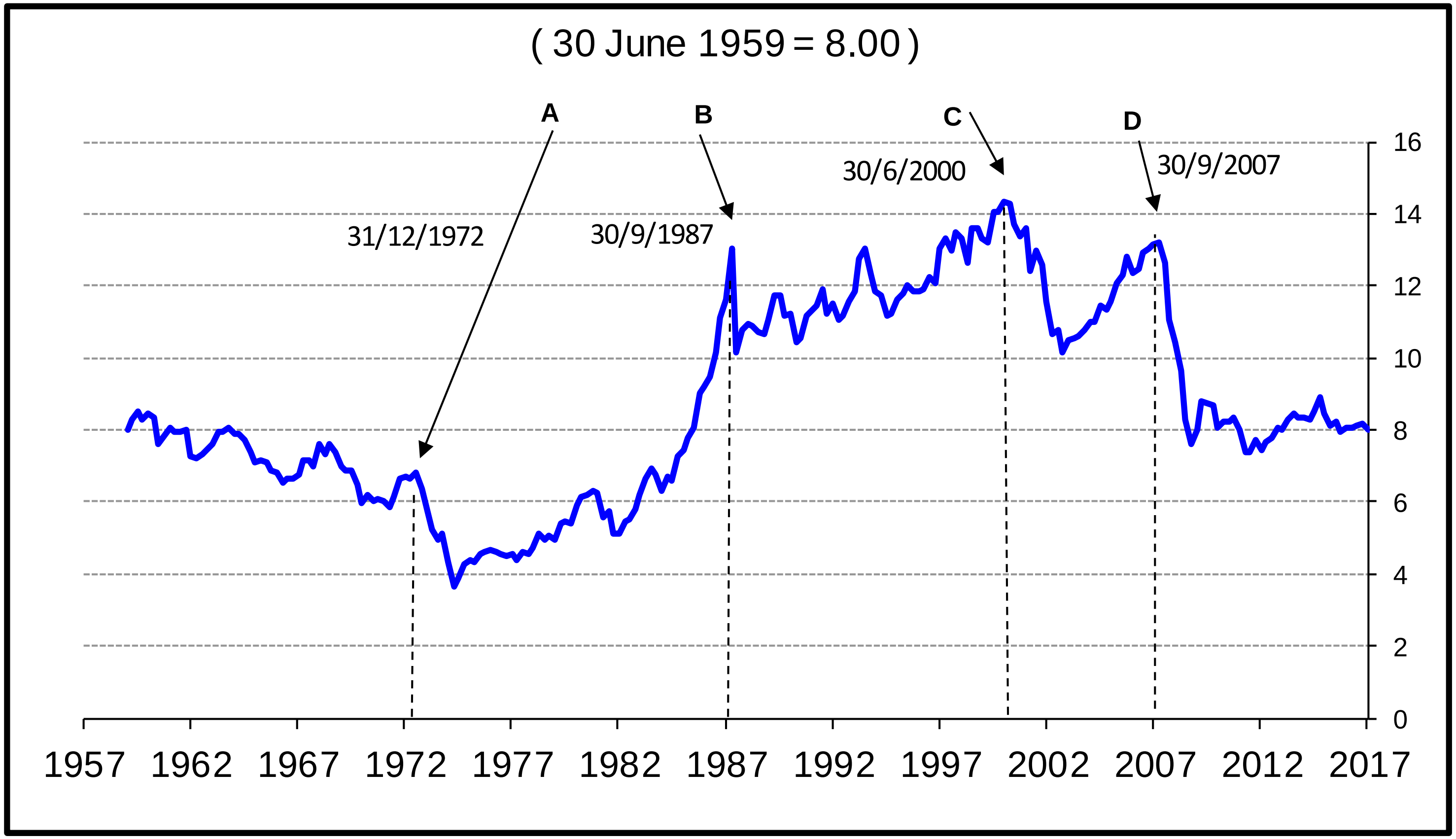
Balanced Portfolio "Discounted Price"

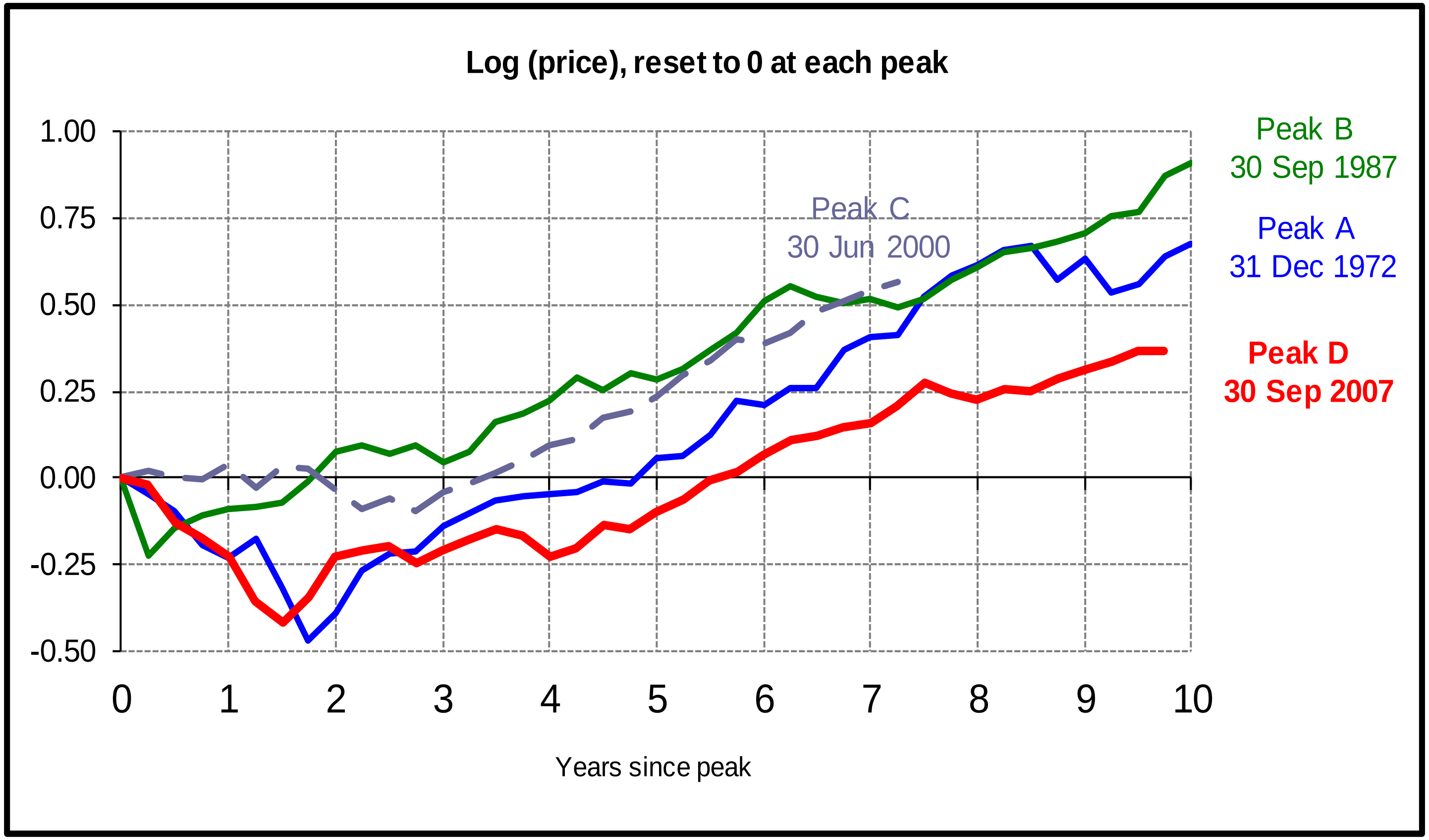
Figure 9.3



A 31 Dec 1972 **B 30 Sep 1987**
C 30 Jun 2000 **D 30 Sep 2007**

Log Price Reset to 0 at Each Peak

Figure 9.4



Balanced Portfolio with Price reset

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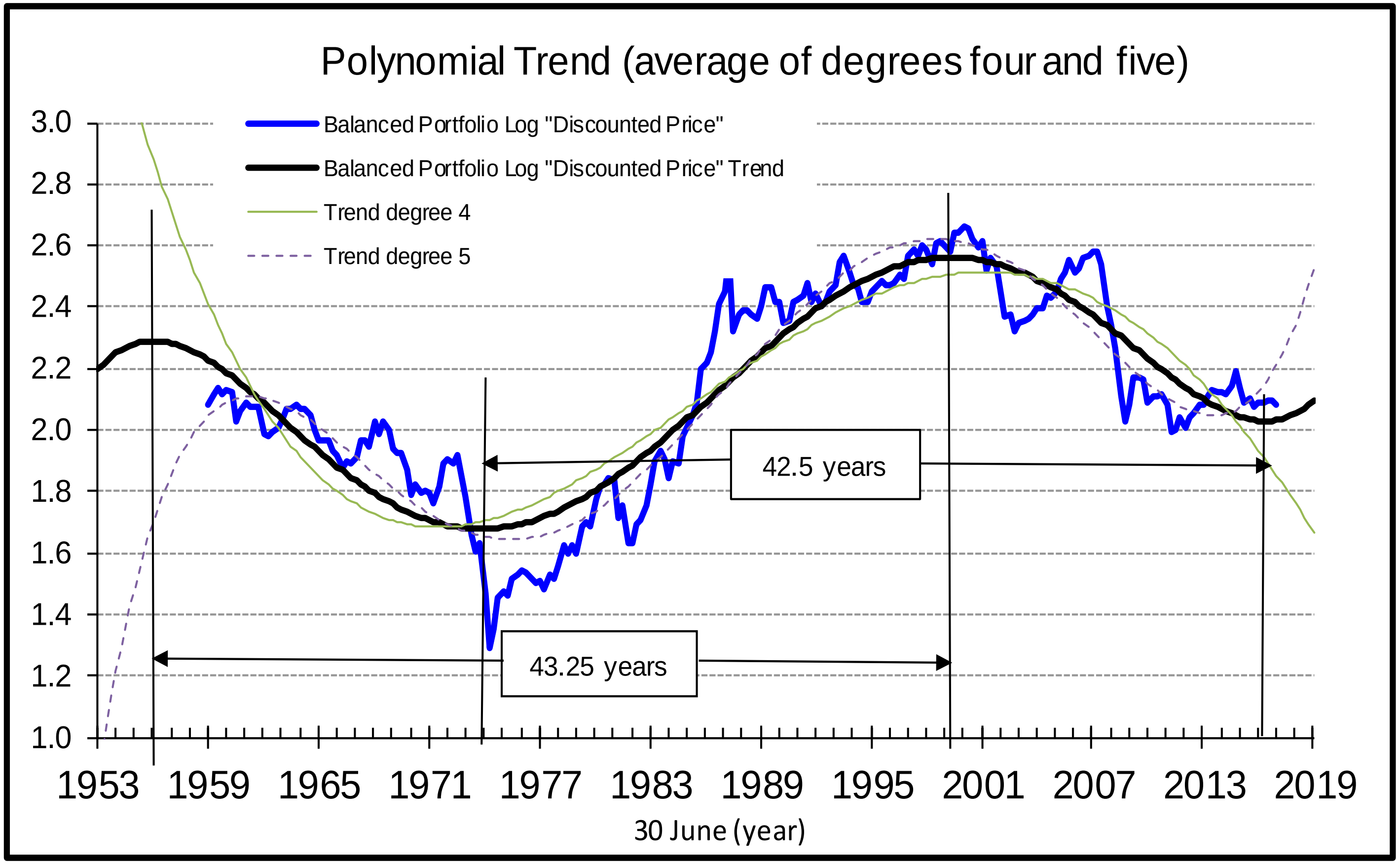
Balanced Portfolio Log "Discounted Price" and Trend

Figure 9.5



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Bonds

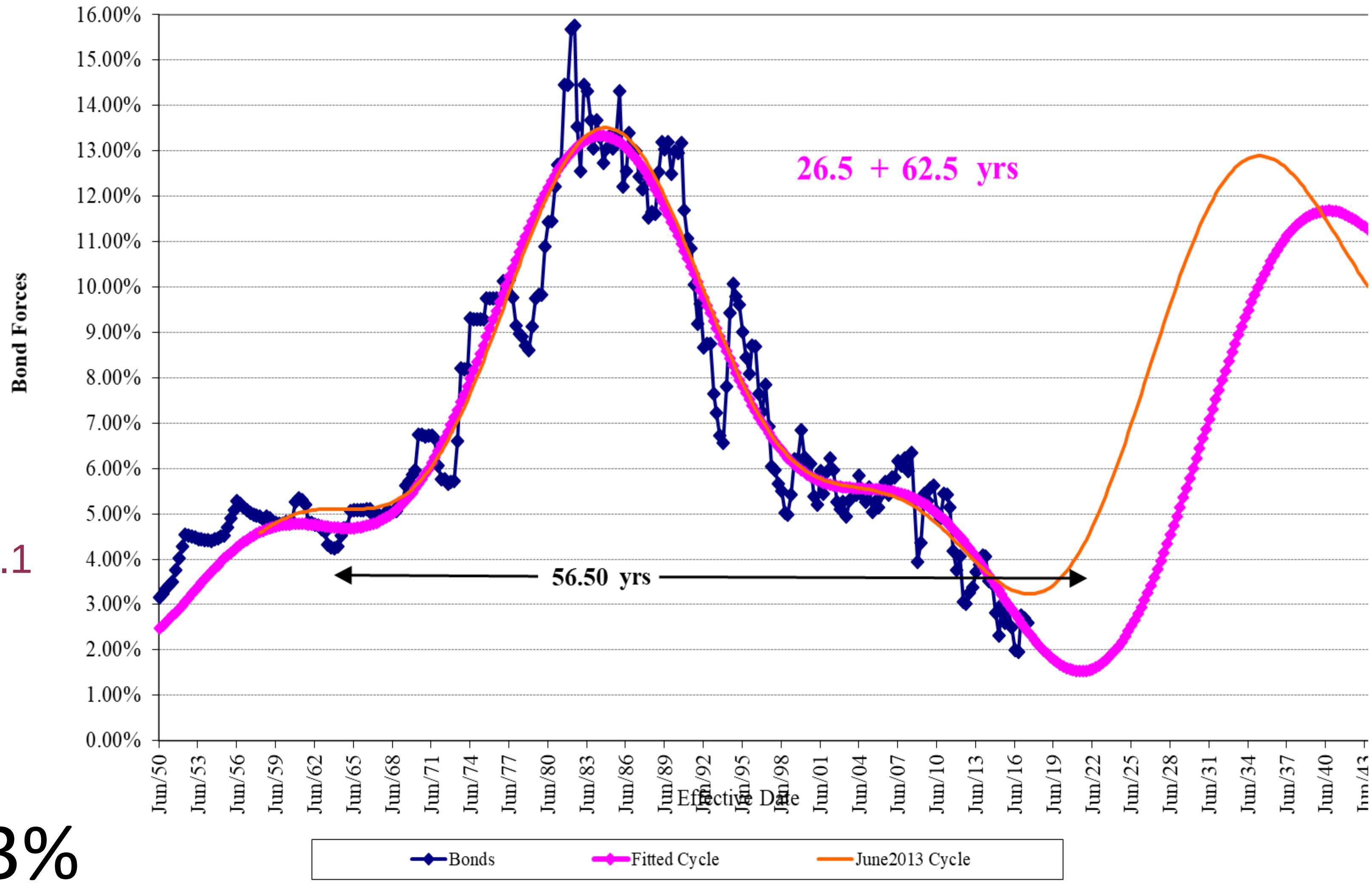
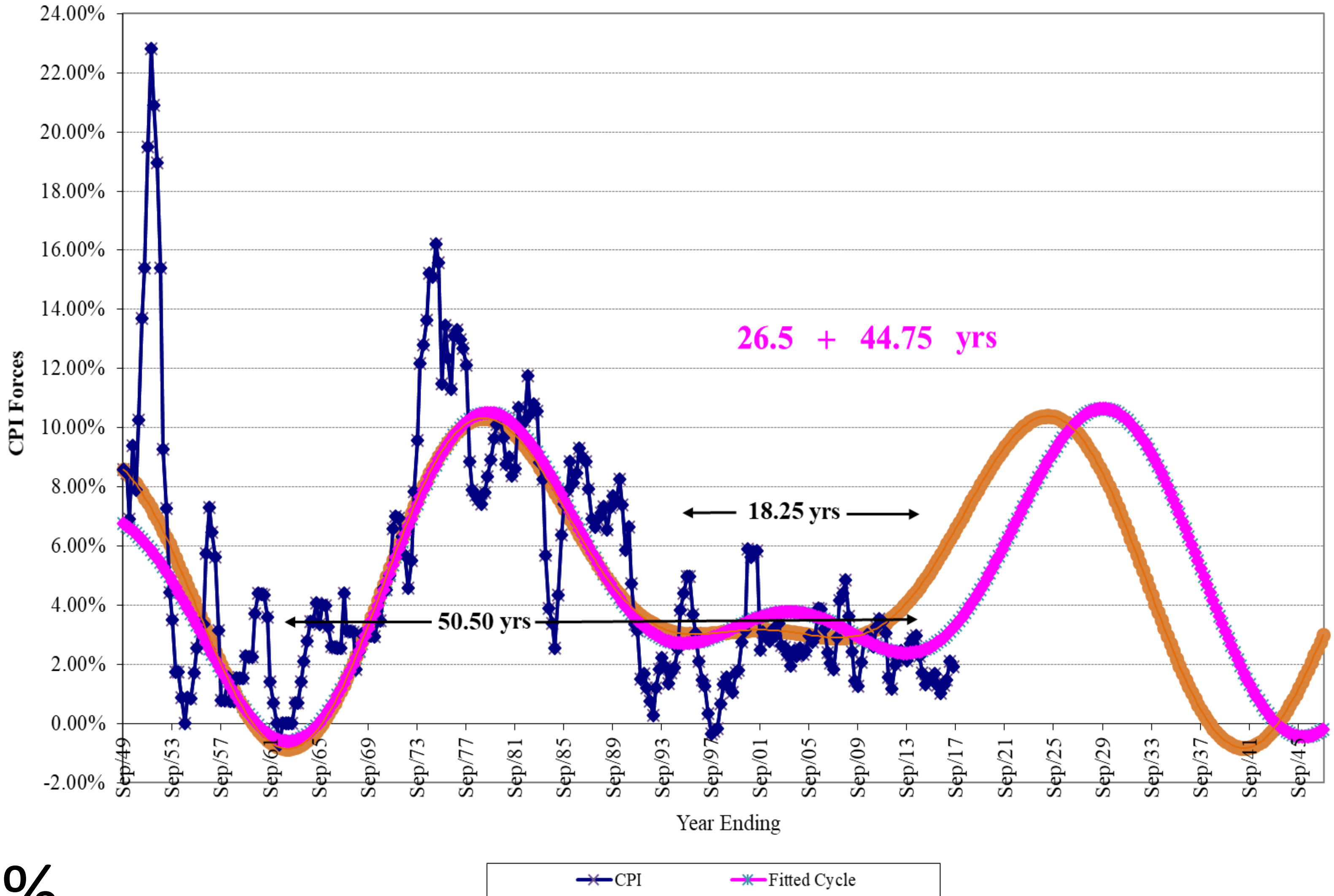


Figure 5.1

93.3%

CPI

Figure 5.2



56.7%

AWOTE

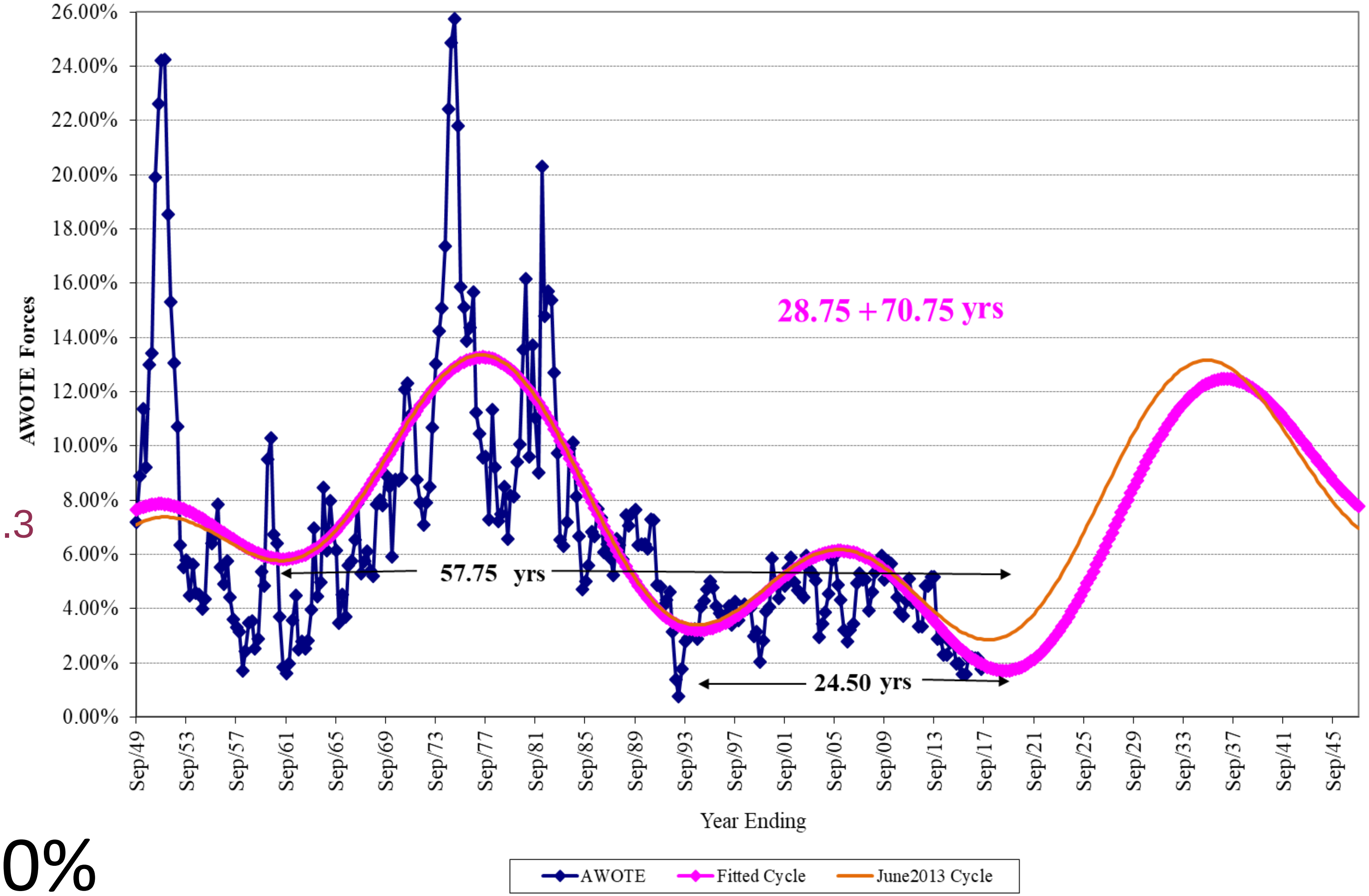
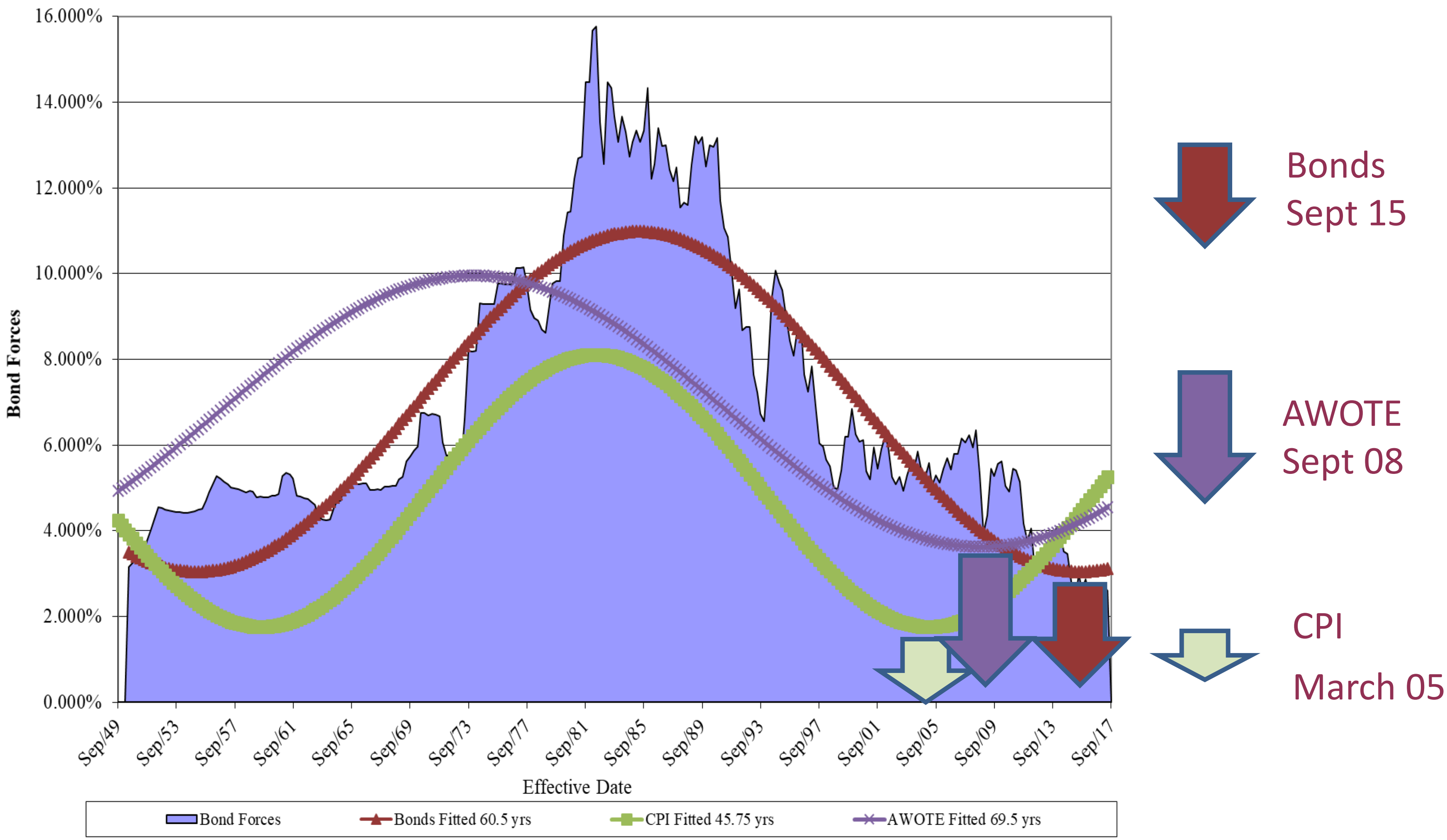


Figure 5.3

56.0%

Bonds, CPI and AWOTE

Figure 5.4



Australian Shares

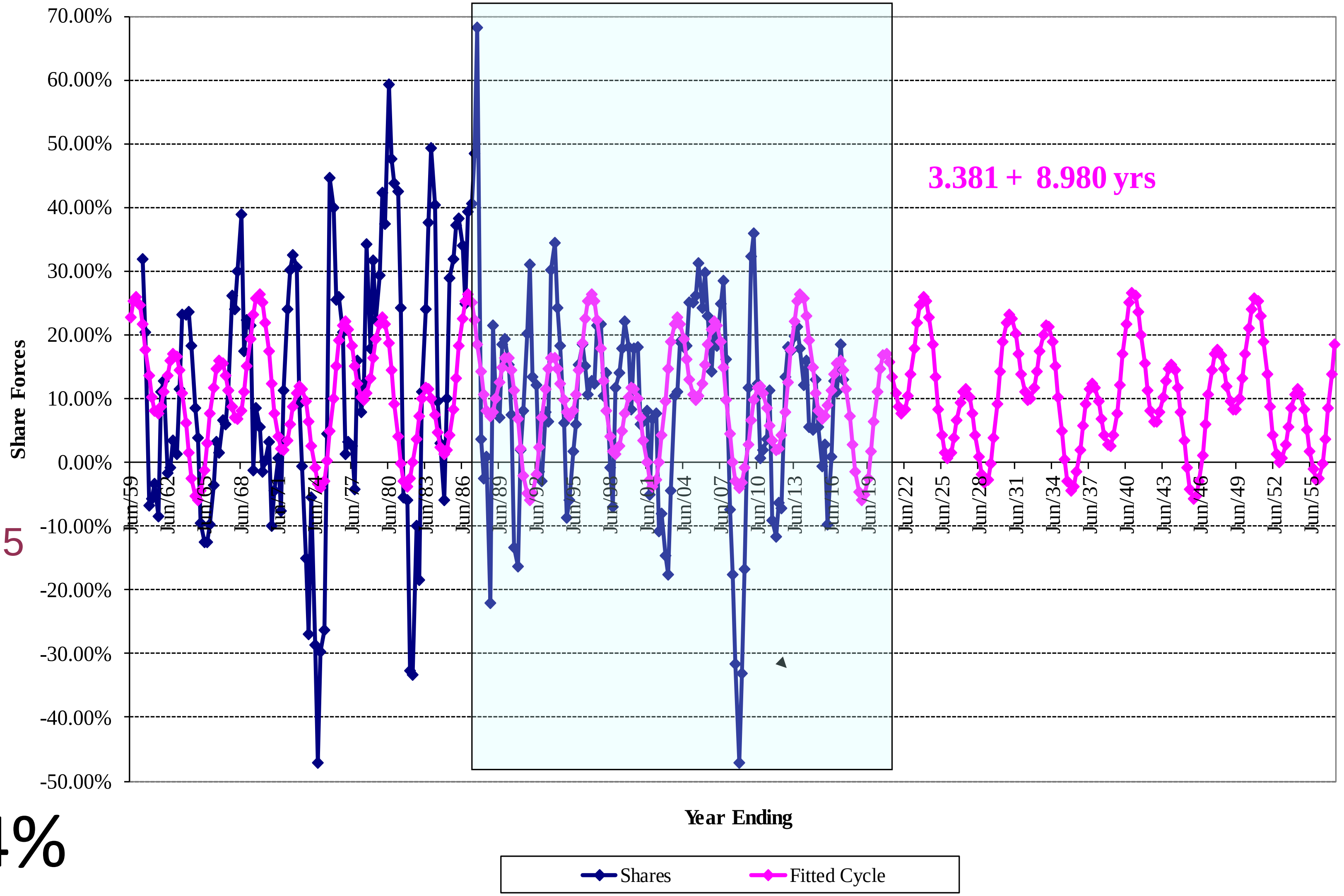
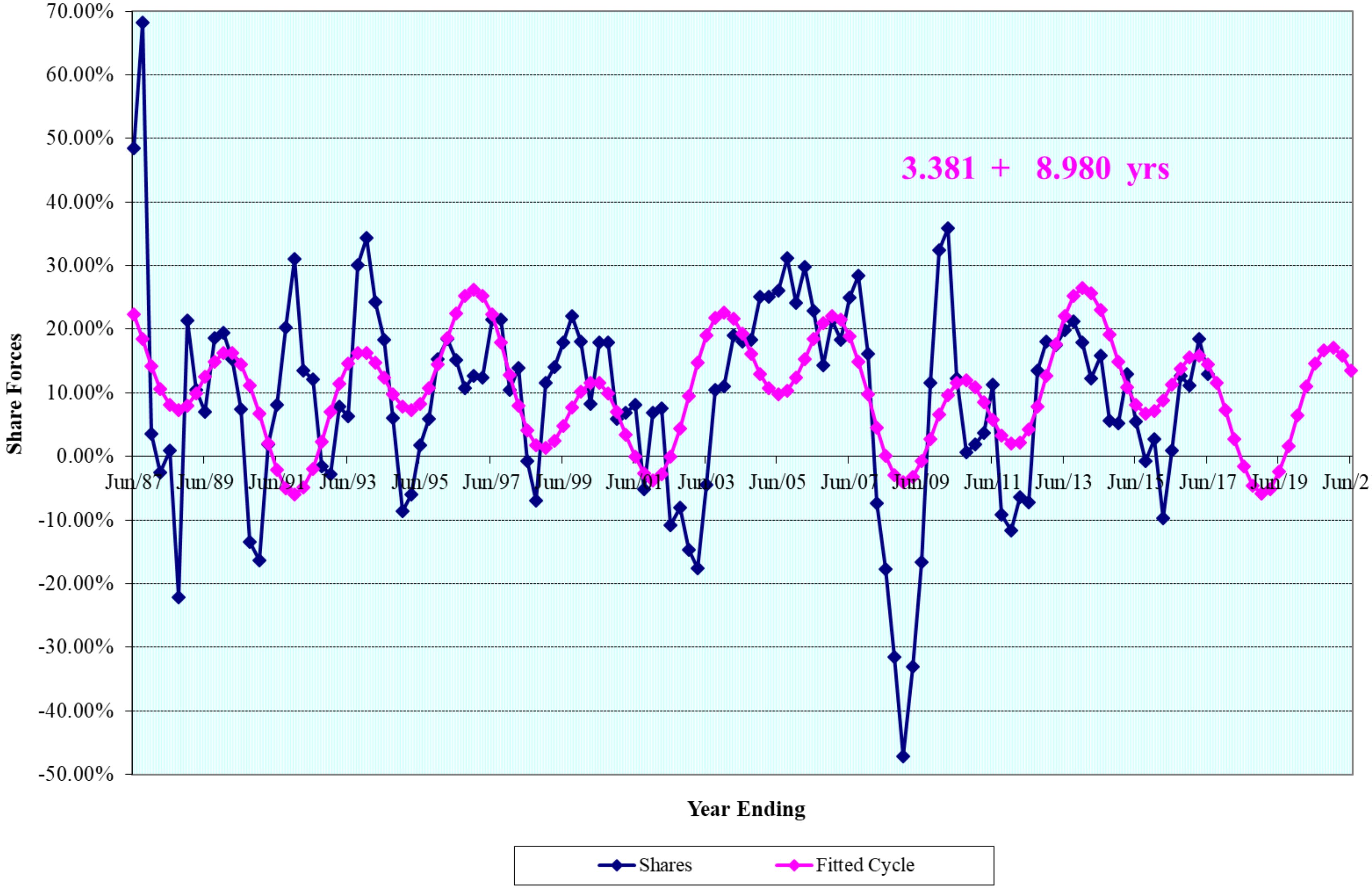


Figure 5.5

20.4%

Shares (close-up)



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QUESTIONS ?

- Demand and supply
- Database
- 15 sectors
- Backdating
- 44-year returns
- GFC
- Cycles
- Sine curves

How?

Assumptions - Methodology

Step 1 Sep, Dec, March, June data

Step 2 determine calculation periods
(see previous slides, 44 and 40 years)

Step 3 annual statistics for the step 2 periods

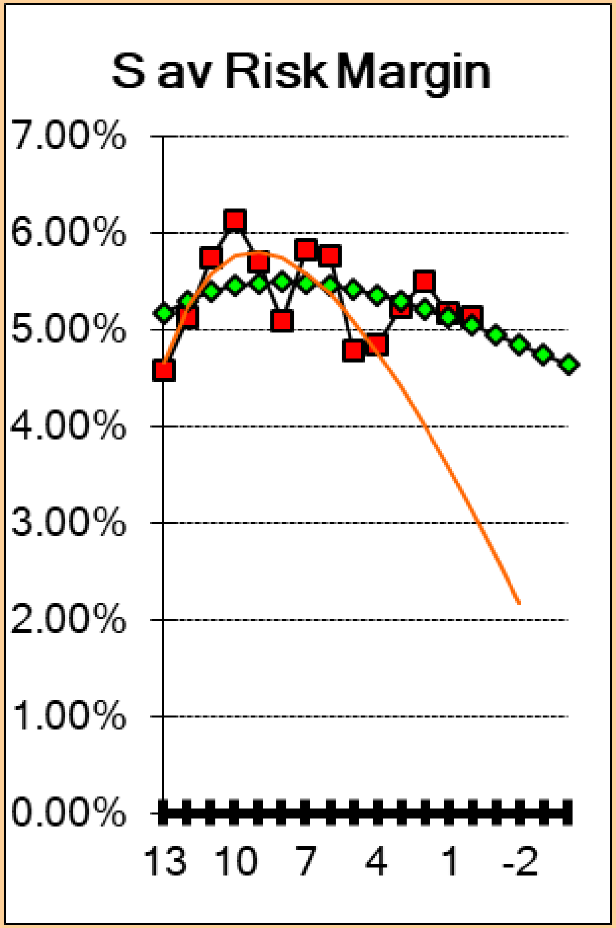
Step 4 14 "running" averages of 4 quarter-end results

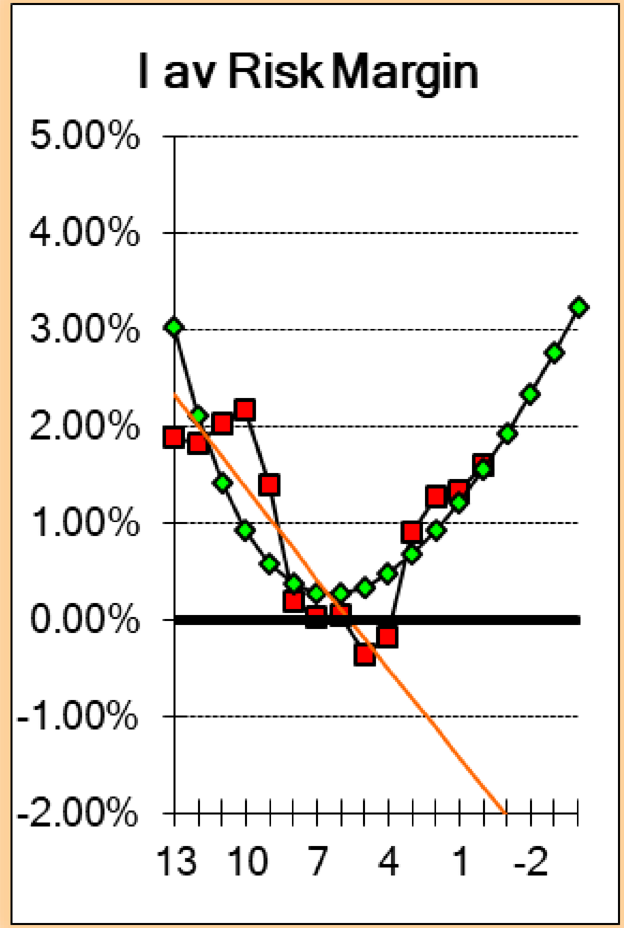
Step 5 weighted quadratic trend and 6 year projection

Step 6 year - 2 (and judgment)

see Section 2

Results: Risk Margins over 44 years





[4.4%] Figure 6.1 [3.0%]

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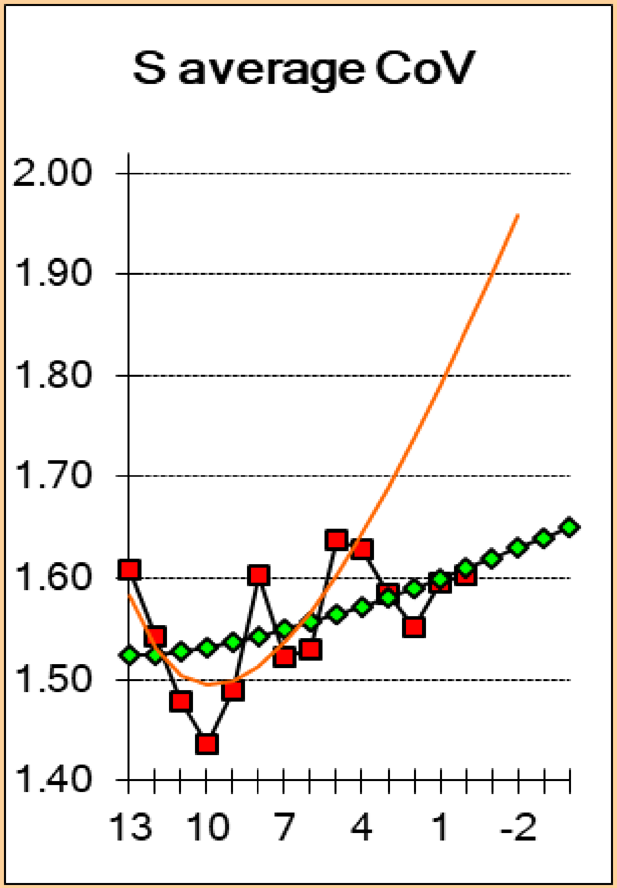
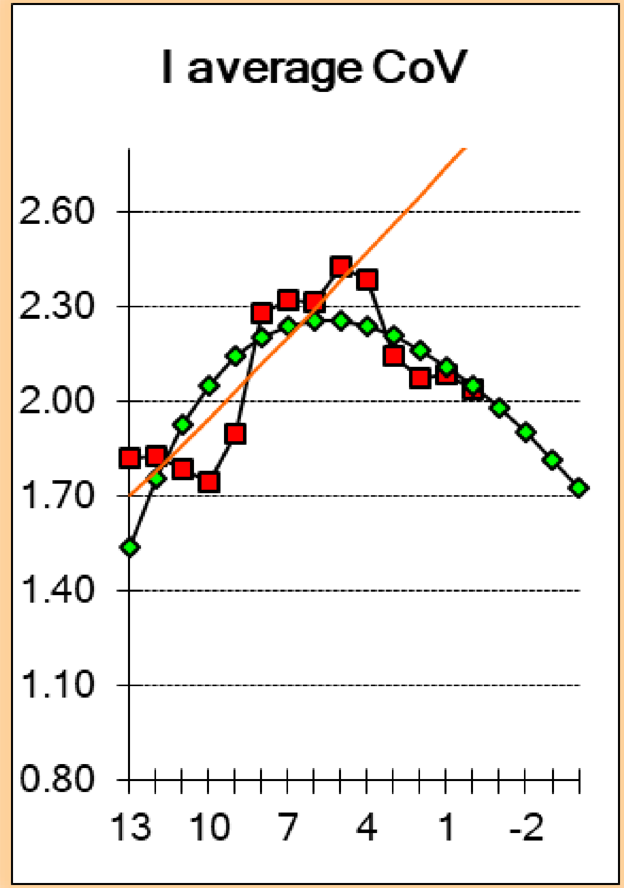
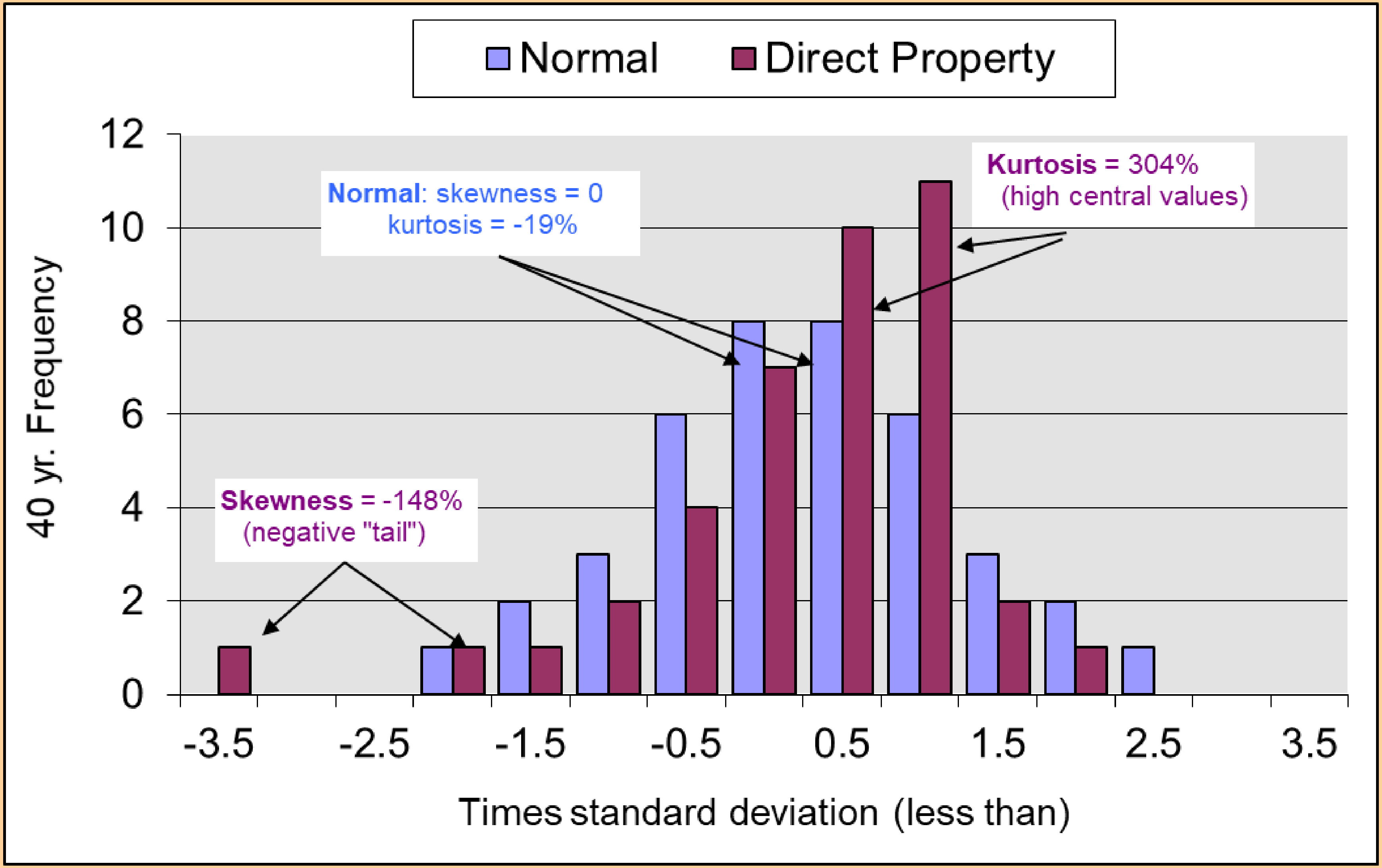
Results: CoV's over 44 years



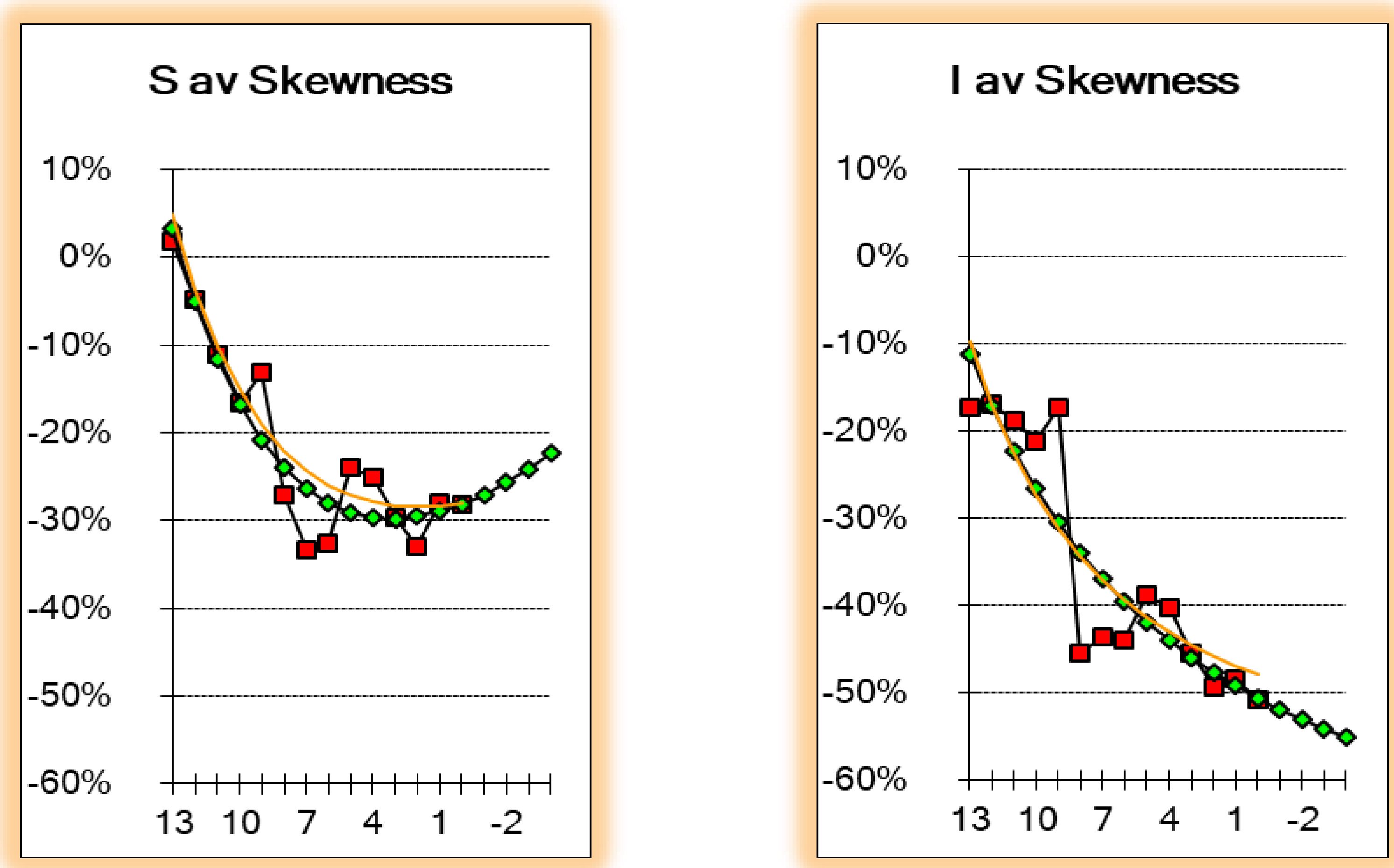


[1.616] Figure 7.1 **[1.623]**

Skewness and Kurtosis



Results: Skewness over 44 years



[-26%]

Figure 11.1

[-53%]

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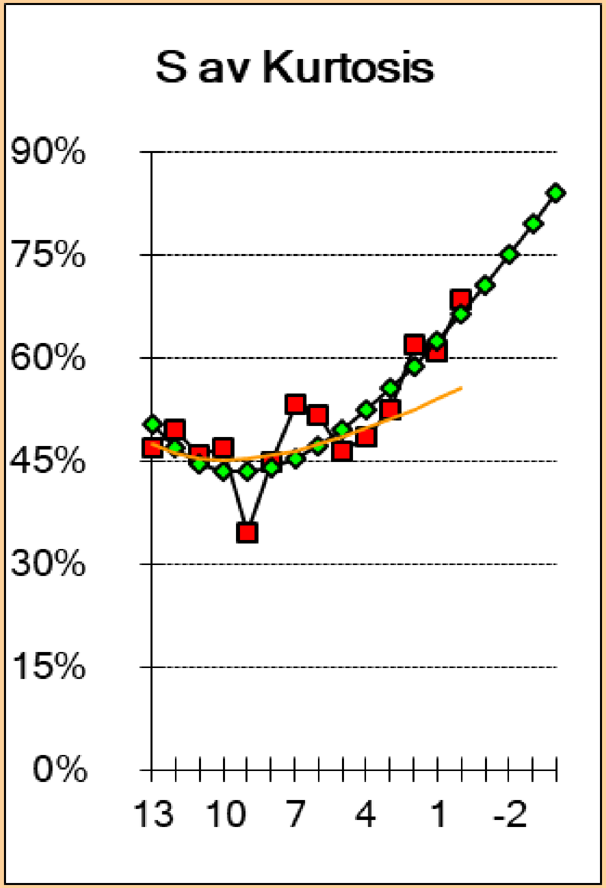
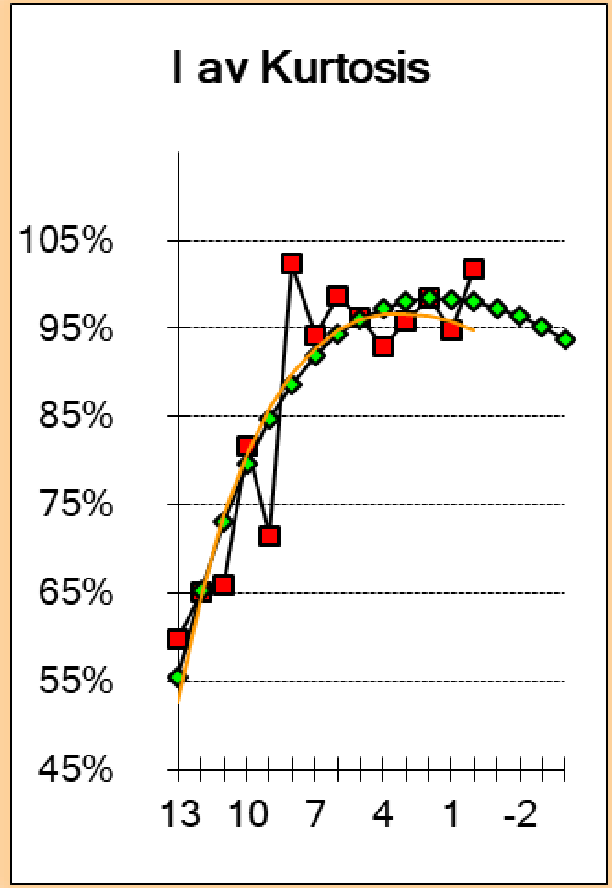
Results: Kurtosis over 44 years





[75%] Figure 12.1 **[96%]**

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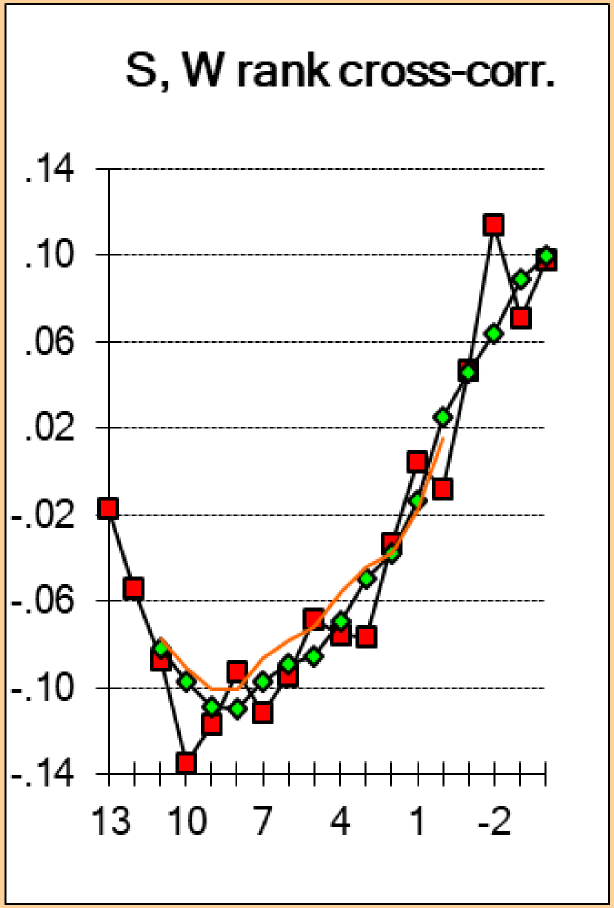
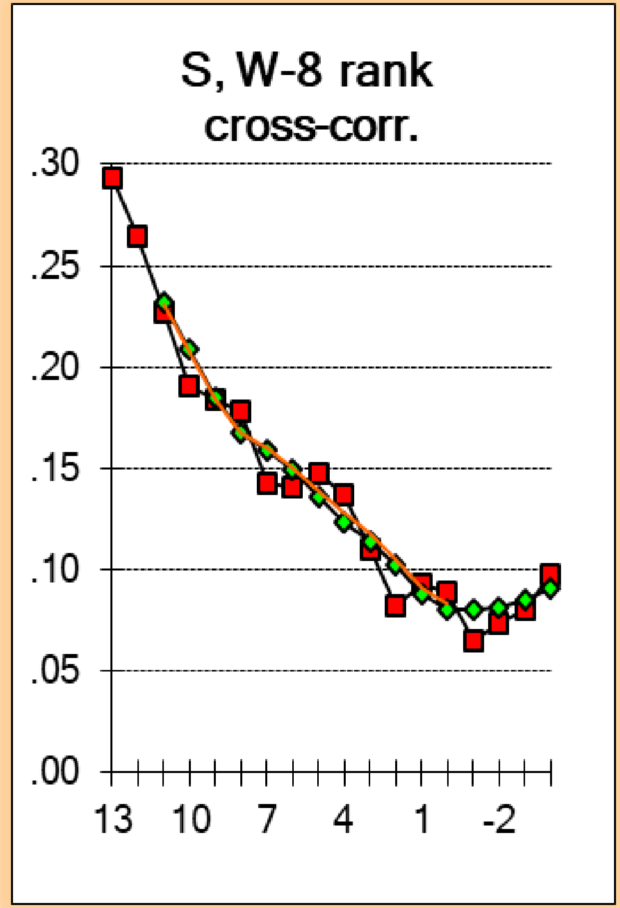
Results: Rank Cross-correlations over 44 years



[6%]



[+8%]

Figure 13.1

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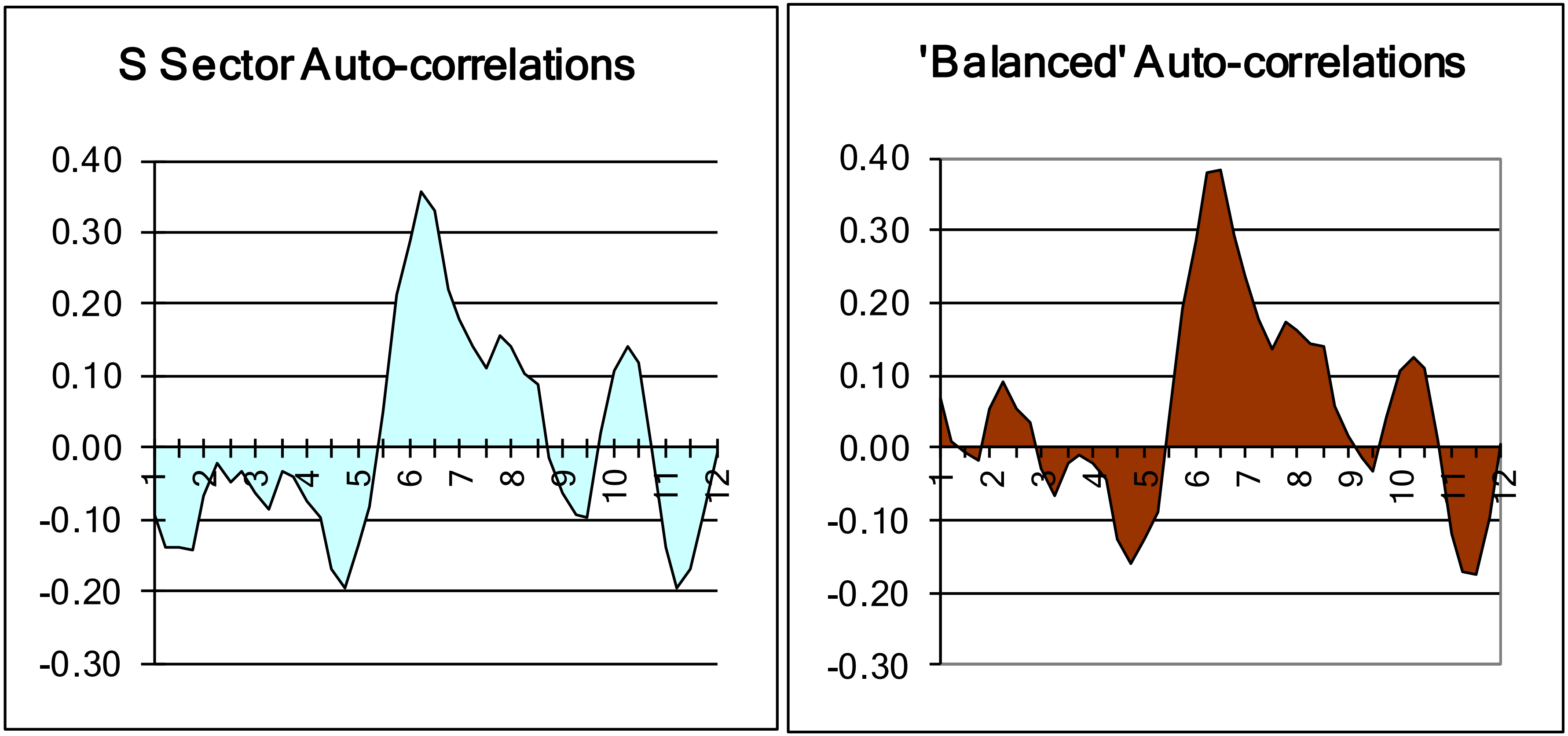
Cross-correlation Assumptions (abridged)

	RANK	CROSS-CORRELATIONS @ 2 YRS (5-point average, rounded)					
SECTOR	Austn. Shares	Listed Property	Fixed Interest	Cash	Direct Property	CPI	AWOTE
Austn. Shares	**1**	.49	-.06	.21	.13	.08	.06
Listed Property	.49	**1**	.25	.13	.18	-.04	.04
Fixed Interest	-.06	.25	**1**	.41	-.03	.11	.17
Cash	.21	.13	.41	**1**	.41	.71	.69
Direct Property	.13	.18	-.03	.41	**1**	.55	.44
CPI	.08	-.04	.11	.71	.55	**1**	.80
AWOTE	.06	.04	.17	.69	.44	.80	**1**

Section 13 and Table 16.3

Auto-correlations over 40 years



Lags 1 to 12 years

Figure 15.1

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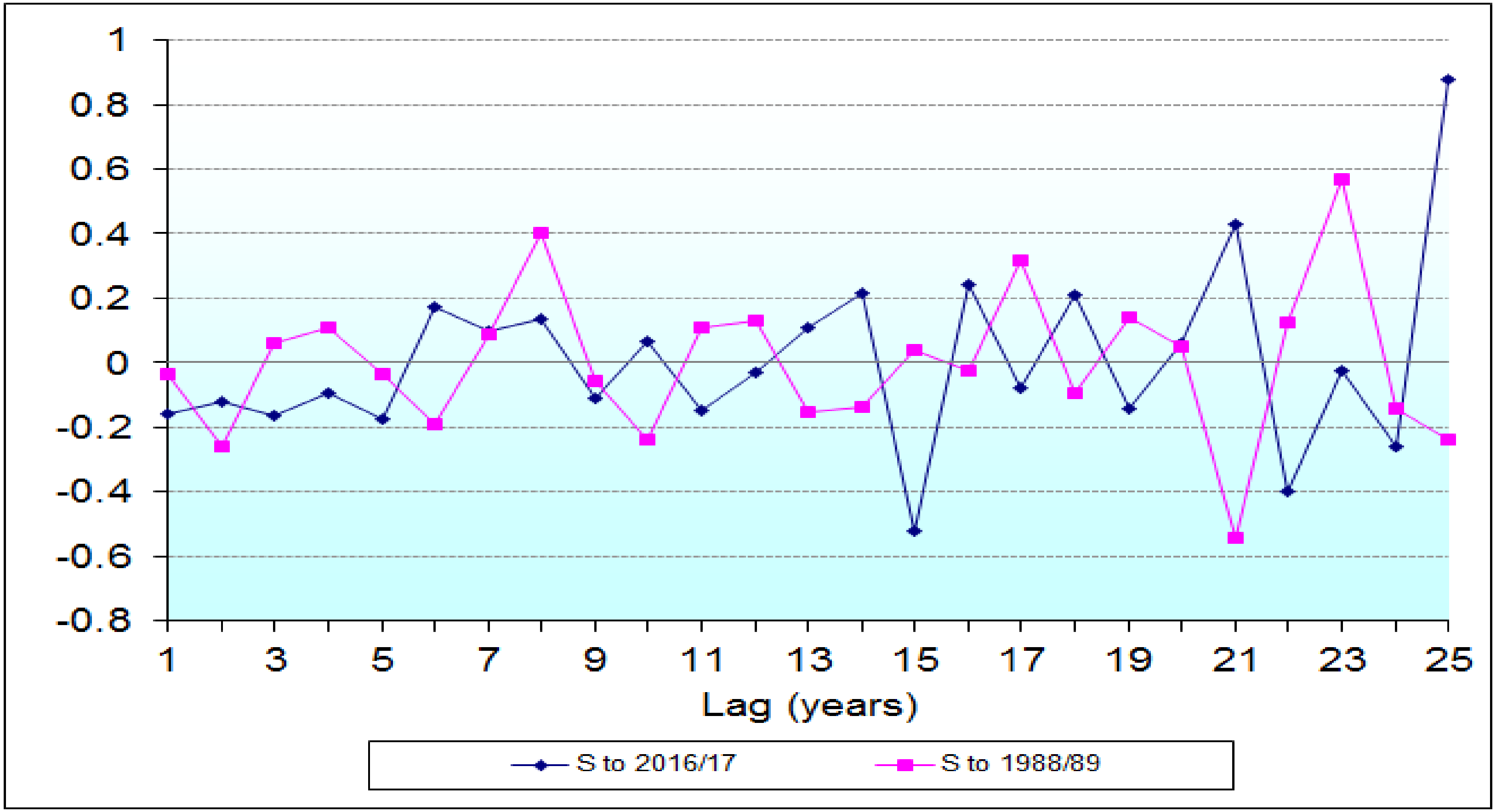
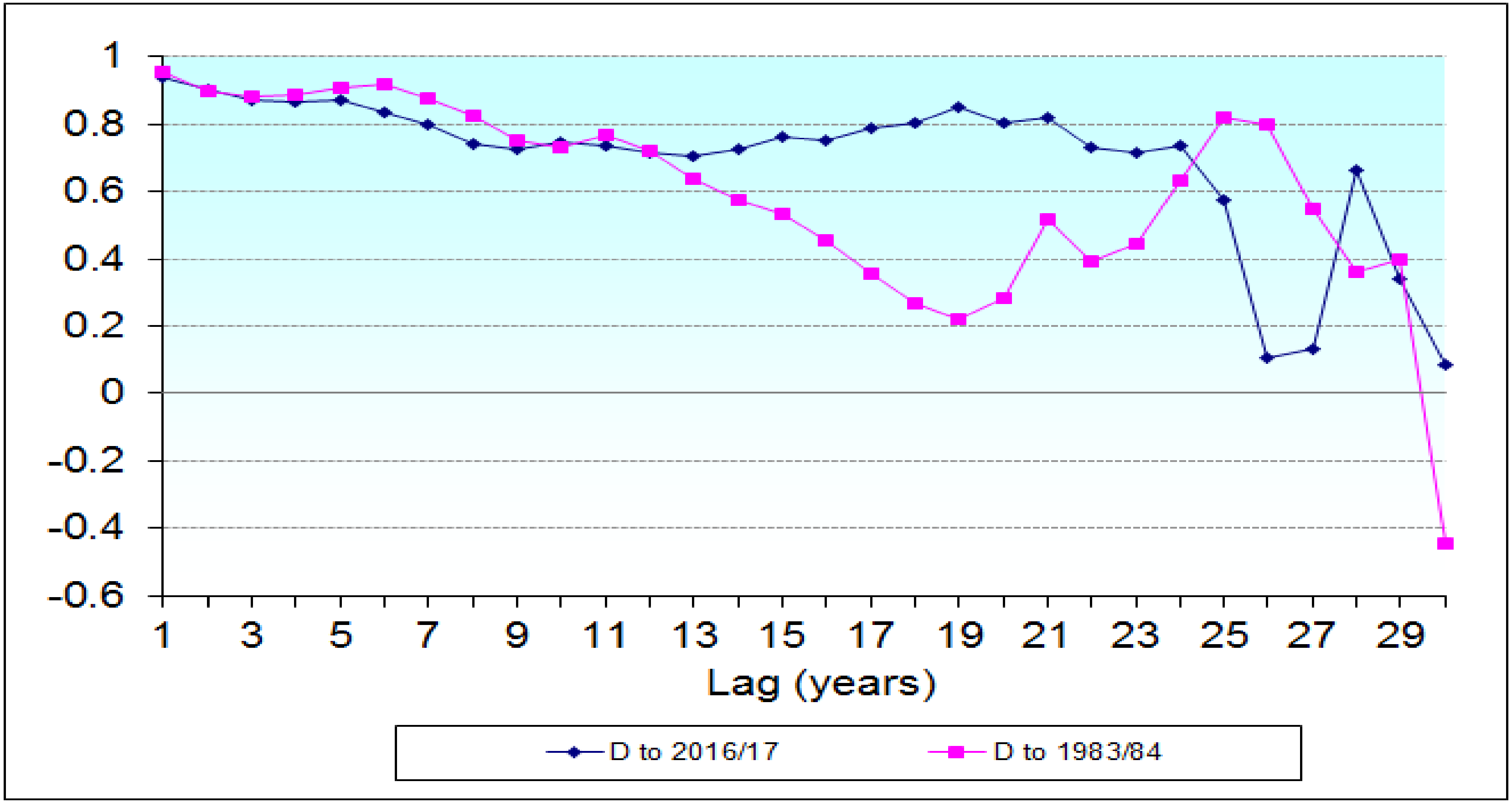
Auto-correlations over 28 years
Australian Shares

Figure 15.3



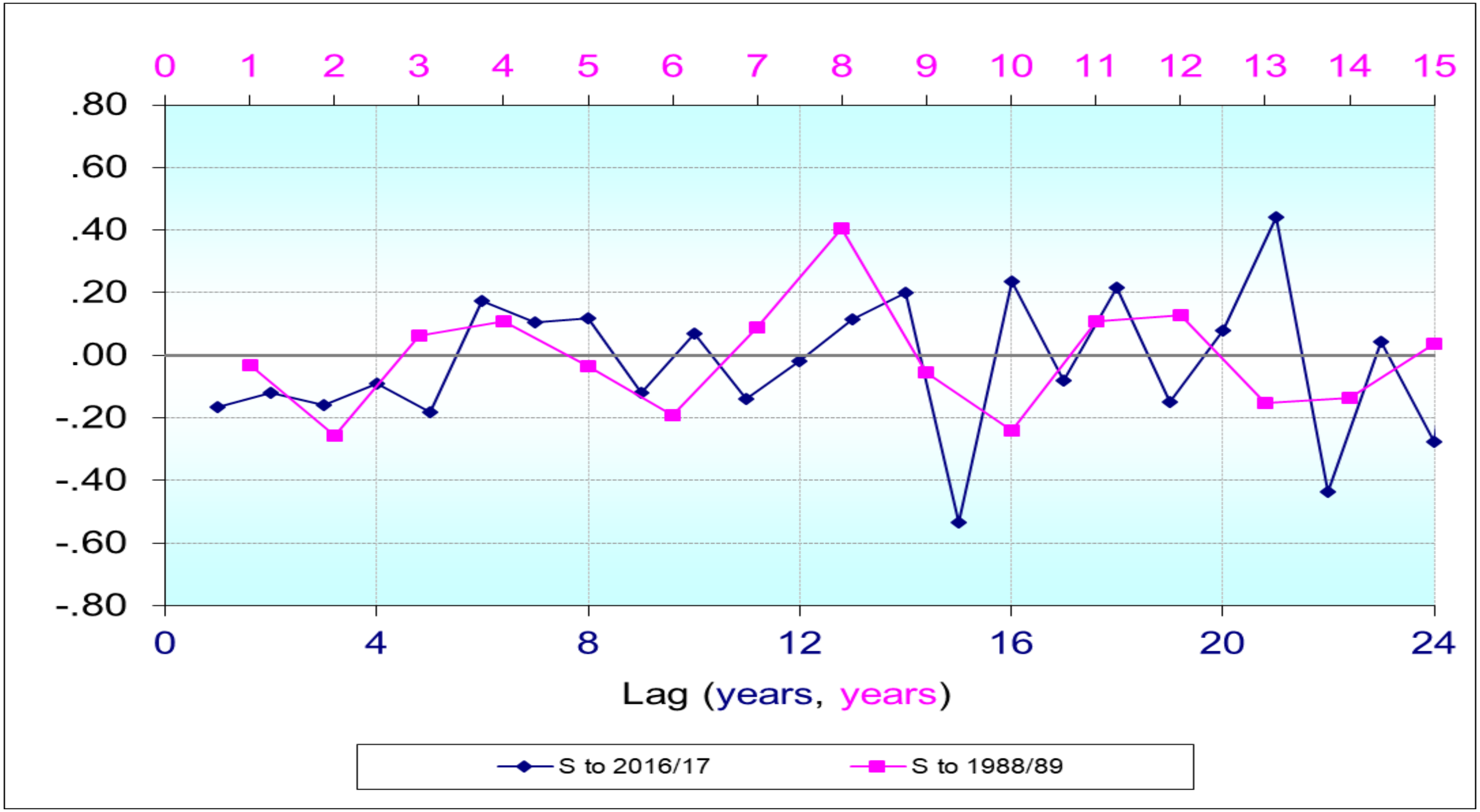
Auto-correlations over 33 years
10-year Bonds

Figure 15.3



Auto-correlations over 28 years
S to 2016/17 versus S to 1988/89

Figure 15.4



Auto-correlation features for last 28 yrs occurred more slowly

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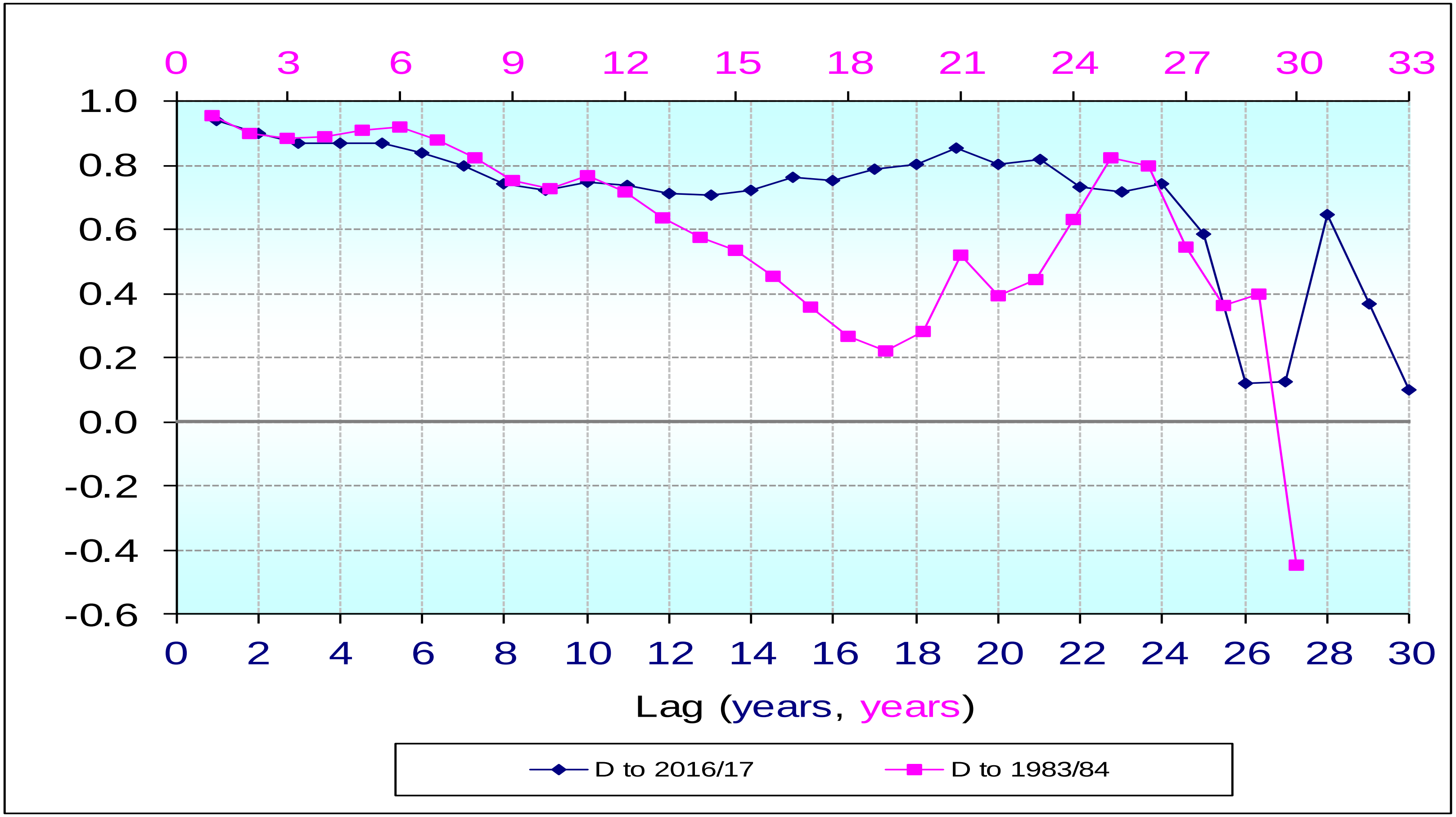
Auto-correlations over 33 years
D to 2016/17 versus D to 1983/84

Figure 15.4



Auto-correlation features for last 33 yrs occurred more <u>quickly</u>

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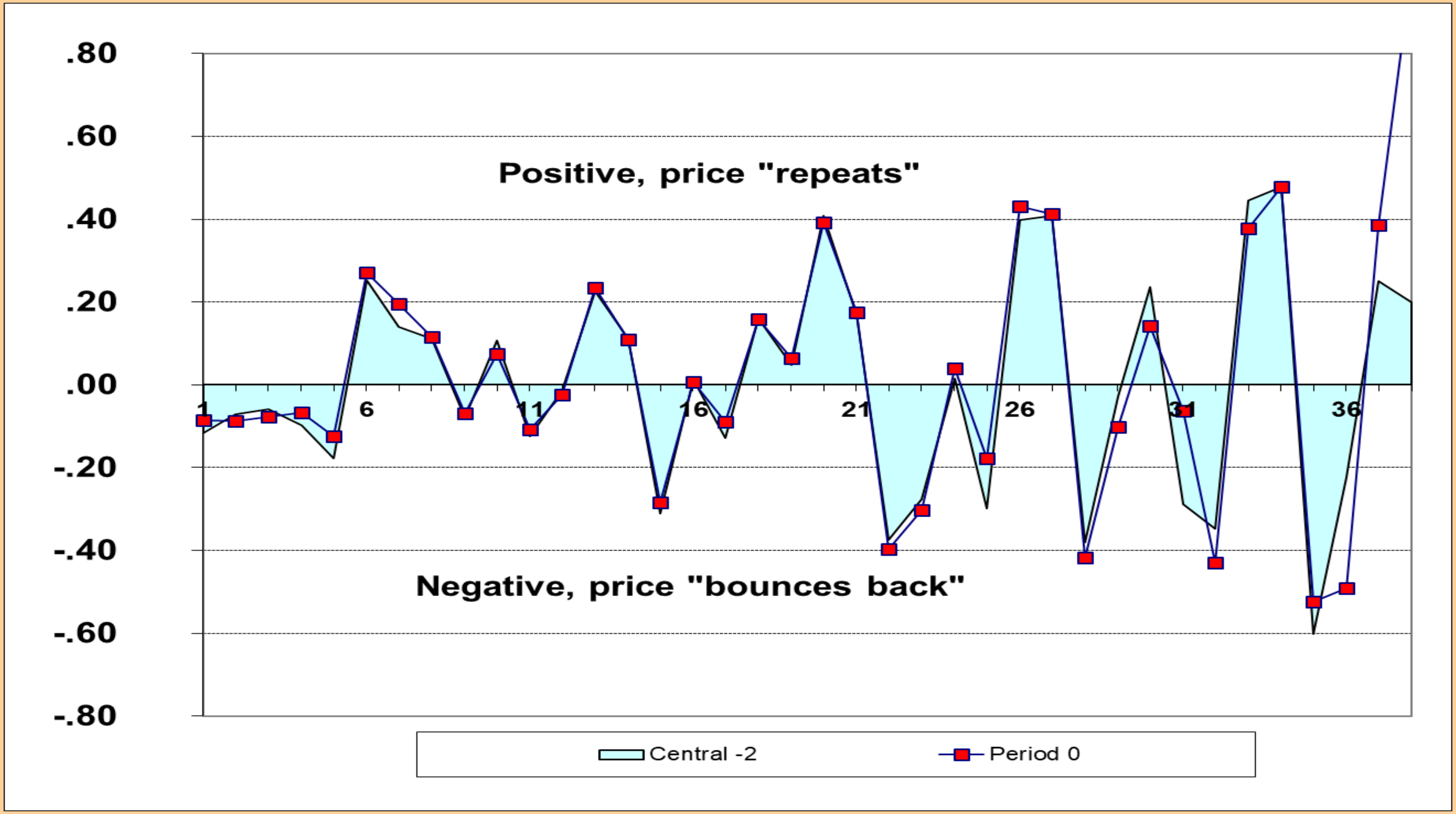
Auto-correlations over 40 years
Australian Shares

Figure 15.5



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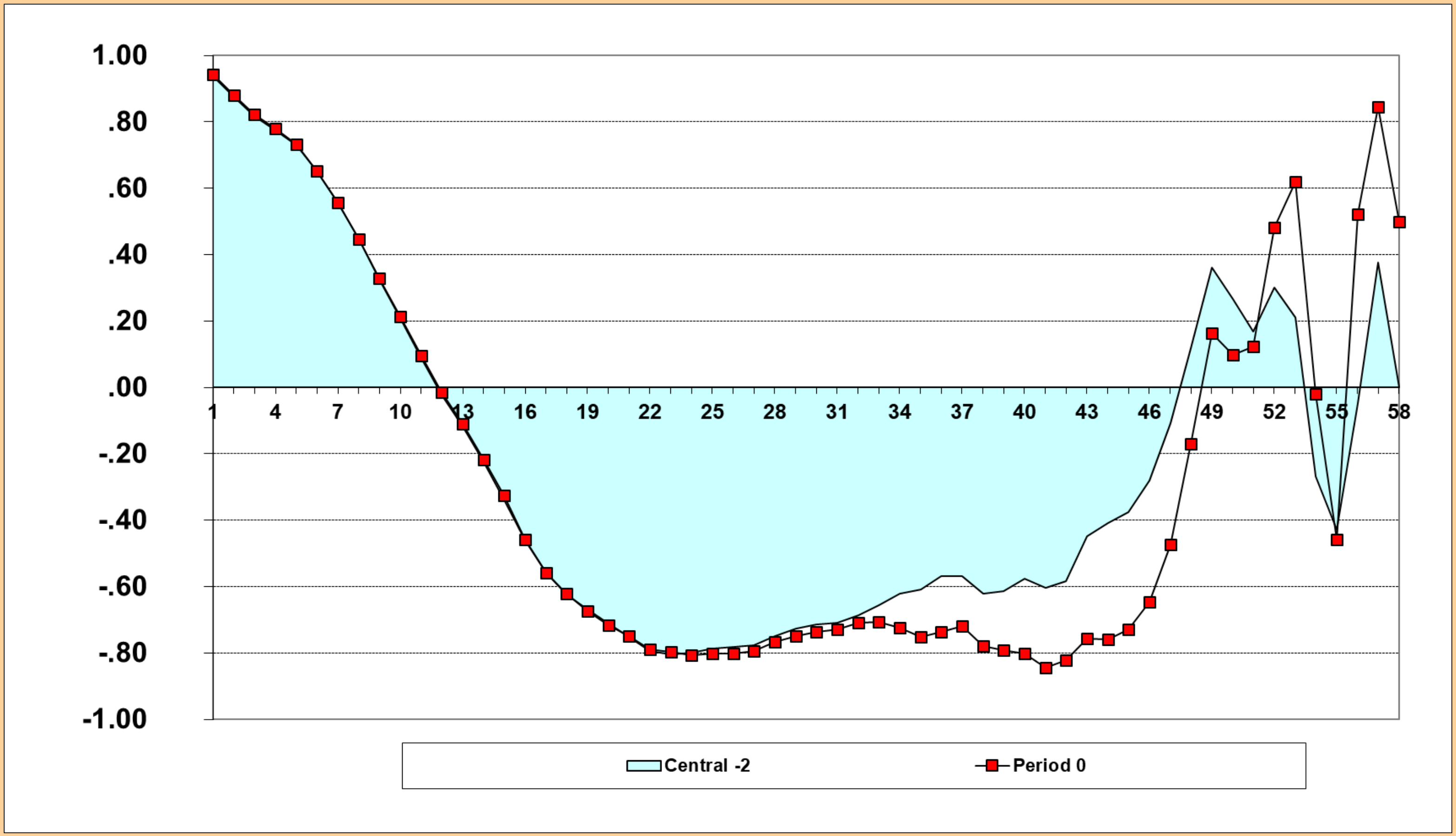
Auto-correlations over 60 years
10-year Bonds

Moves to the left

Figure 15.6



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Assumptions – Changes in Means

Section 6.12

Sector		NEW	OLD	Change
S	Shares	9.9%	10.0%	**-0.1%**
I	Int'l Shrs	8.5%	8.6%	**-0.1%**
Q	Prop Trust	8.5%	8.6%	**-0.1%**
P	Direct Prop	7.3%	7.5%	**-0.2%**
H	Hedged IS	8.6%	8.7%	**-0.1%**
L	Loans/credit	7.1%	7.2%	**-0.1%**
F	Fixed Int	6.2%	6.4%	**-0.2%**
G	Semi-govt	6.2%	6.4%	**-0.2%**
J	Int'l Fxd Int	6.0%	6.2%	**-0.2%**
C	Cash	5.3%	5.8%	**-0.5%**
N	Infln Linked	7.0%	7.0%	**0.0%**
Balncd	Balanced	7.89%	8.03%	**-0.14%**
CapStb	Cap Stable	6.57%	6.81%	**-0.23%**
B	Bills	5.30%	5.80%	**-0.50%**
D	Bonds	5.50%	6.00%	**-0.50%**
W	AWOTE	3.70%	4.20%	**-0.50%**
X	CPI	2.50%	2.70%	**-0.20%**

Arithmetic, before tax, fees and imputation credits

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Investment Assumptions

Table 16.1

Sector		Risk margin (arithmetic average)	Mean rate (arithmetic average)	Compound average	Coefficient of variation	Standard deviation of rates	Skewness	Kurtosis
							'Moderate'	
							High'	
							'Extreme'	
S	Shares	4.4%	9.9%	8.7%	1.616	16.0%	-26%	75%
I	Int'l Shrs	3.0%	8.5%	7.6%	1.623	13.8%	-53%	96%
Q	Prop Trust	3.0%	8.5%	7.3%	1.624	13.8%	-247%	1000%
P	Direct Prop	1.8%	7.3%	7.1%	0.877	6.4%	-148%	304%
H	Hedged IS	3.1%	8.6%	7.7%	1.558	13.4%	-84%	146%
L	Loans/credit	1.6%	7.1%	7.0%	0.493	3.5%	66%	-12%
F	Fixed Int	0.7%	6.2%	6.1%	0.758	4.7%	-91%	388%
G	Semi-govt	0.7%	6.2%	6.1%	0.613	3.8%	39%	-50%
J	Int'l Fxd Int	0.5%	6.0%	5.9%	0.633	3.8%	-93%	367%
C	Cash	-0.2%	5.3%	5.3%	0.566	3.0%	52%	-77%
N	Infln Linked	1.5%	7.0%	6.9%	0.714	5.0%	-43%	52%
Balncd	Balanced	2.39%	7.89%	7.53%	1.124	8.87%	-82%	132%
CapStb	Cap Stable	1.07%	6.57%	6.48%	0.671	4.41%	-61%	205%
B	Bills	-0.20%	5.30%	5.26%	0.585	3.10%	66%	-44%
D	Bonds		5.50%	5.47%	0.472	2.60%	19%	-103%
W	AWOTE	-1.80%	3.70%	3.66%	0.758	2.80%	200%	447%
X	CPI	-3.00%	2.50%	2.48%	0.800	2.00%	86%	-24%

Before tax, fees and imputation credits

Assumptions gross/net tax/fees

Table 18.1

Sector		Mean rate (arithmetic average)			Accum-ulation	Pension
		Before tax Before fees	Before tax After fees	After tax & IC's After fees	Compound average rates after tax & IC's after fees	
S	Shares	9.90%	9.64%	9.45%	8.51%	9.62%
I	Int'l Shrs	8.50%	8.21%	7.55%	6.83%	7.67%
Q	Prop Trust	8.50%	8.21%	7.35%	6.38%	7.34%
P	Direct Prop	7.30%	6.60%	5.63%	5.47%	6.39%
H	Hedged IS	8.60%	8.31%	7.64%	6.93%	7.78%
L	Loans	7.10%	6.81%	5.79%	5.75%	6.75%
F	Fixed Int	6.20%	6.02%	5.12%	5.03%	5.91%
G	Semi-govt	6.20%	6.02%	5.12%	5.07%	5.95%
J	Int'l Fxd Int	6.00%	5.82%	4.95%	4.89%	5.75%
C	Cash	5.30%	5.15%	4.38%	4.35%	5.11%
N	Infln Linked	7.00%	6.81%	5.85%	5.76%	6.69%
Balncd	Balanced	7.89%	7.64%	7.12%	6.83%	7.79%
CapStb	Cap Stable	6.57%	6.36%	5.67%	5.60%	6.48%
B	Bills	5.30%	5.30%	4.51%	4.47%	5.26%
D	Bonds	5.50%	5.50%	4.68%	4.65%	5.47%

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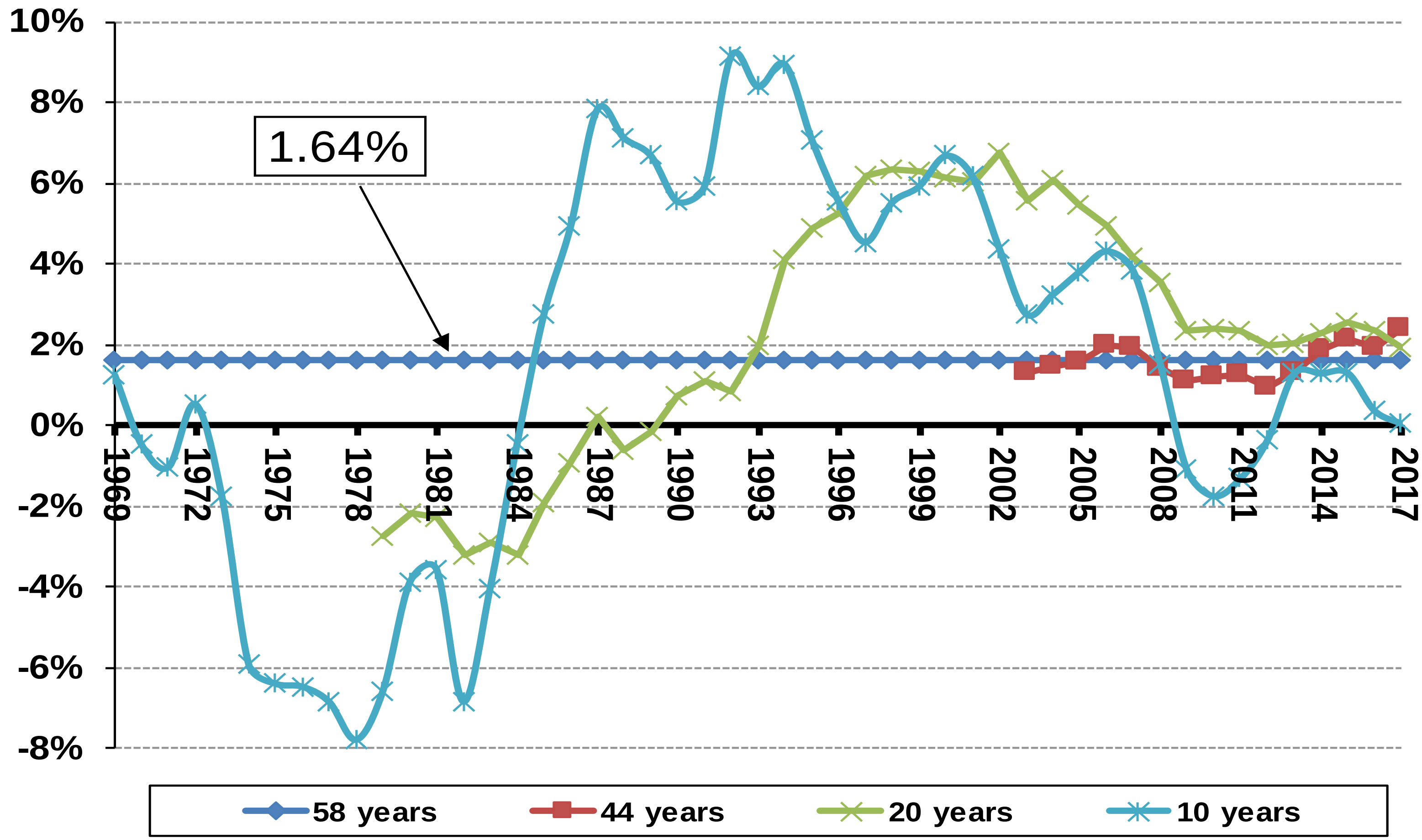
Rolling Average Real 'Balanced' Returns over AWOTE

Figure 19.1



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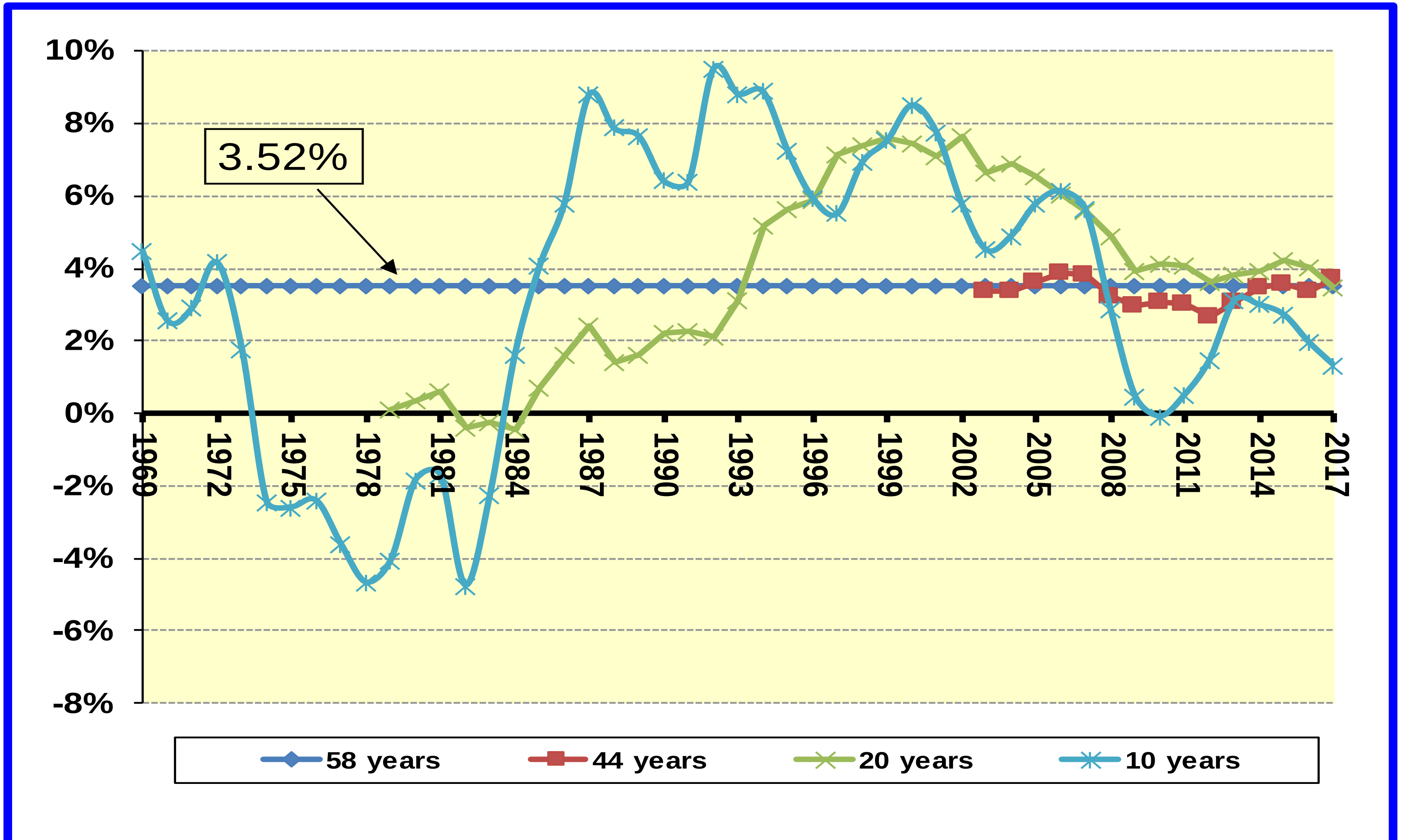
Rolling Average Real 'Balanced' Returns over CPI

Figure 19.1



Appendices

A Modelling Skewness and Kurtosis

Normal power approximation, and
a gamma exponential variable

B Modelling Auto-correlations

Shares (S sector) – one extreme
Bonds (D sector) – other extreme

C *Austmod* Investment Simulation Model

The 26 inputs are described
"*Historical random start*" modelling defined
Summary of algorithms and output

Concluding Remarks Section 20

- It is desirable for the setting of long-term assumptions to analyse results over at least one full economic cycle
- **The 'sum of two sine curves' technique is a powerful tool for analysing economic cycles but a single sine curve is sometimes preferable**
- Care is needed when using running averages because their trends are impacted by the old data dropping off
- **The impact of the GFC was not an isolated event**
- Skewness and kurtosis assumptions for many sectors indicate that their return distributions are not normal or lognormal
- **There is a slight negative bias in Balanced portfolio (and share) auto-correlations up to a lag of about 5.5 years**
- Average 28-year S and 33-year D auto-correlations indicate some stability after rescaling the x-axis

Acknowledgments

- Alan Brown
- Cary Helenius and Clive Amery
- Janice Jones
- Ray Stevens, Darren Grenfell and Hazel Lamden
- Ord Minnett
- Designers of National Mutual EFG investment system
- Ken Tan
- *“Black Swans, Fat Tails and Spherical Cows”*
  by Jeremy Waite

NEXT ?

2017	Quarterly Data Updates
2018	Over 60 years
2021	Paper (s)

QUESTIONS ?

- Methodology
- Assumptions
- Rank correlations
- Auto correlations
- Skewness & kurtosis
- Real returns
- Next ?

Thank you very much for your attention!

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