

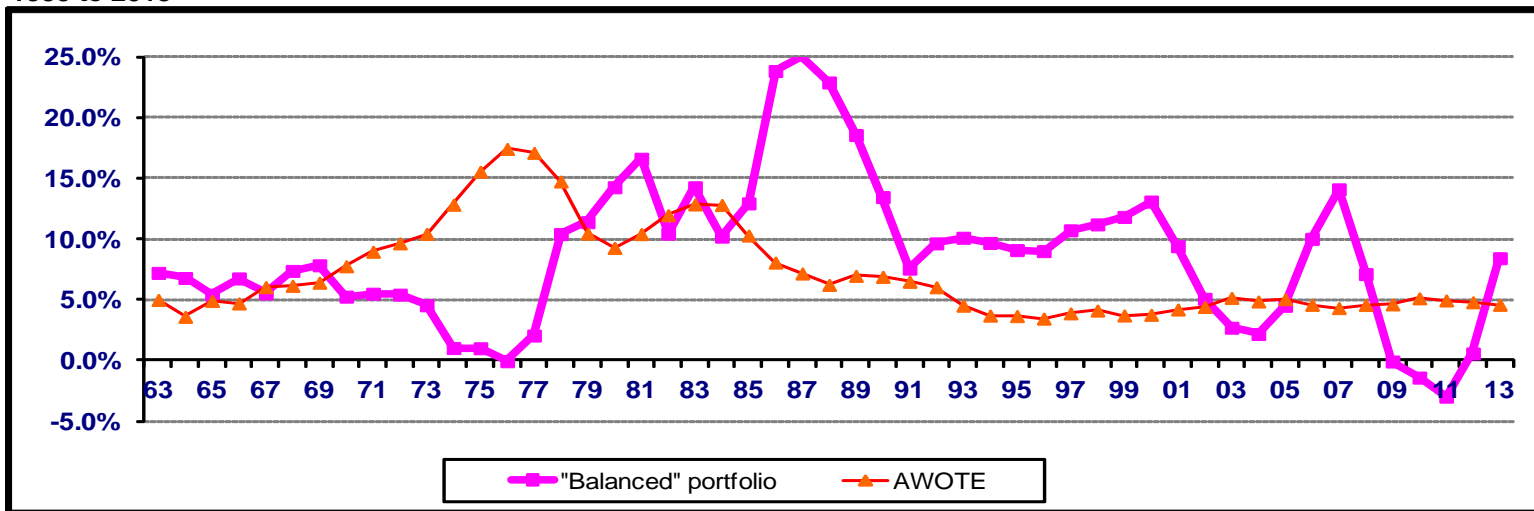


**Actuaries
Institute**

Australian Investment Performance 1959 to 2013 (and Investment Assumptions for Stochastic Models)

Colin Grenfell

1959 to 2013



Historical 4-year (ending 30/6/63 to 30/6/13) compound average annual returns

Source: *Austmod*, net of tax and fees

Presentation

Why?

What?

How? ... briefly

Results ... some of the 82 charts

... just 4 of 30 tables

Acknowledgments

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
- And, what is the impact of the global financial crisis (GFC)?

Supply “push”

- **Valuable 54-year database:**

- EFG investment system (48 years)
- Published indices and rates (4-54 years)

- **I’m keen to see Australian actuaries make greater use of:**

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

What?

- (1) Australian investment performance
30 June 1959 to 30 June 2013**

[question time] and

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

[more questions]

What? Growth Securities, Interest Income and Financial Indicators

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

- **X** CPIndex (annual increase)
- **W** AWOTE (annual increase)
- **B** 90-day bill rates (mid-year)
- **D** 10-year bondl rate (mid-year)

- **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

Section 3

“Backdating”

(1) Different Data Series

<u>CODE</u>	<u>PRIOR</u>	<u>SERIES</u>
SIPLFJC	2009	NM/AXA/AMP Nos.2 & 4 Funds
I	1988	MSCI accumulation index
I	...1970	S&P500 +3% +\$AU/\$US
F	1985	G (Government) sector
W	1981	AWOTE males
W	...1974	AWE all males, total earnings
S	1971	E (Equities) sector
S	...1965	All ordinaries accumulation index
B	1969	13-wk treasury note + 1.37%

Section 4

“Backdating”

(2) Method of Least Squares

<u>CODE</u>	<u>PRIOR</u>	<u>FORMULA</u>
H	2000	$108.54\%I + 80.97\%LN(e_0/e_{-4}) + 1.81\%$
N	1991	$71.38\%X + 62.99\%F - 195.05\%d$
J	1986	$76.74\%C + 19.25\%F$
C	1979	$22.68\%B_{-2} + 27.44\%B_{-1}$ $+ 22.82\%B + 25.76\%B_{+1}$
Q	1977	$52.06\%F + 30.42\%S + 14.40\%C$ $+ 6.42\%L$
P	1971	$88.58\%C + 50.02\%X - 23.89\%F$
F	1965	$87.09\%D + 14.33\%B - 673.02\%d$

What? Statistics

- Risk margins (over 10-year bond rates)
- Coefficients of variation (of rates)
- Skewness (of **forces**)
- Kurtosis (of **forces**)
- Cross-correlations (of **forces**)
rank and 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**
- sec.8
- sec.17
- sec.18

44-year Average (compound) Returns pa

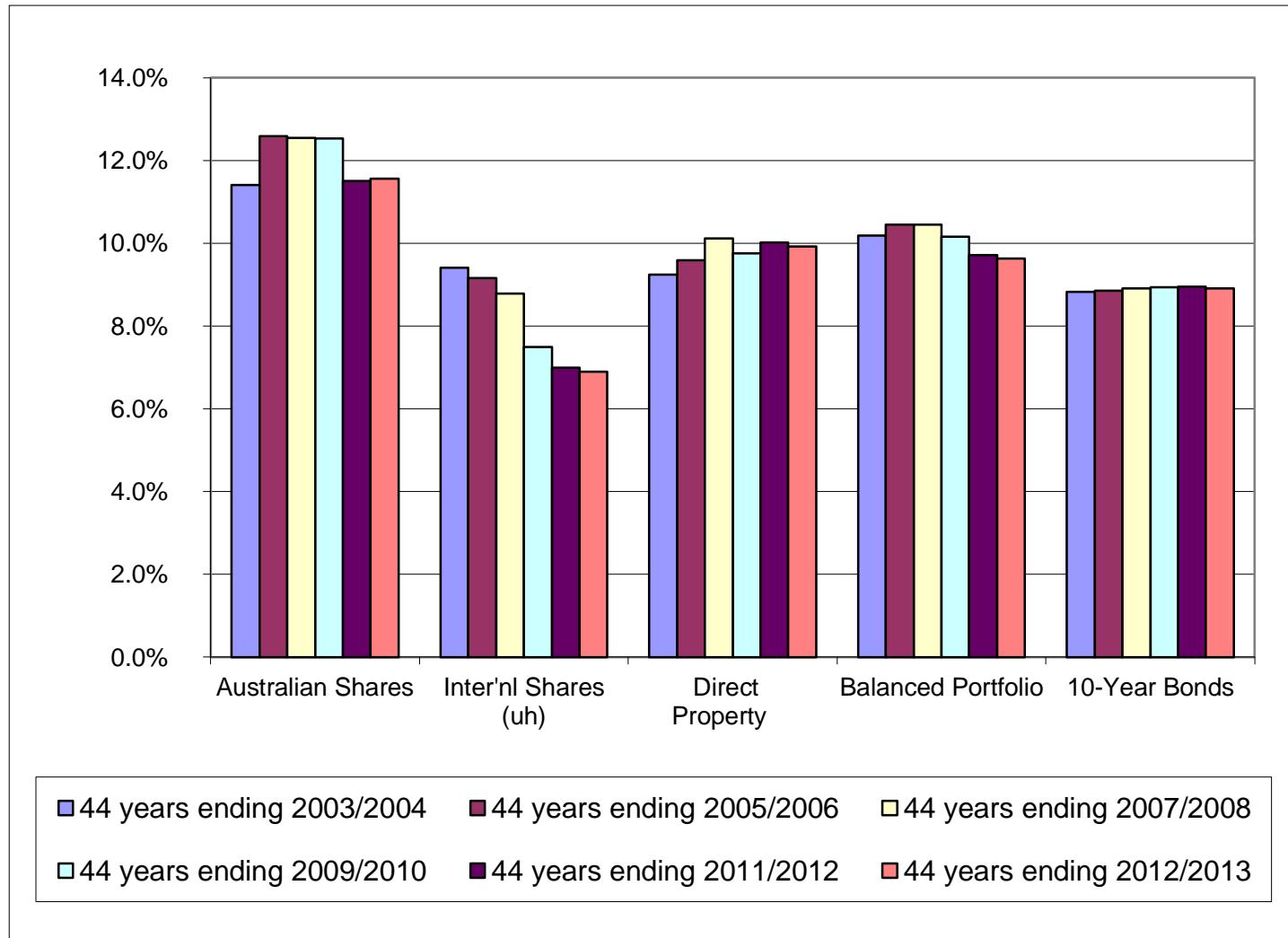


Figure 8.1, before tax and fees

44-year Average (compound) Returns pa

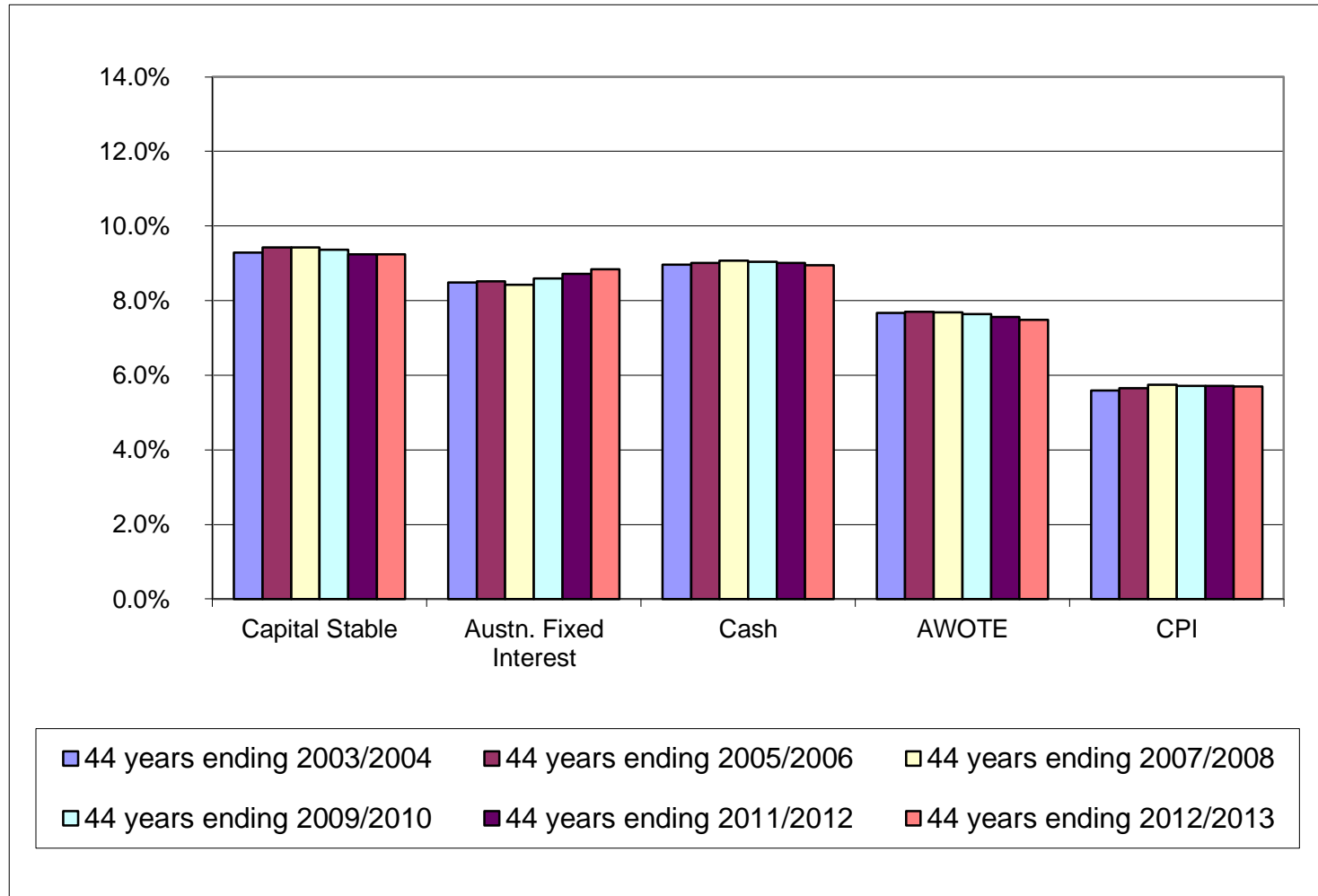


Figure 8.1, before tax and fees

Impact of GFC on Balanced Portfolio

Figure 9.1

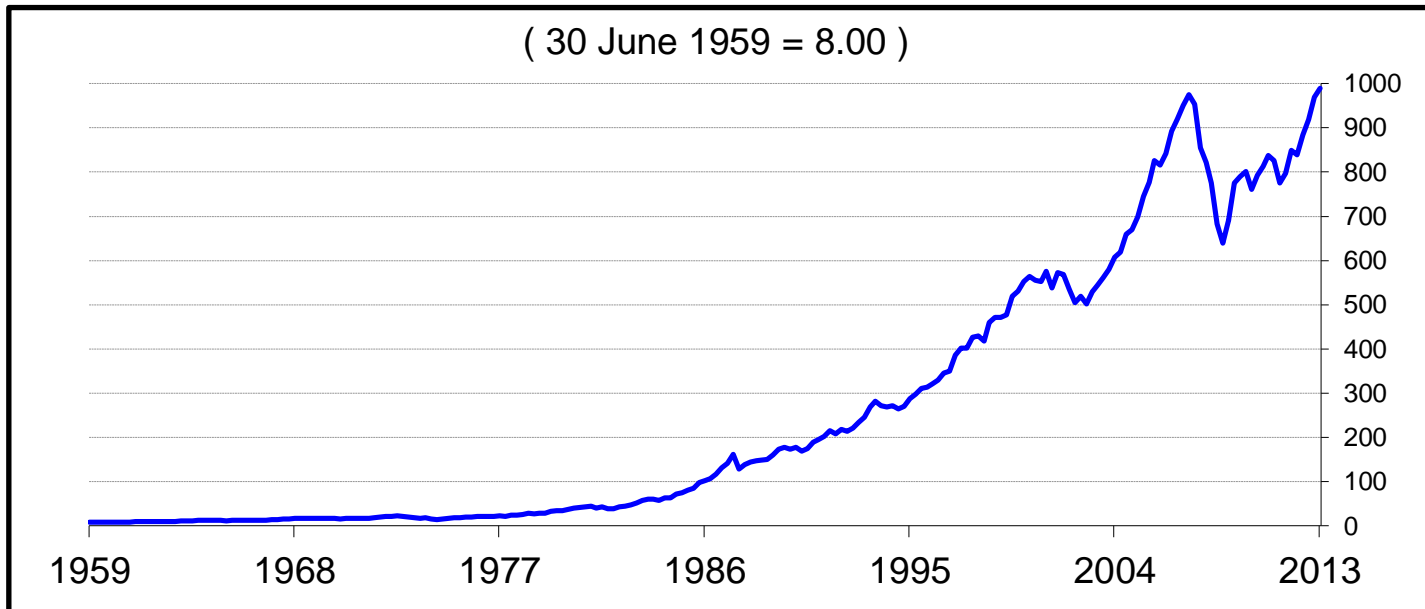
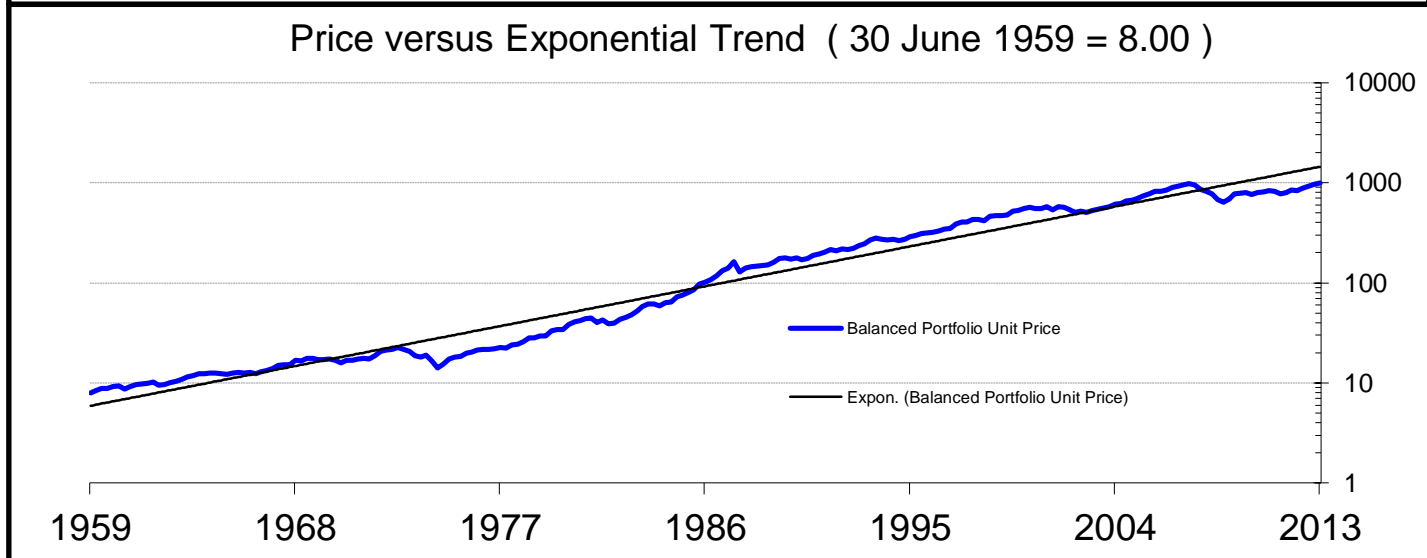
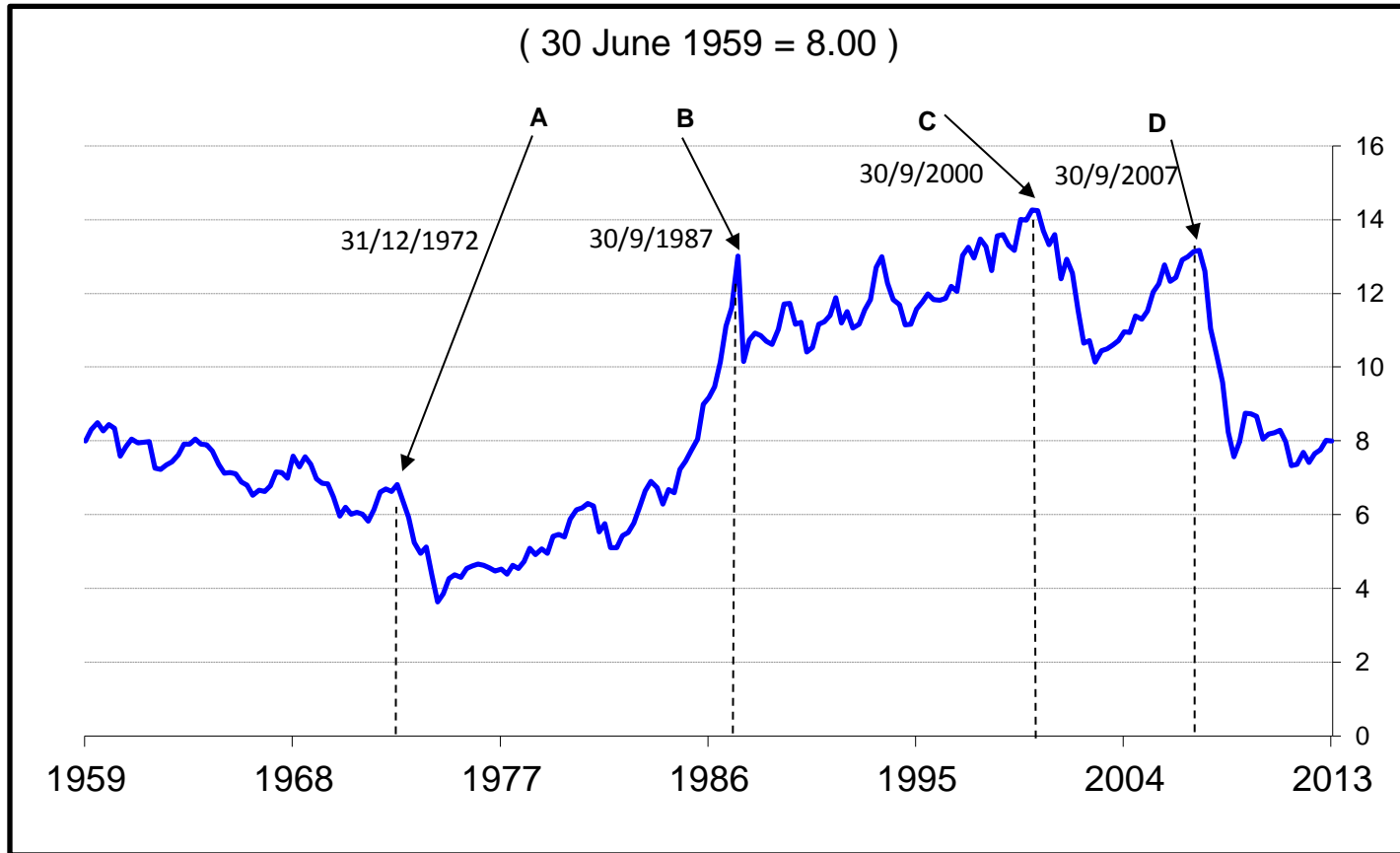


Figure 9.2



Balanced Portfolio “Discounted Price”

Figure 9.3



A 31 Dec 1972

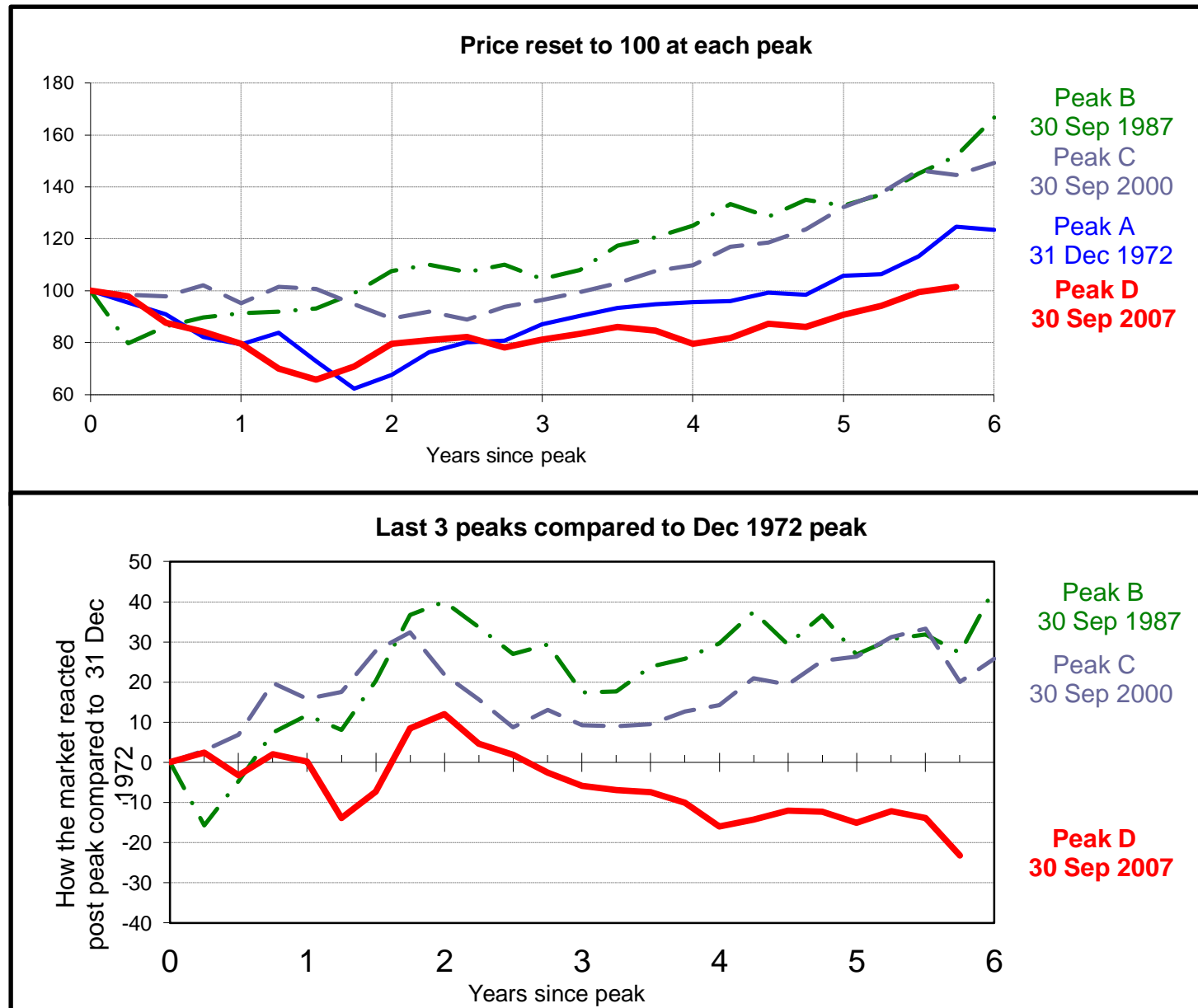
B 30 Sep 1987

C 30 Sep 2000

D 30 Sep 2007

Price Reset to 100 at Each Peak

Figure 9.4



Balanced
Portfolio
Unit
Price

Balanced Portfolio

“Discounted Price” Trend

Polynomial Trend (average of degrees four and five)

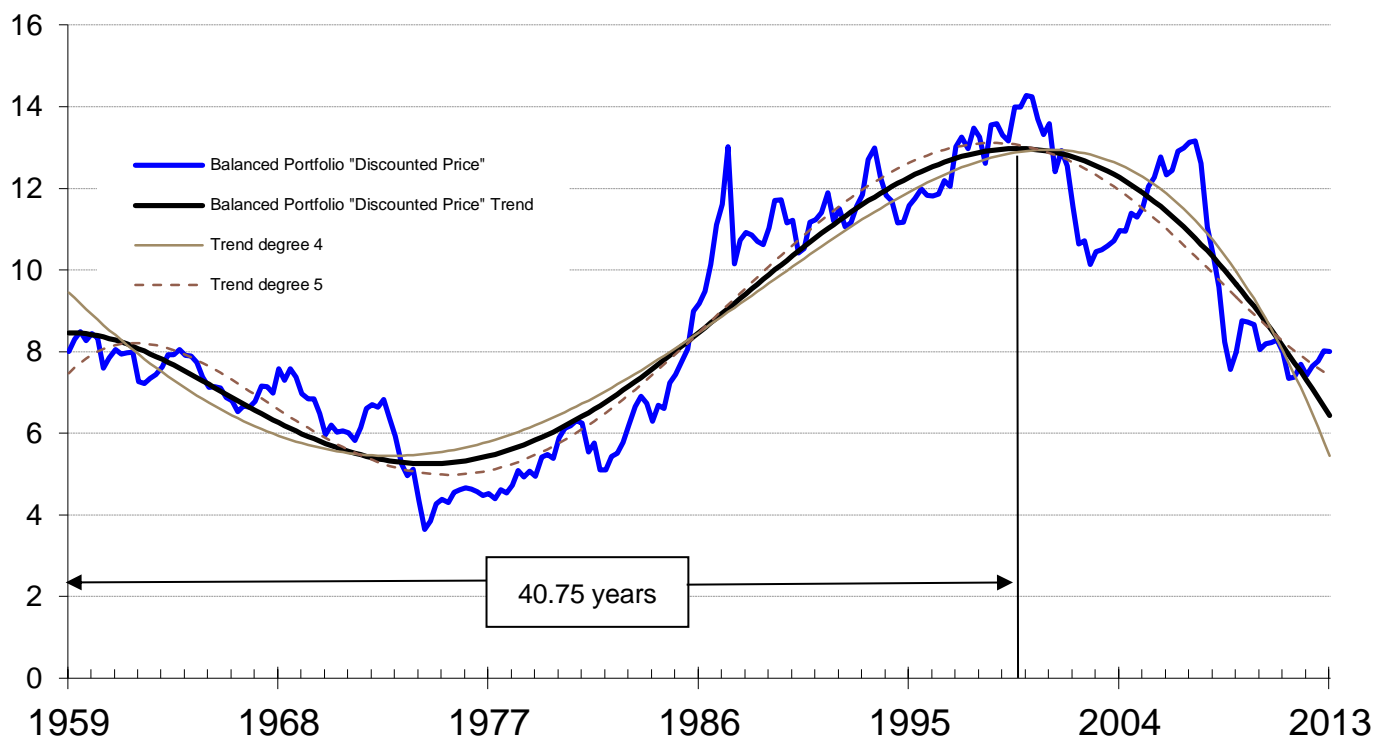
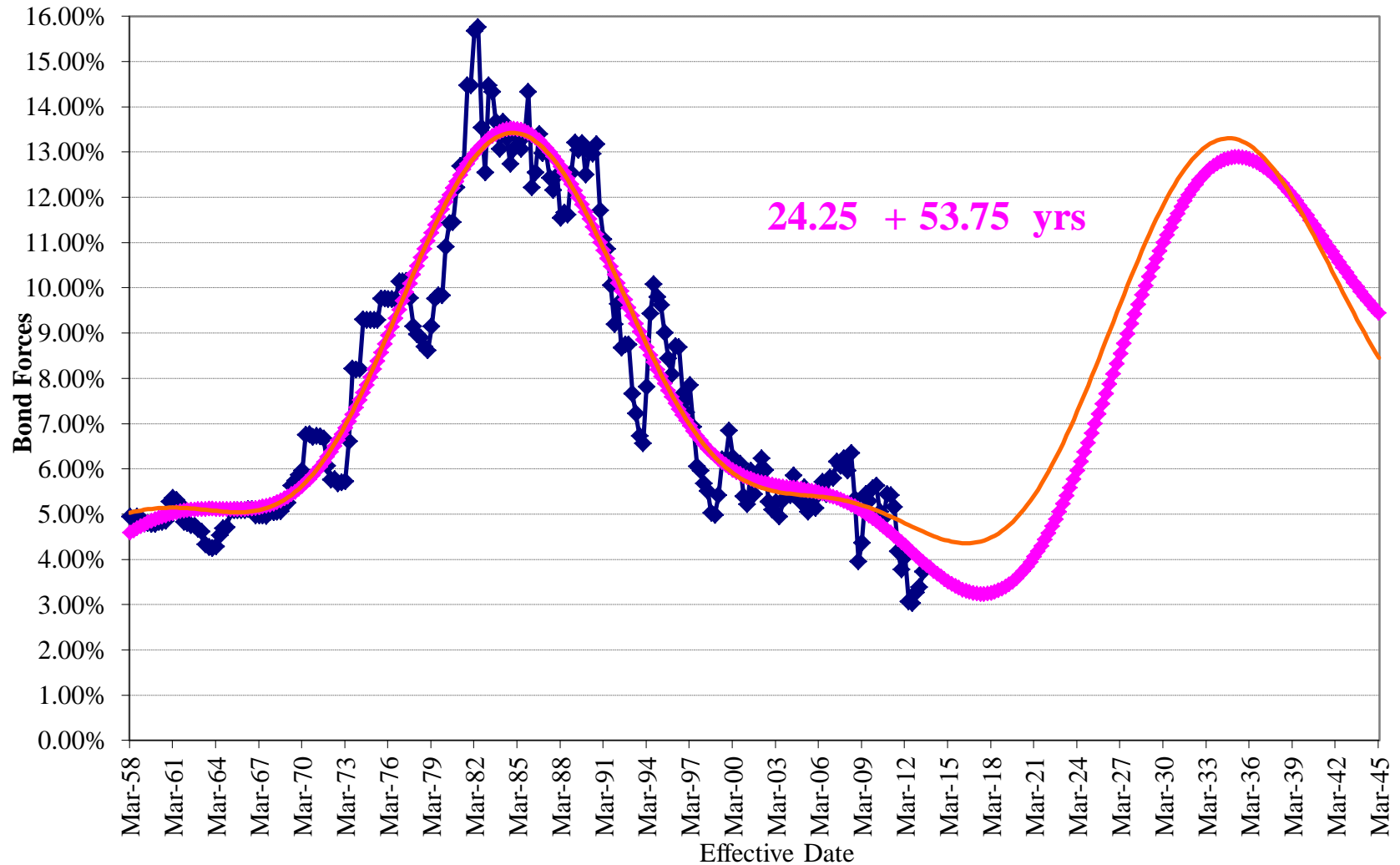


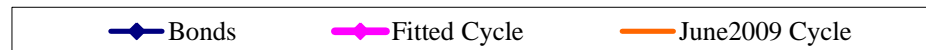
Figure
9.5

40.75 YRS

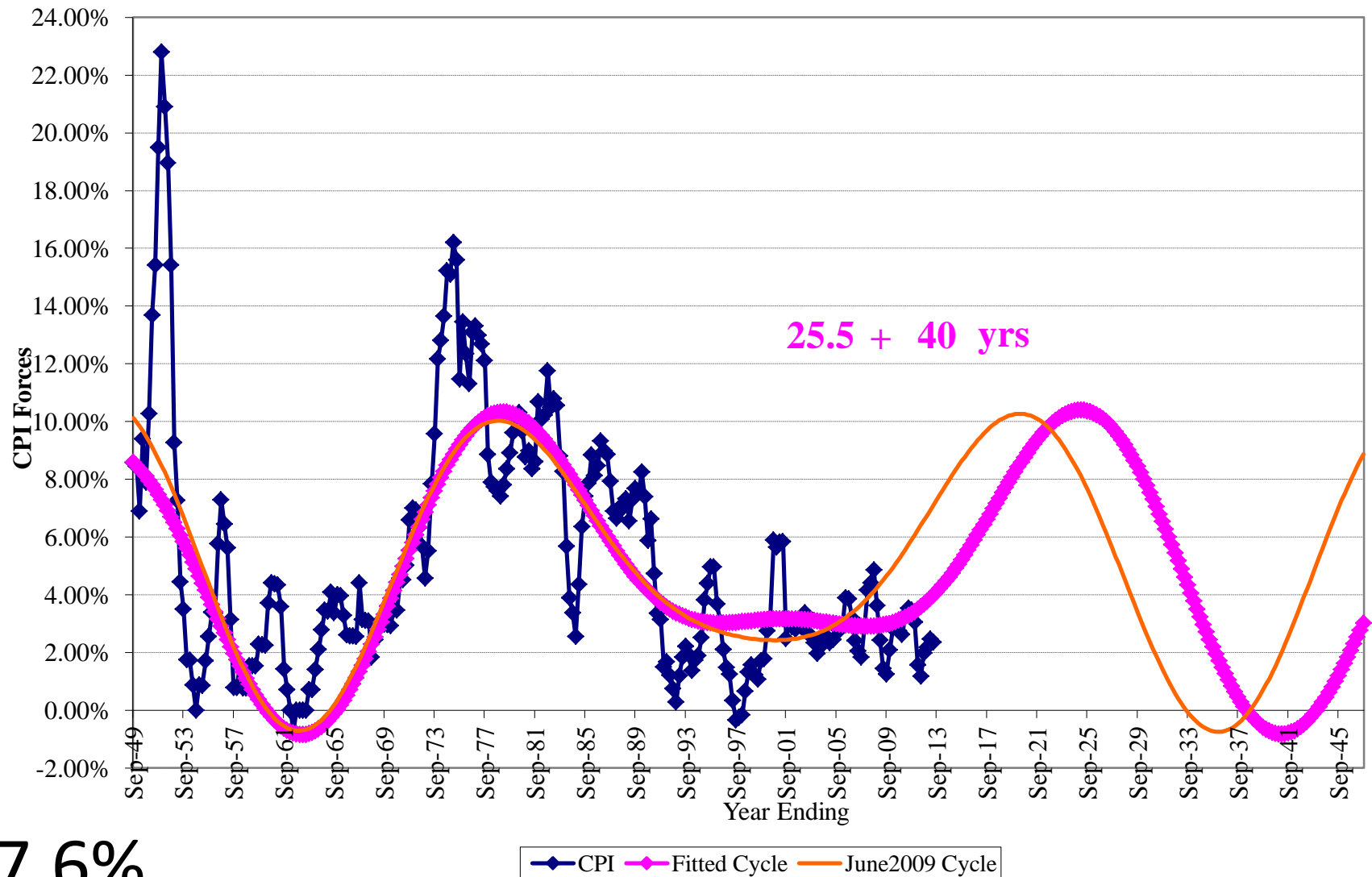
Bonds Figure 5.1



91.2%

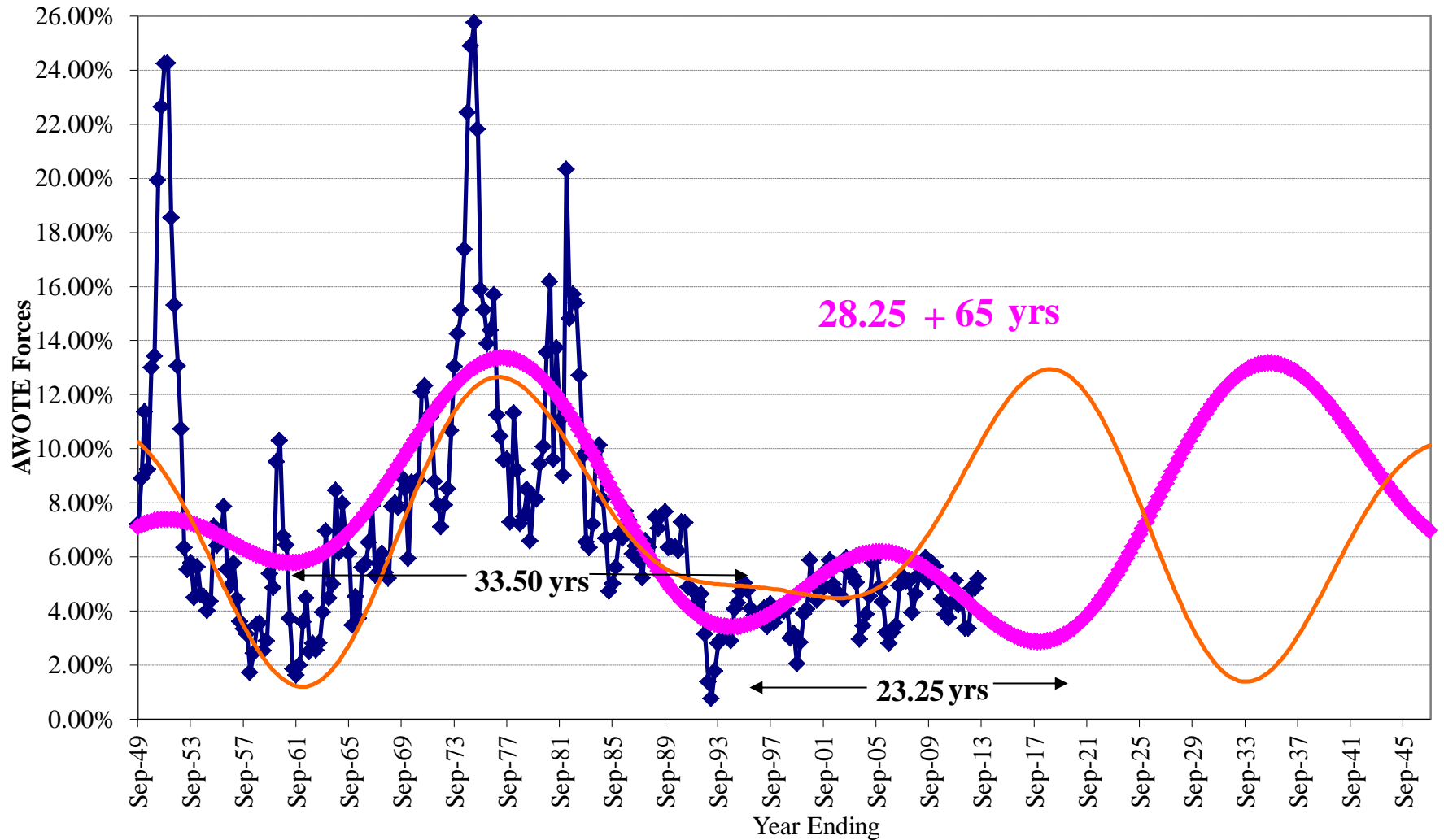


CPI Figure 5.2



AWOTE

Figure 5.3

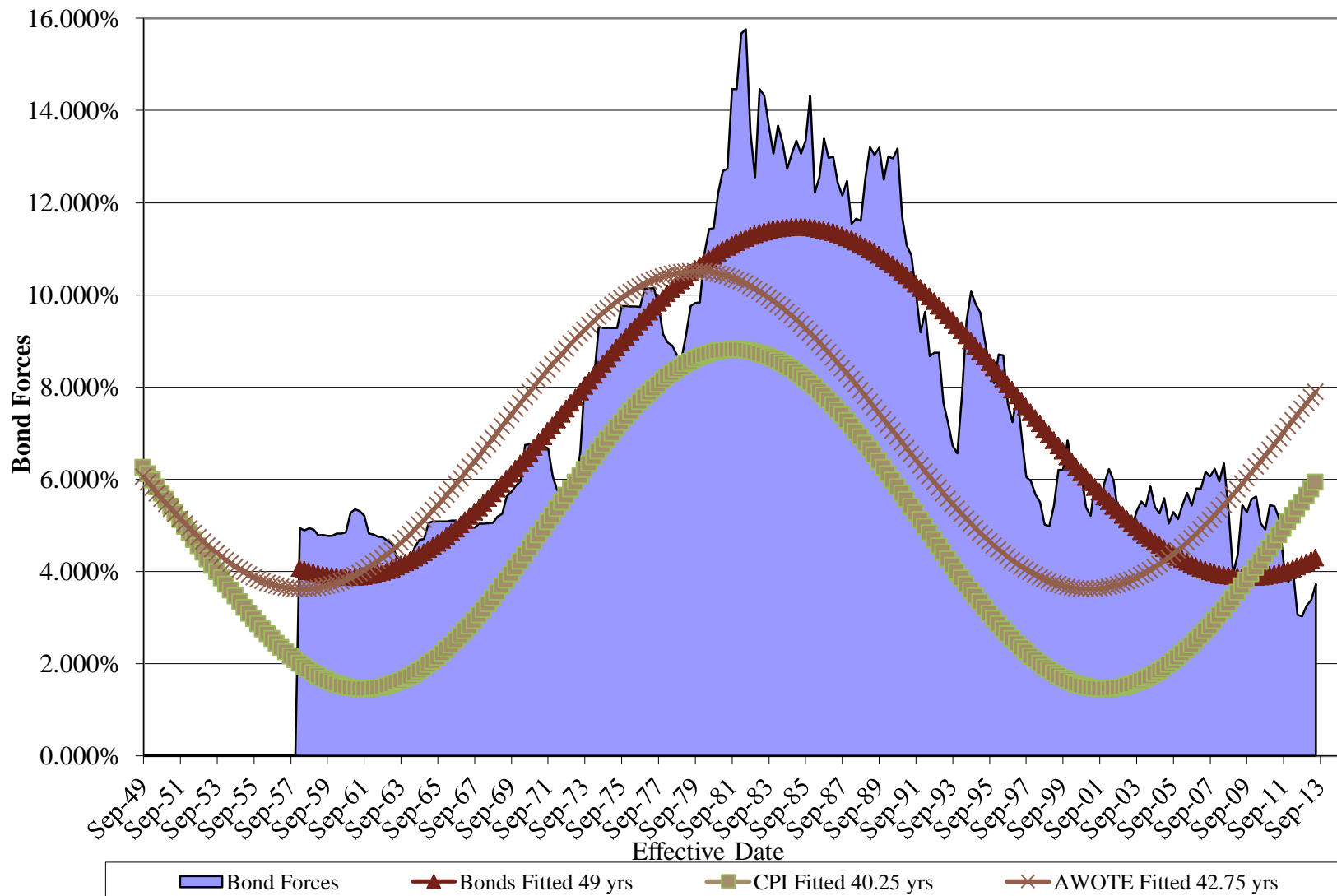


49.8%

AWOTE Fitted Cycle June 2009 Cycle

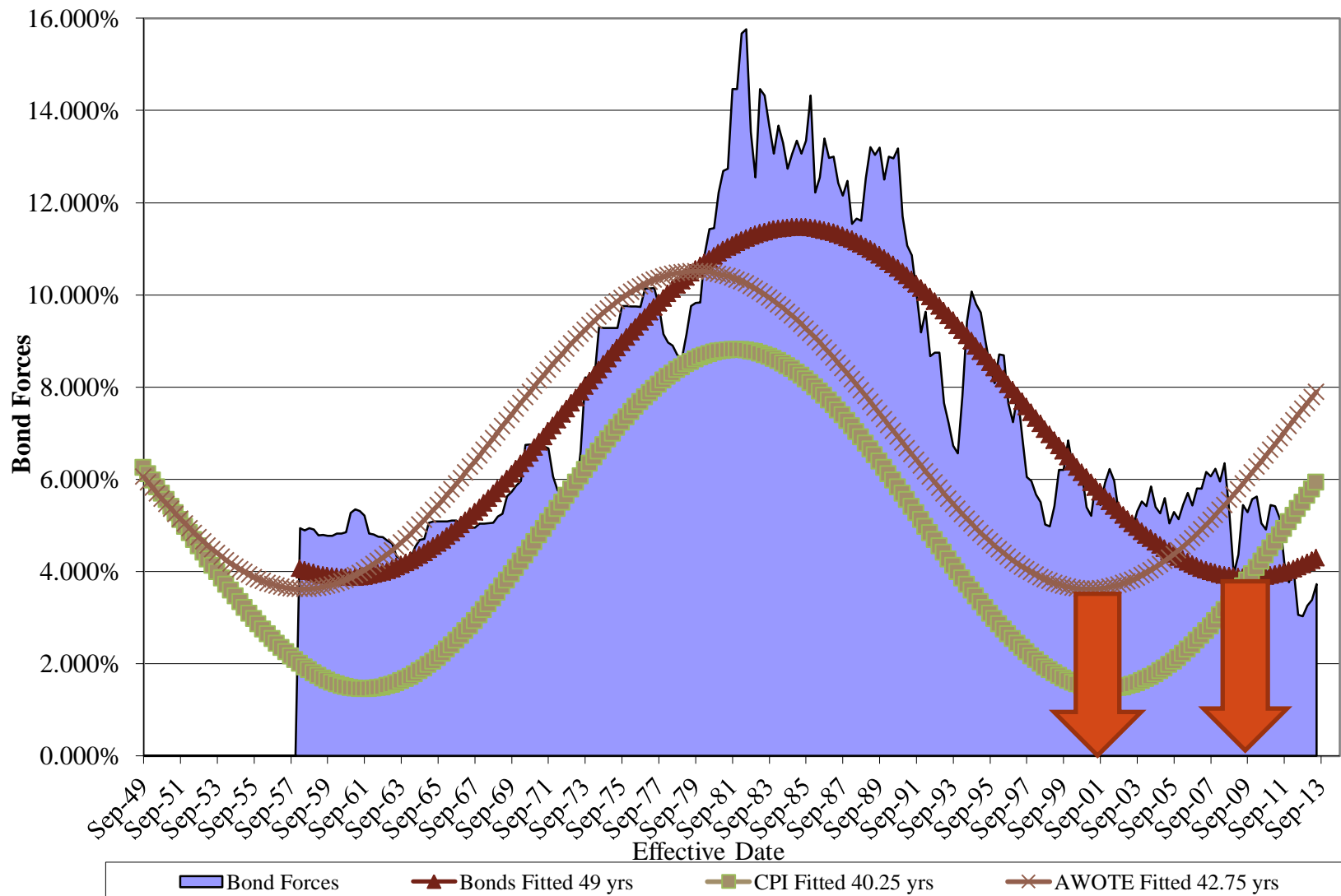
Bonds, CPI and AWOTE

Figure 5.4



Bonds, CPI and AWOTE

Figure 5.4



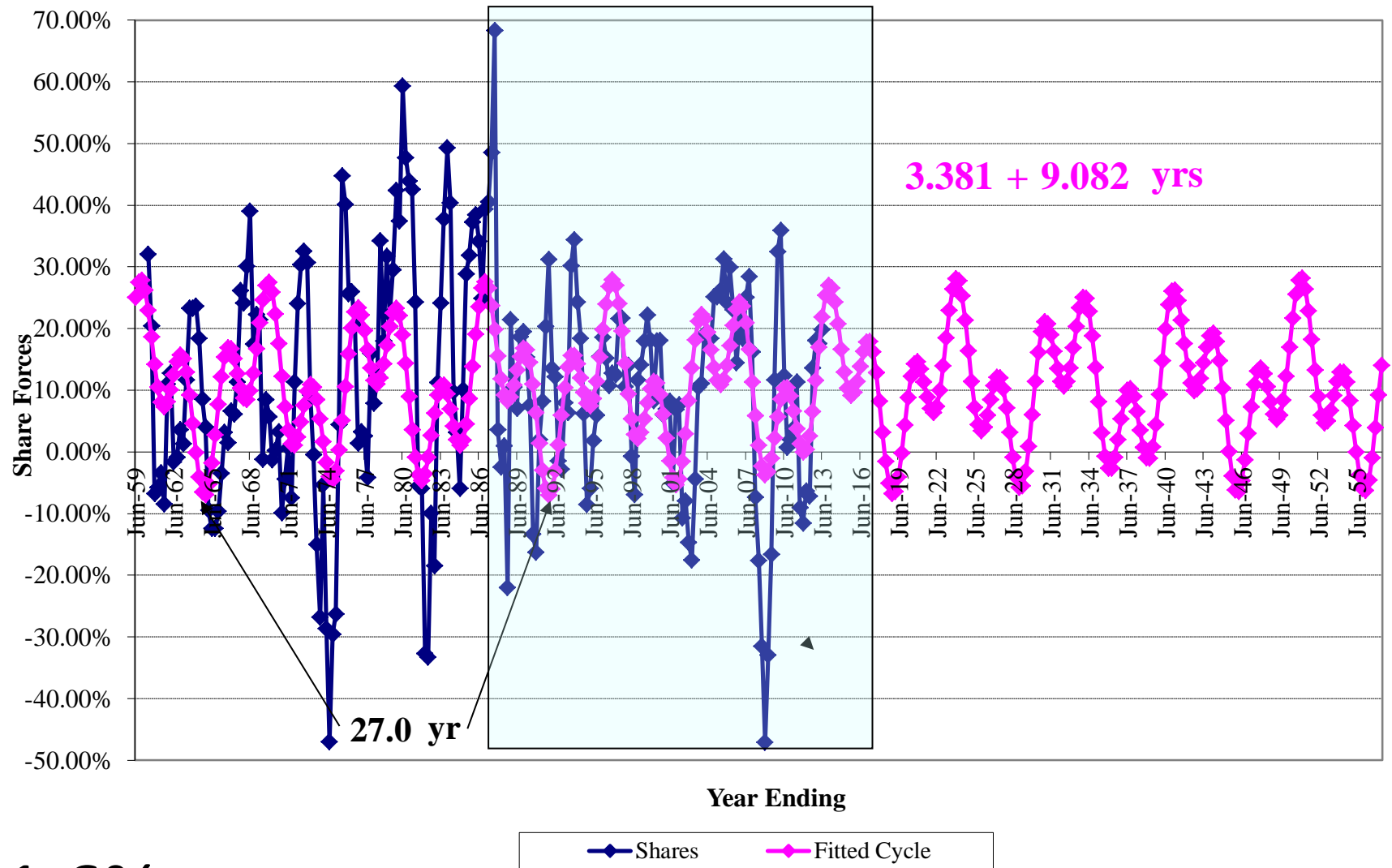
49 YRS



40.25 YRS

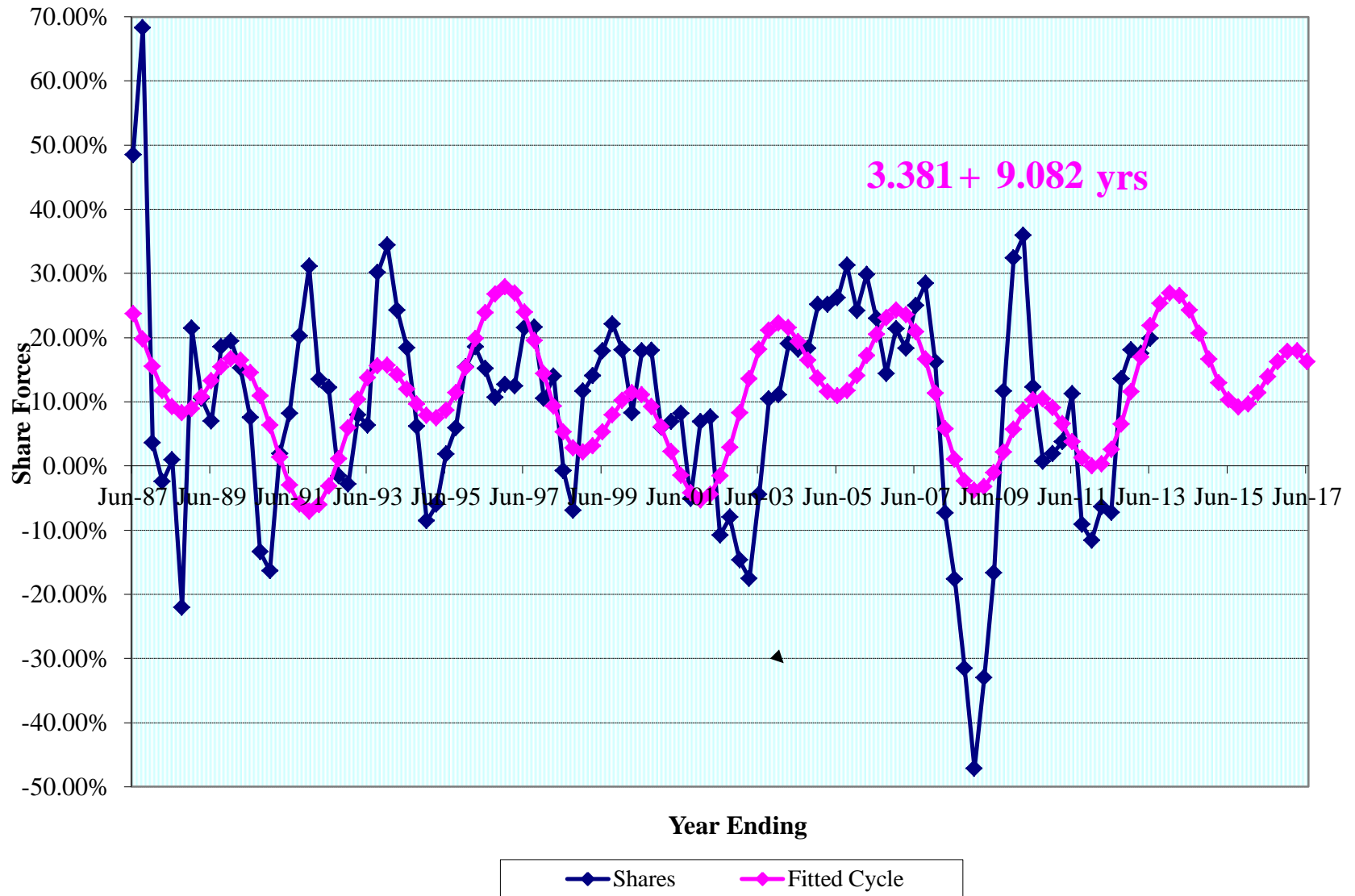
42.75 YRS

Australian Shares Figure 5.5



21.6%

Shares (close-up) Figure 5.5



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)
- Step 3** annual statistics
- Step 4** 10 “running” averages (of 4)
- Step 5** quadratic trend and
6 year projection
- Step 6** year - 2 (and judgment)

see Section 2

Property Trust (Q sector) steps 1 & 3

Year Ending	30-Sep	Year Ending	30-Sep
1969/70	3.0%	1991/92	4.6%
1970/71	0.4%	1992/93	15.1%
1971/72	2.9%	1993/94	23.7%
1972/73	21.7%	1994/95	-1.3%
1973/74	-15.6%	1995/96	9.4%
1974/75	-12.7%	1996/97	11.6%
1975/76	18.1%	1997/98	21.7%
1976/77	13.3%	1998/99	13.6%
1977/78	4.6%	1999/00	0.0%
1978/79	31.2%	2000/01	8.7%
1979/80	13.6%	2001/02	15.1%
1980/81	4.7%	2002/03	11.3%
1981/82	17.9%	2003/04	6.1%
1982/83	13.8%	2004/05	25.5%
1983/84	29.9%	2005/06	15.5%
1984/85	22.0%	2006/07	22.8%
1985/86	5.4%	2007/08	18.3%
1986/87	24.5%	2008/09	-54.1%
1987/88	42.7%	2009/10	-26.2%
1988/89	-20.6%	2010/11	-4.6%
1989/90	10.0%	2011/12	-6.5%
1990/91	8.8%	2012/13	25.4%

-136%

30-Sep

Statistics for all 44 years:

8.99%

16.86%

-136%

373%

mu

sigma

skewness

kurtosis



Actuaries
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Property Trust (Q sector) steps 3 & 4

Year Ending	30-Sep	31-Dec	31-Mar	30-Jun	Year Ending	30-Sep	31-Dec	31-Mar	30-Jun
1969/70	3.0%	1.2%	-3.0%	-1.0%	1991/92	4.6%	18.3%	10.0%	13.8%
1970/71	0.4%	-3.2%	0.9%	5.2%	1992/93	15.1%	6.8%	15.5%	15.8%
1971/72	2.9%	11.7%	19.6%	21.3%	1993/94	23.7%	26.3%	16.9%	9.4%
1972/73	21.7%	17.9%	7.1%	-2.5%	1994/95	-1.3%	-5.7%	2.5%	7.6%
1973/74	-15.6%	-18.6%	-11.6%	-17.0%	1995/96	9.4%	12.0%	3.7%	3.6%
1974/75	-12.7%	-7.2%	-5.9%	8.6%	1996/97	11.6%	13.5%	18.1%	25.1%
1975/76	18.1%	16.9%	12.0%	12.6%	1997/98	21.7%	18.5%	23.6%	9.5%
1976/77	13.3%	6.2%	6.7%	6.6%	1998/99	13.6%	16.5%	4.5%	4.2%
1977/78	4.6%	15.8%	25.2%	29.5%	1999/00	0.0%	-5.1%	1.0%	11.3%
1978/79	31.2%	26.4%	19.3%	14.4%	2000/01	8.7%	16.4%	12.0%	13.0%
1979/80	13.6%	10.0%	15.2%	10.6%	2001/02	15.1%	13.8%	16.0%	14.2%
1980/81	4.7%	6.2%	25.1%	22.0%	2002/03	11.3%	11.2%	13.0%	11.5%
1981/82	17.9%	27.8%	-3.0%	3.5%	2003/04	6.1%	8.4%	13.1%	15.9%
1982/83	13.8%	5.0%	18.1%	21.3%	2004/05	25.5%	27.9%	18.2%	16.9%
1983/84	29.9%	40.7%	34.6%	30.2%	2005/06	15.5%	12.0%	17.0%	16.6%
1984/85	22.0%	9.6%	12.5%	11.1%	2006/07	22.8%	29.3%	25.2%	23.4%
1985/86	5.4%	5.1%	14.3%	21.3%	2007/08	18.3%	-8.7%	-27.7%	-47.4%
1986/87	24.5%	30.3%	26.4%	34.6%	2008/09	-54.1%	-80.5%	-86.9%	-54.7%
1987/88	42.7%	5.6%	8.8%	-2.8%	2009/10	-26.2%	9.1%	35.1%	18.5%
1988/89	-20.6%	14.9%	1.2%	-1.1%	2010/11	-4.6%	-0.7%	4.6%	5.7%
1989/90	10.0%	2.3%	9.6%	14.2%	2011/12	-6.5%	-1.6%	1.7%	10.4%
1990/91	8.8%	8.3%	12.1%	7.4%	2012/13	25.4%	28.4%	26.6%	21.5%

30-Sep	31-Dec	31-Mar	30-Jun		
Statistics for all 44 years:				Average across	
8.99%	9.07%	9.29%	9.44%	mu	9.20%
16.86%	18.33%	19.05%	16.51%	sigma	17.68%
-136%	-268%	-315%	-228%	skewness	-237%
373%	1274%	1487%	717%	kurtosis	963%

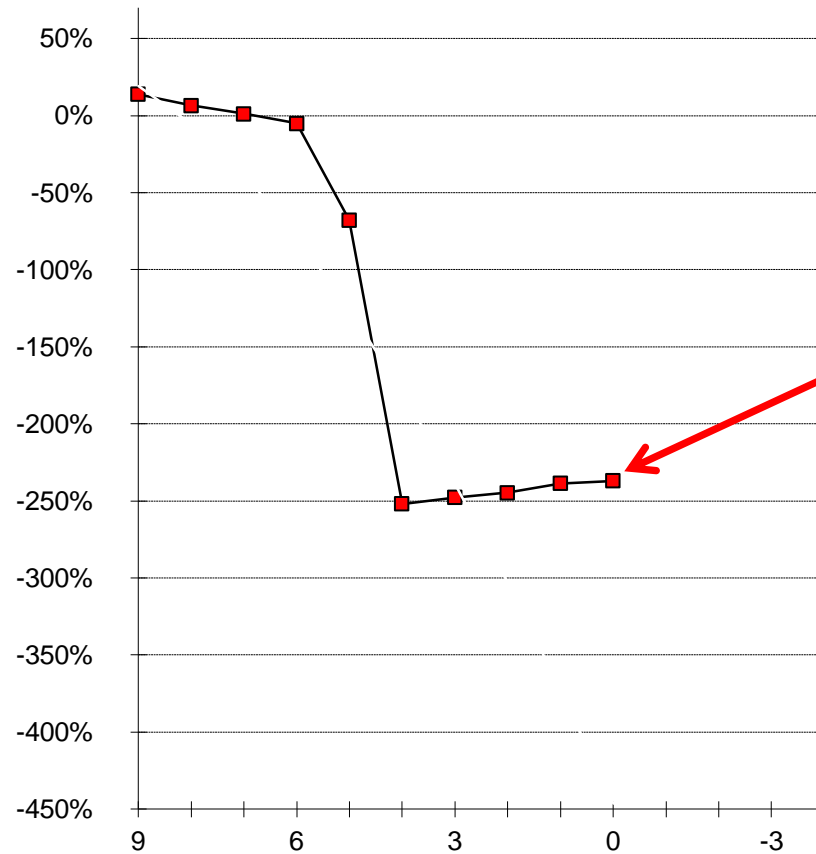
-237%

Table10.1

Property Trust (Q sector)

– step 4

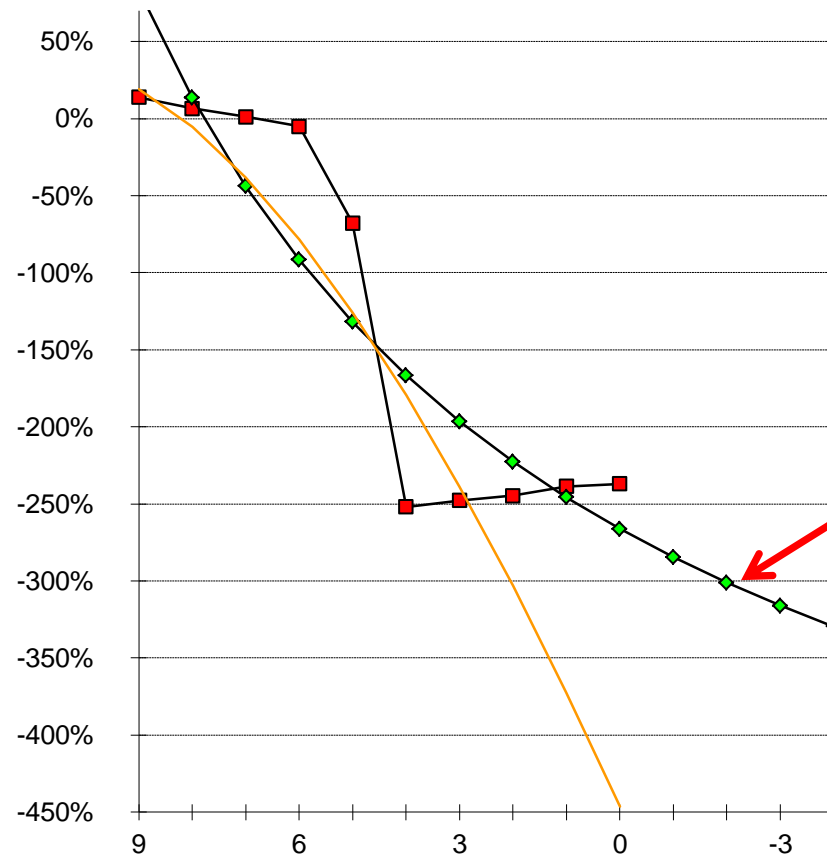
Q av Skewness



-237%

Property Trust (Q sector) – step 5

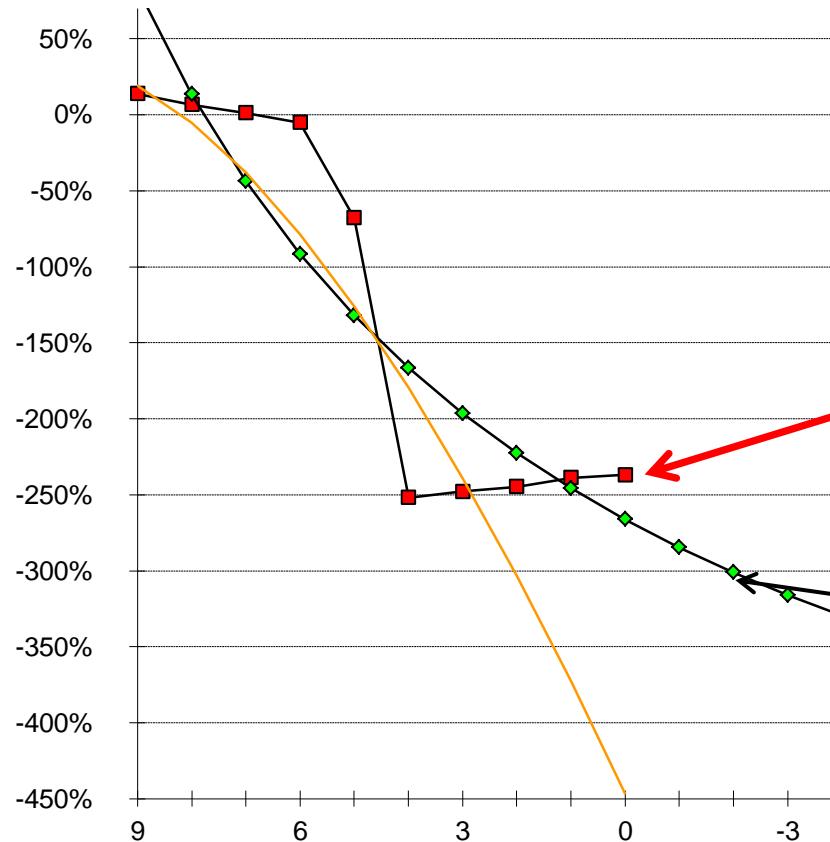
Q av Skewness



-301%

Property Trust (Q sector) – step 6

Q av Skewness

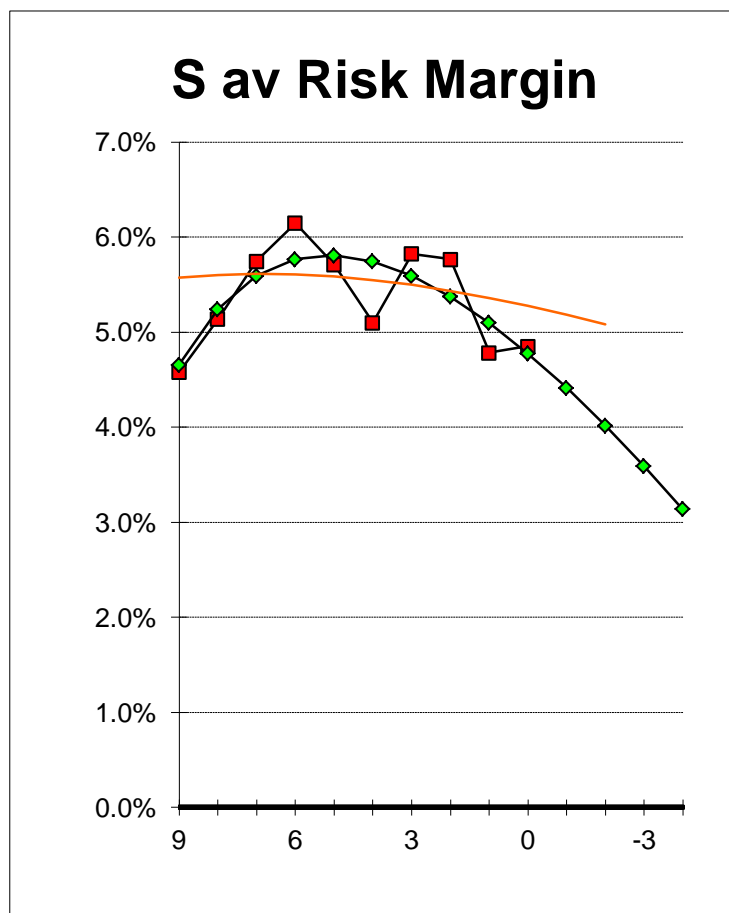


Because
Q was an outlier
– see section 10

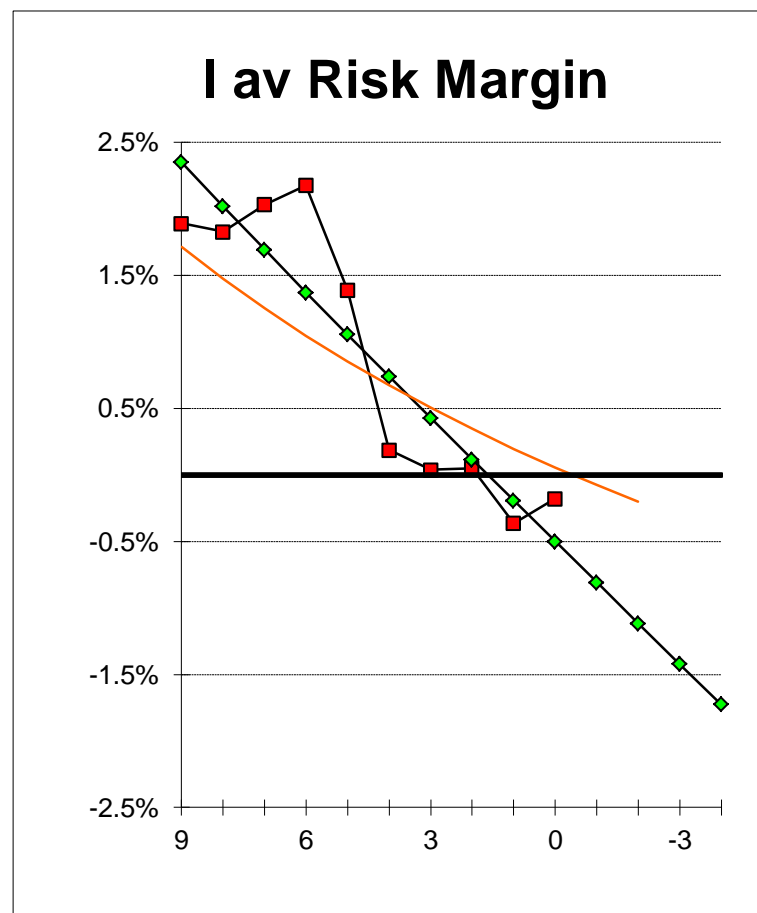
-237%

**Pointer - 2
-301%**

Results: Risk Margins over 44 years



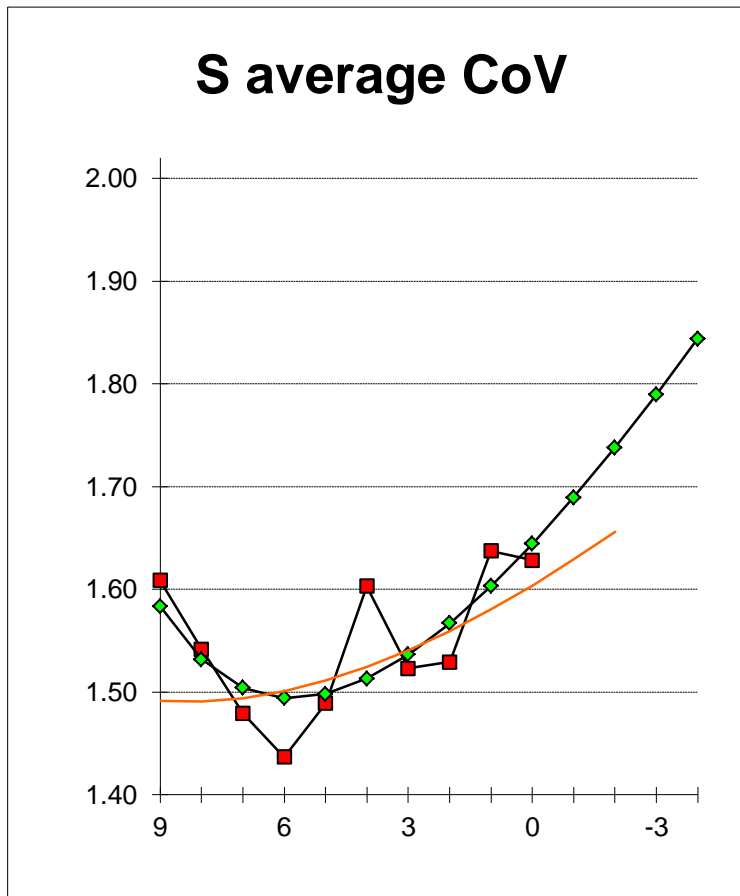
[4.0%]



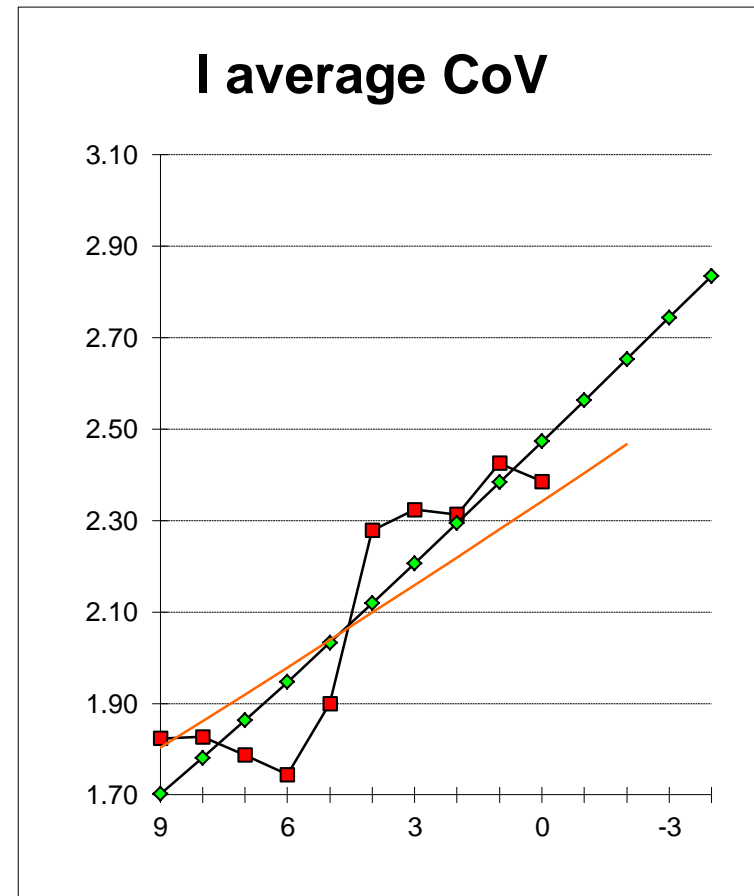
[2.6%]

Figure 6.1

Results: CoV's over 44 years



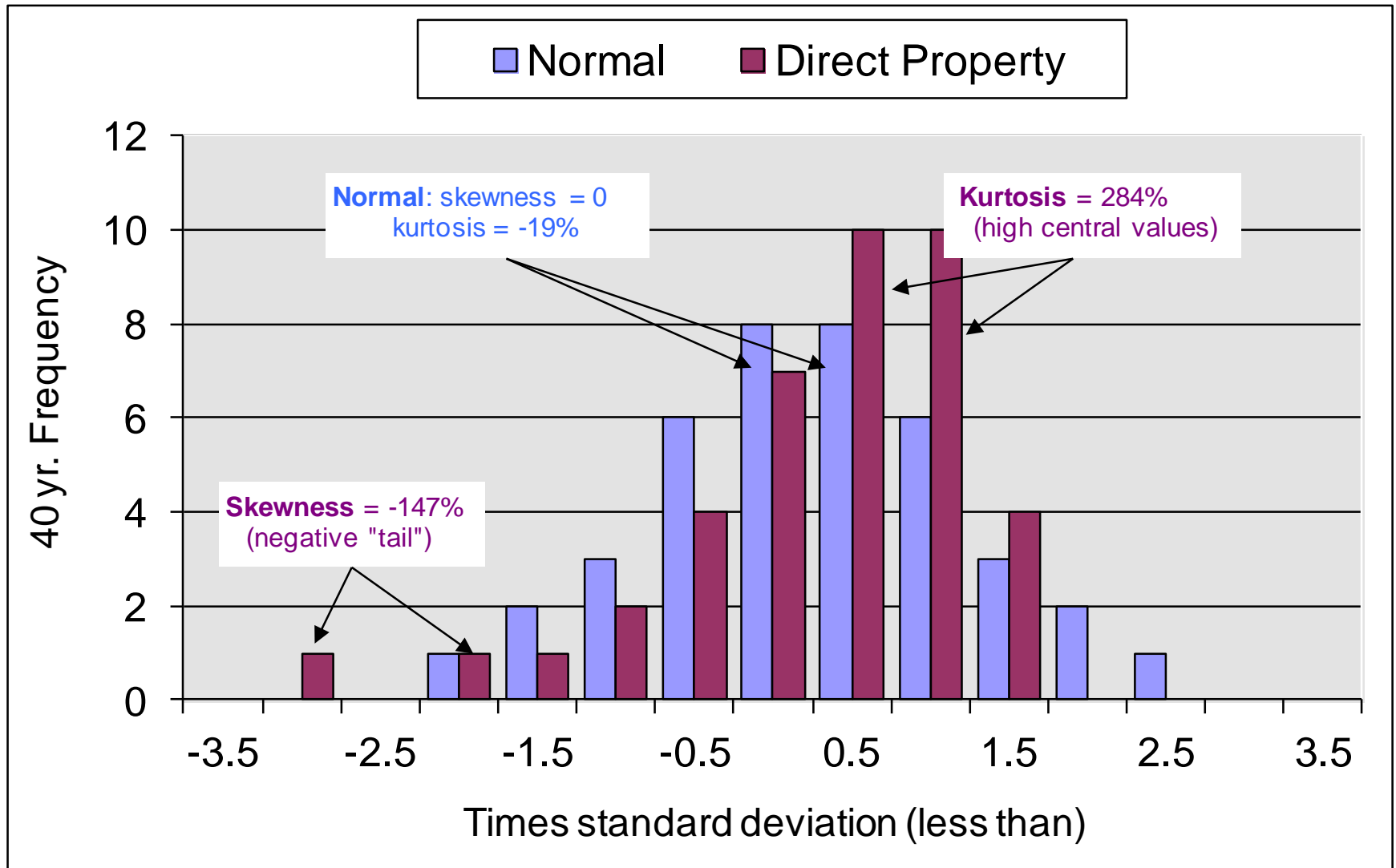
[1.650]



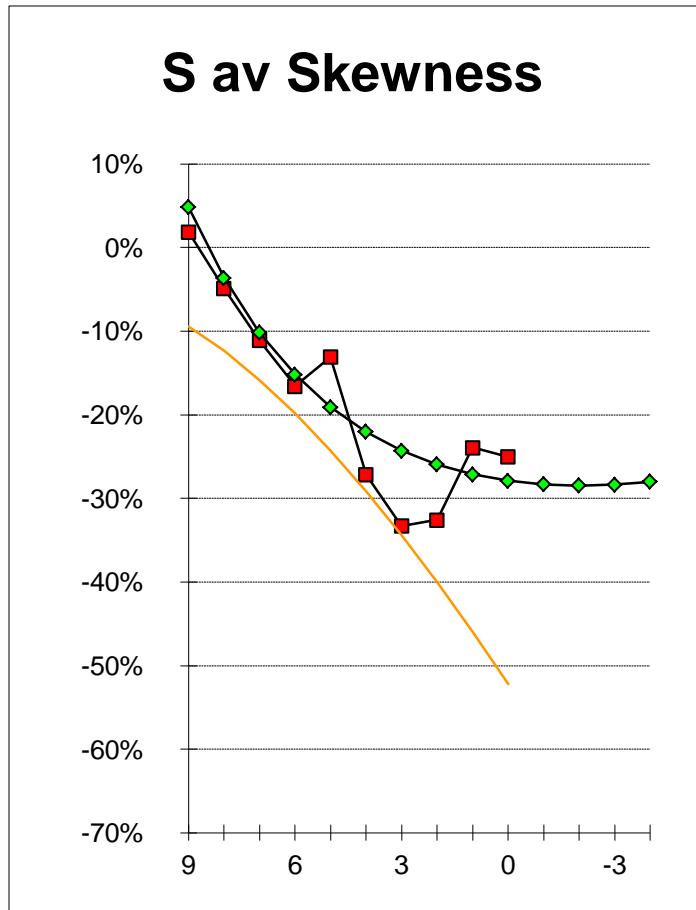
[1.721]

Figure 7.1

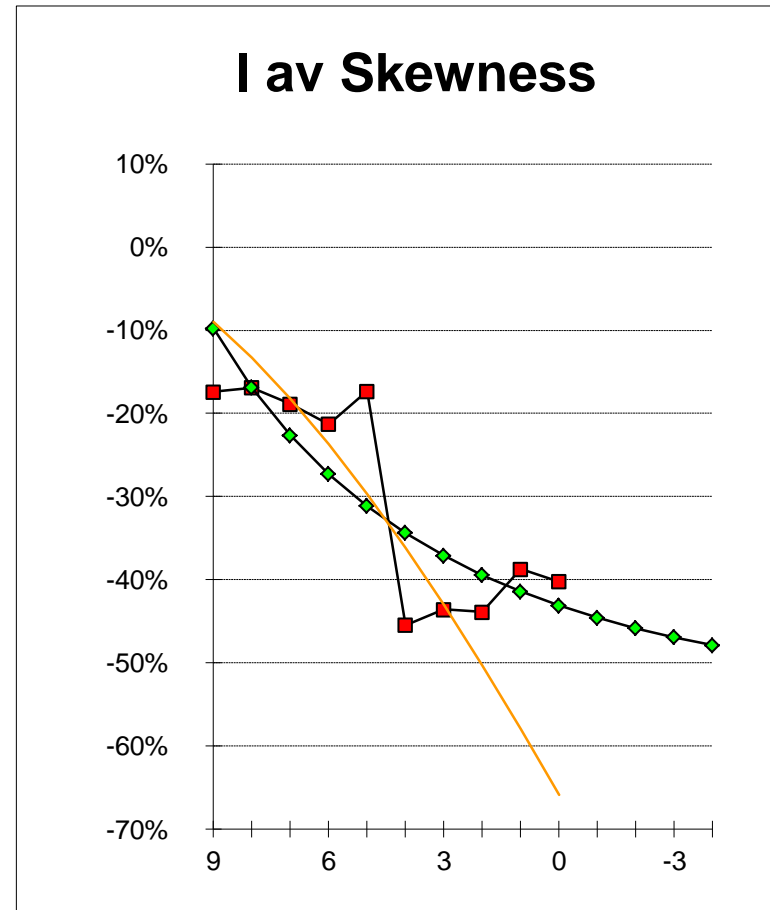
Skewness and Kurtosis



Results: Skewness over 44 years



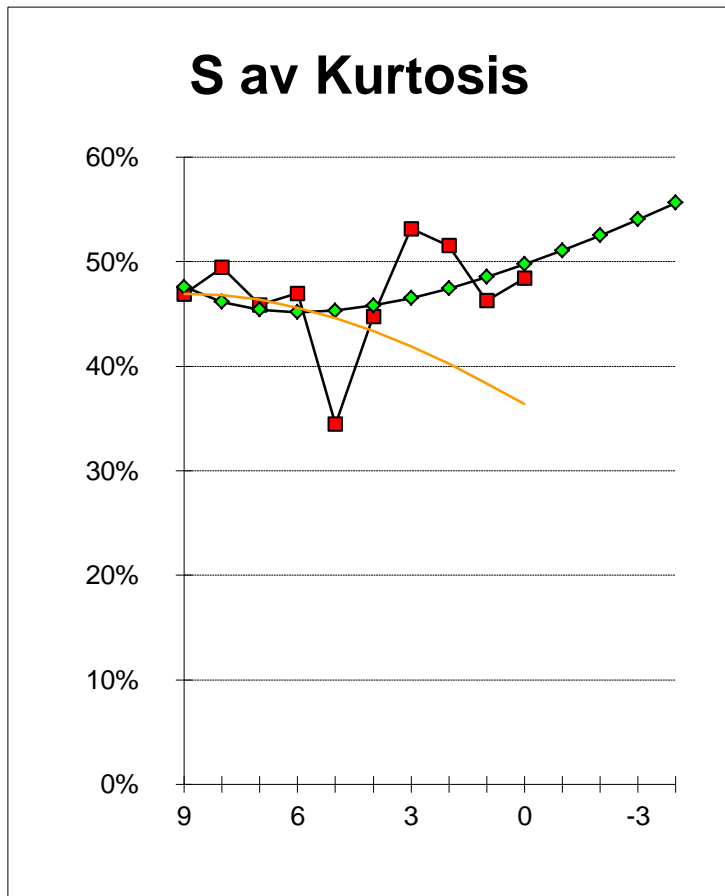
[-28%]



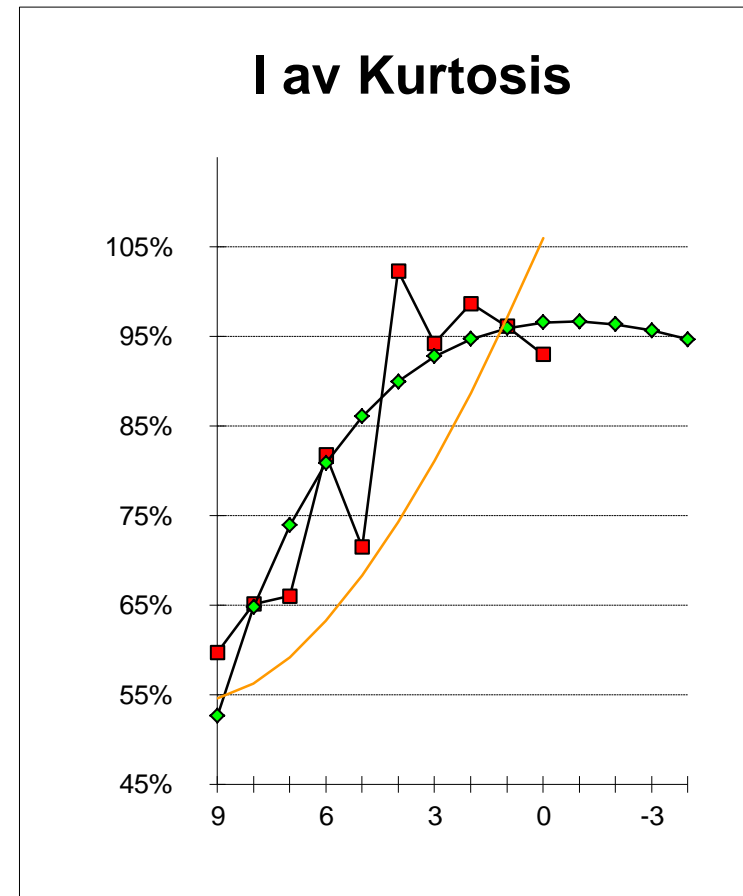
[-46%]

Figure 11.1

Results: Kurtosis over 44 years



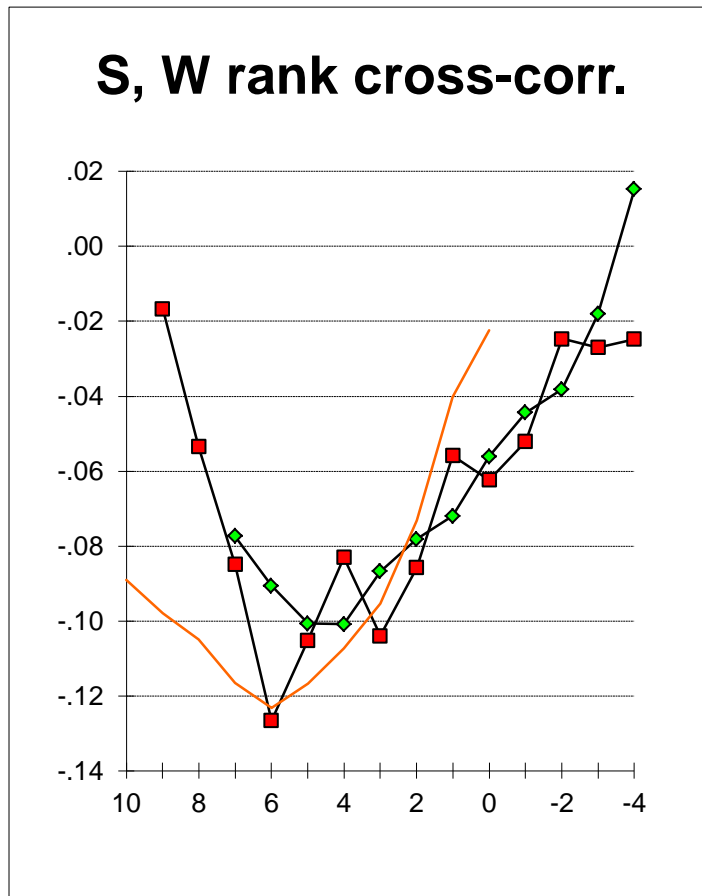
[53%]



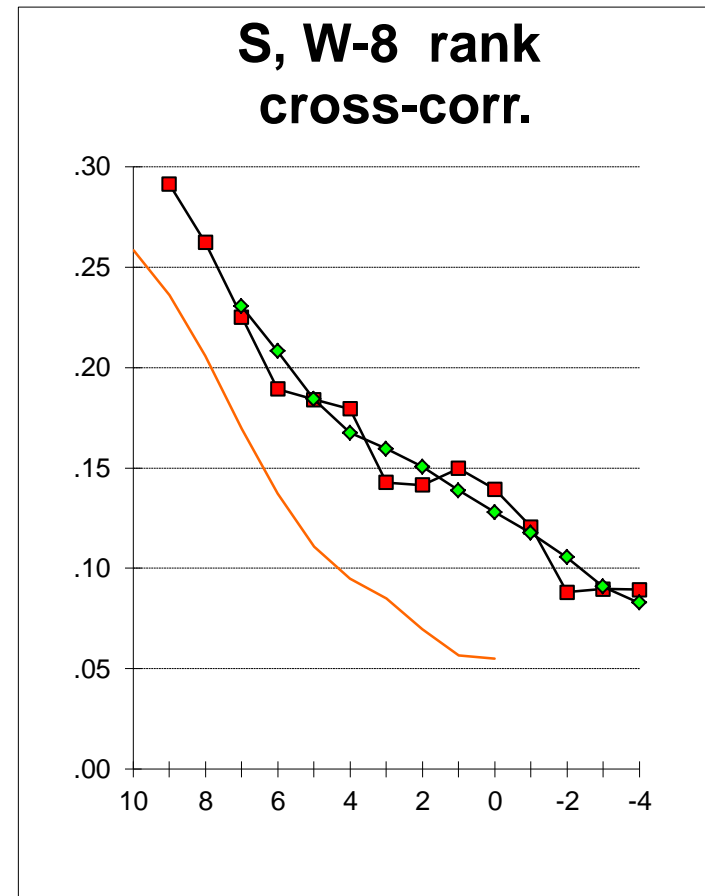
[96%]

Figure 12.1

Results: Cross-correlations over 44 years



[-4%]



[+11%]

Figure 13.1

Cross-correlation Assumptions (abridged)

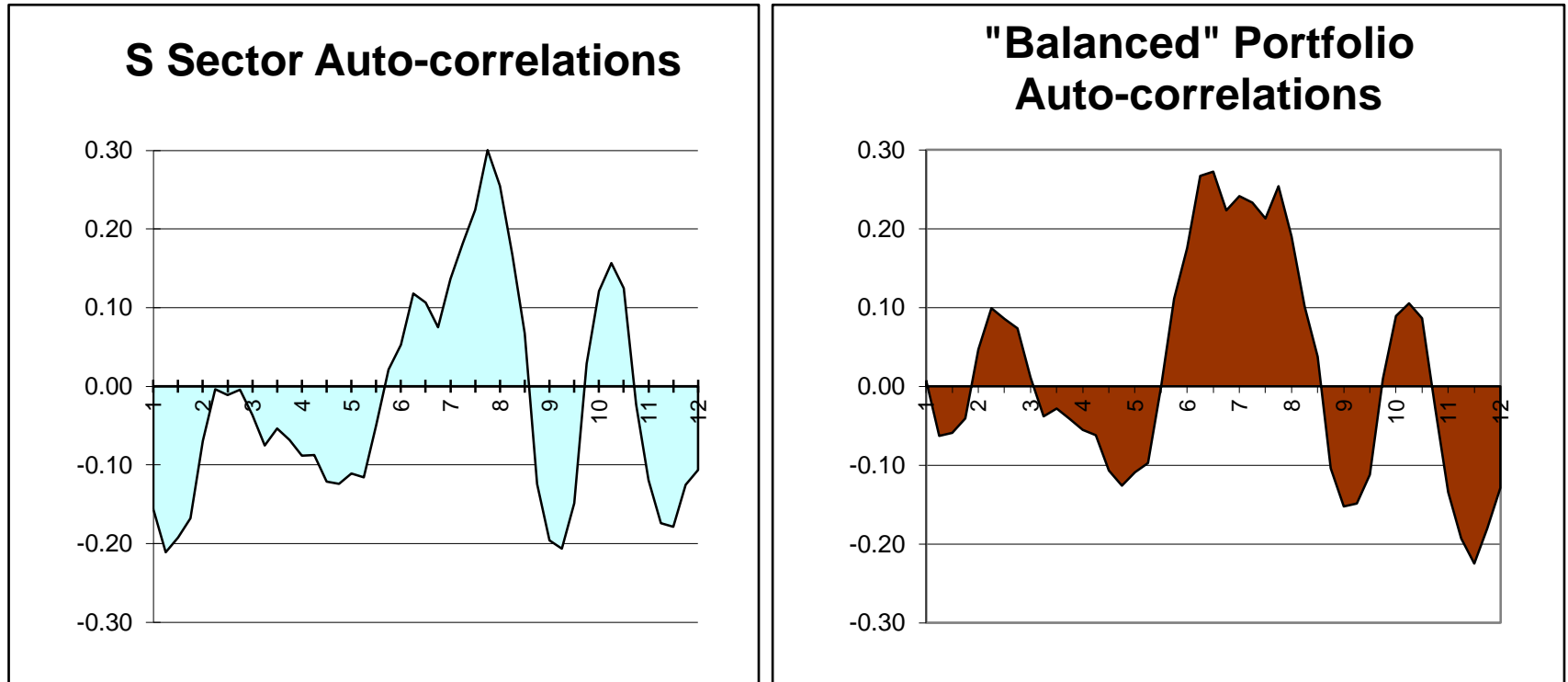
RANK CROSS-CORRELATIONS @ 2 YRS (5-point average, rounded)

SECTOR	Austn. Shares	Listed Property	Fixed Interest	Cash	Direct Property	CPI	AWOTE
Austn. Shares	1	.60	.06	.18	.13	-.01	-.04
Listed Property	.60	1	.34	.17	.14	-.09	-.04
Fixed Interest	.06	.34	1	.31	-.03	-.01	-.04
Cash	.18	.17	.31	1	.44	.66	.55
Direct Property	.13	.14	-.03	.44	1	.54	.42
CPI	-.01	-.09	-.01	.66	.54	1	.81
AWOTE	-.04	-.04	-.04	.55	.42	.81	1

Section 13 and Table 16.3

Auto-correlations over 40 years

Figure 15.1



Lags 1 to 12 years

Auto-correlations over 26 years

Australian Shares to 2012/13

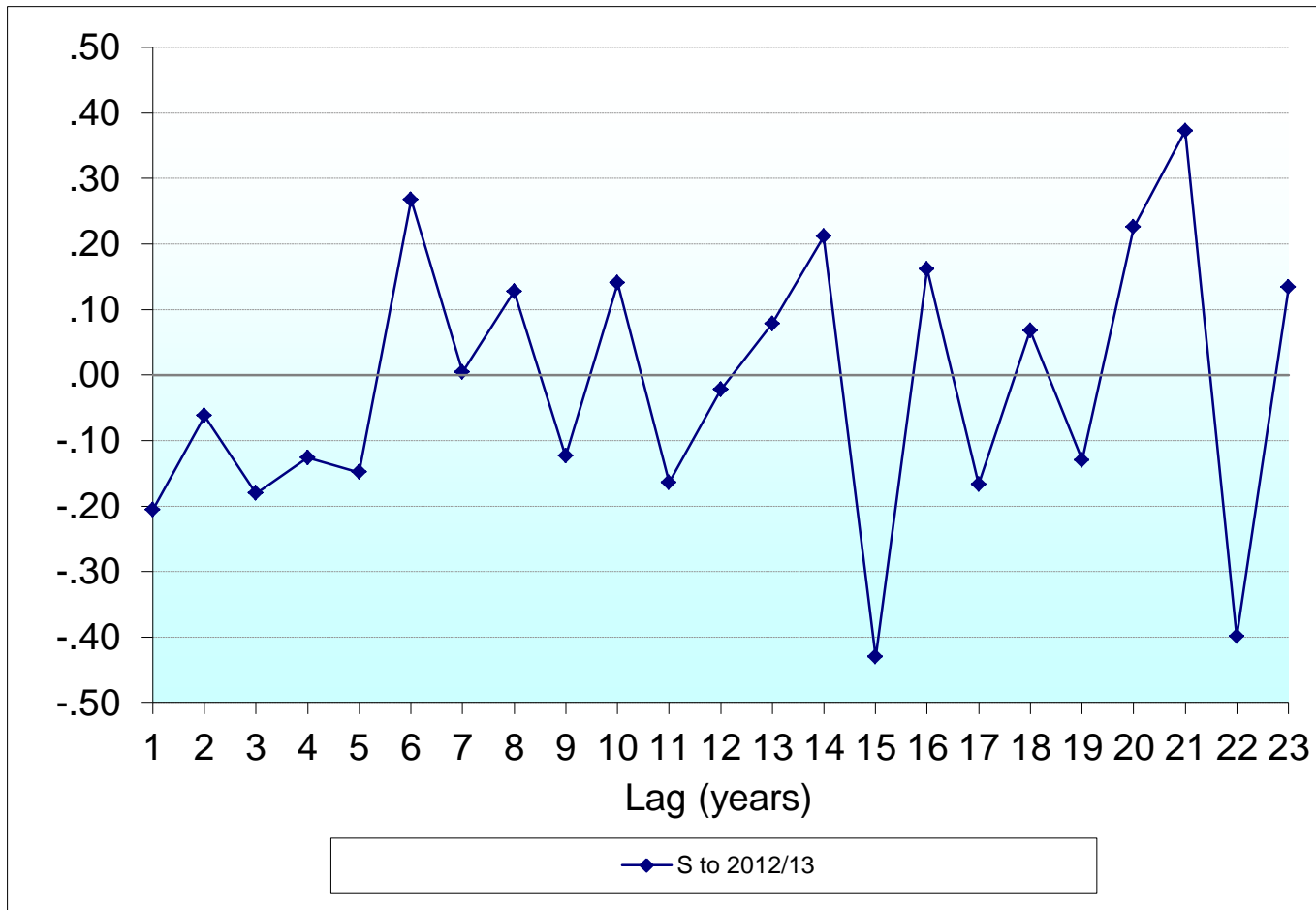
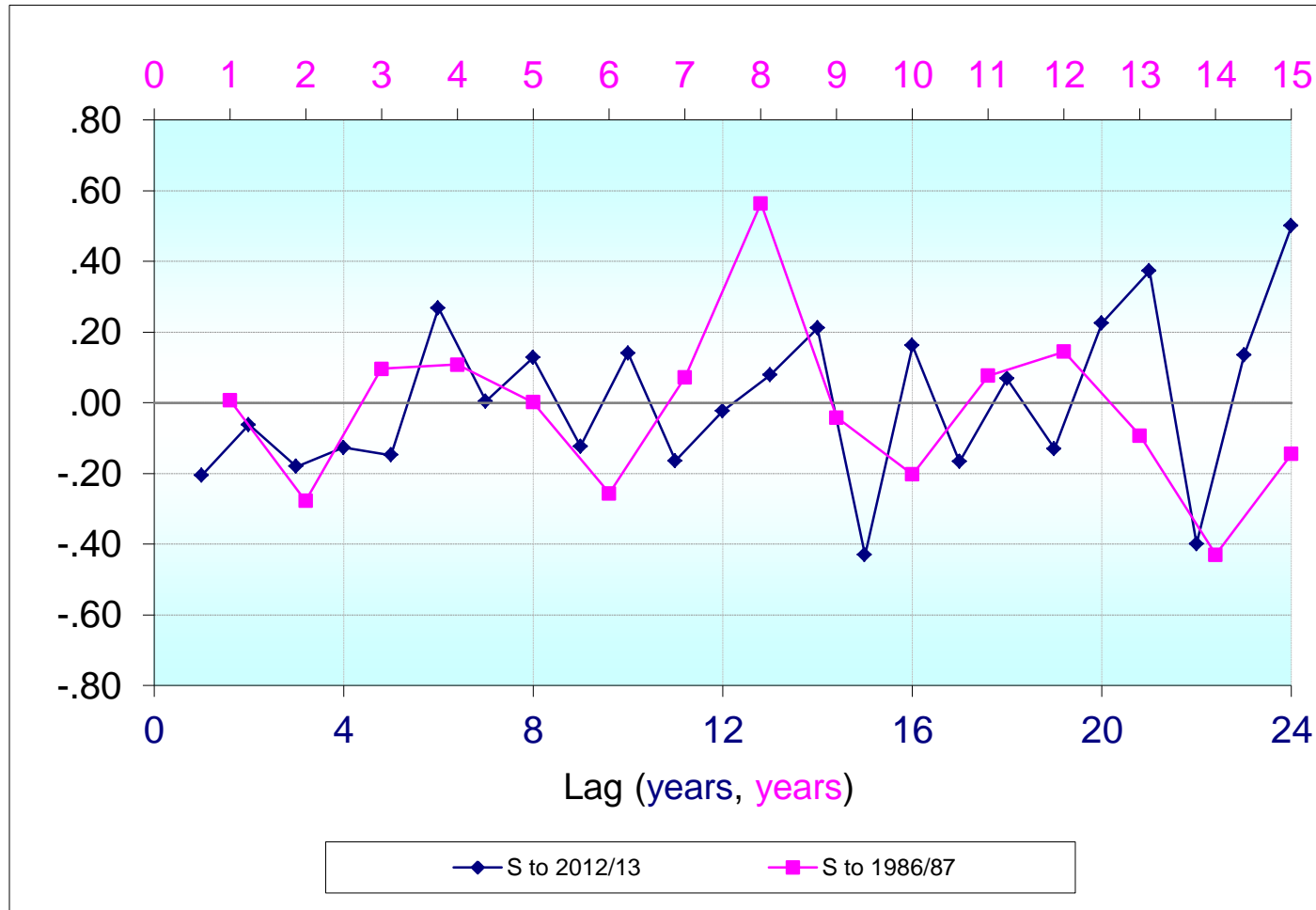


Figure 15.3

Auto-correlations over 26 years

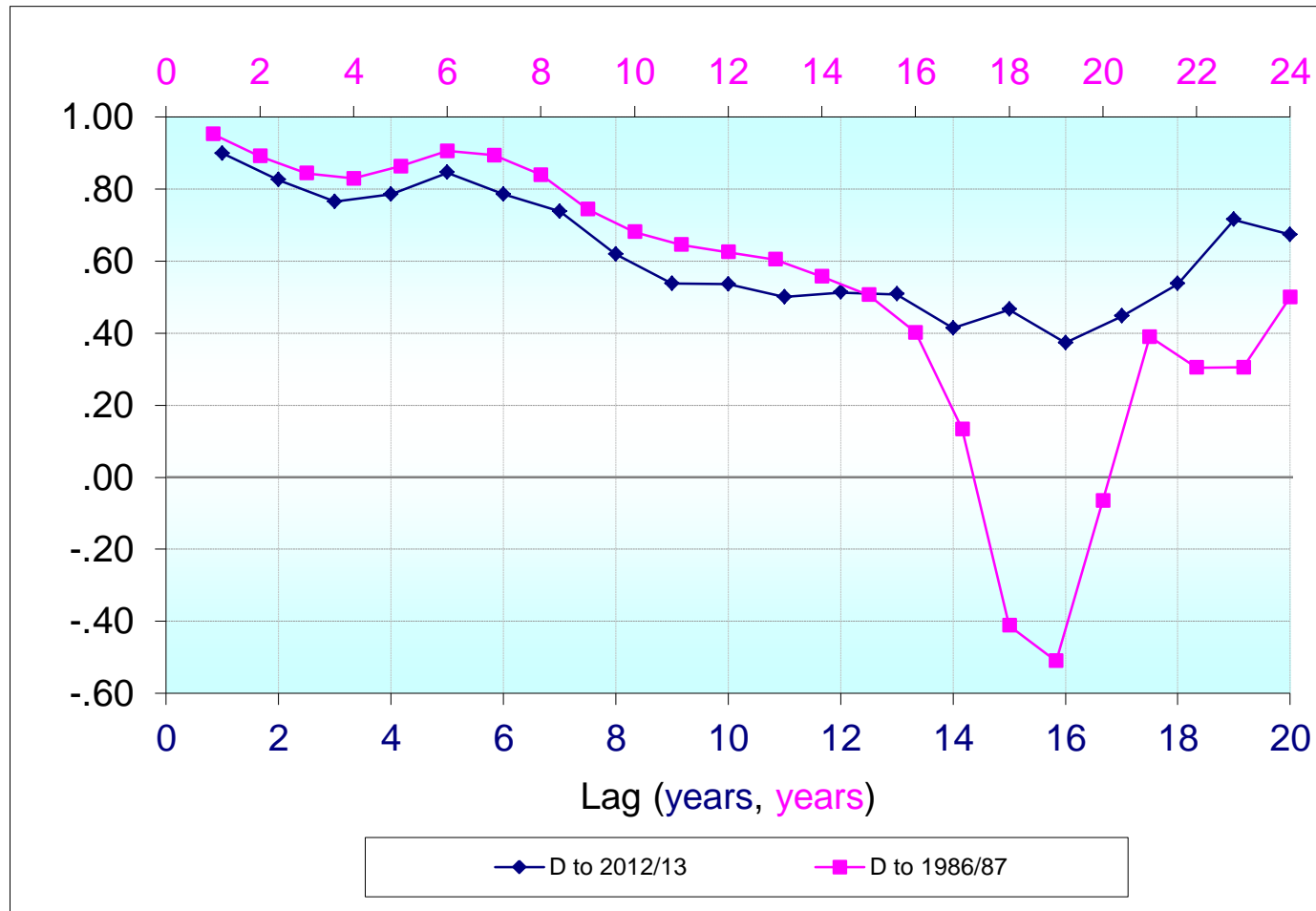
S to 2012/13 versus S to 1986/87



Auto-correlation features for last 26 yrs occurred more slowly

Auto-correlations over 26 years

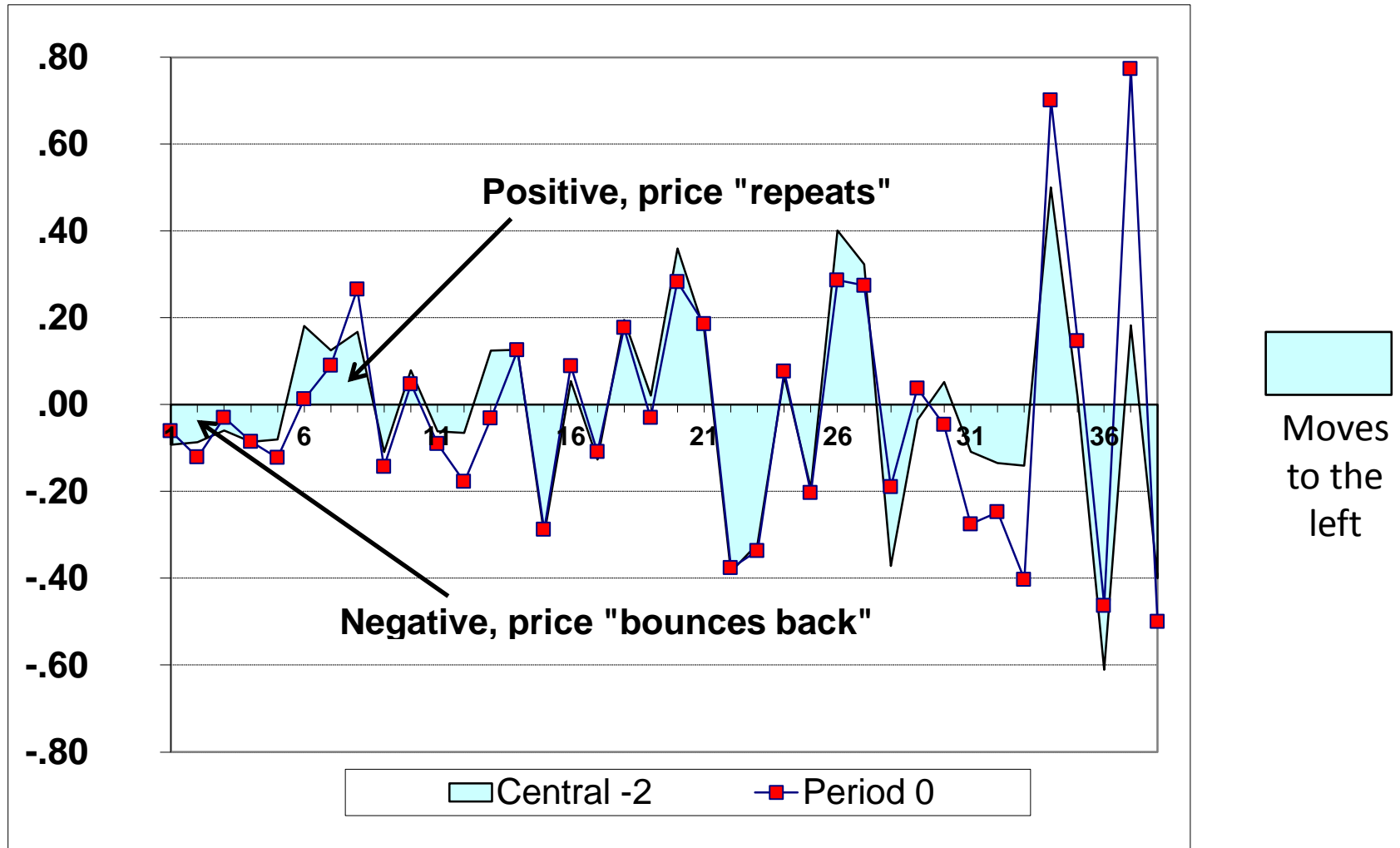
D to 2012/13 versus D to 1986/87



Auto-correlation features for last 26 yrs occurred more quickly

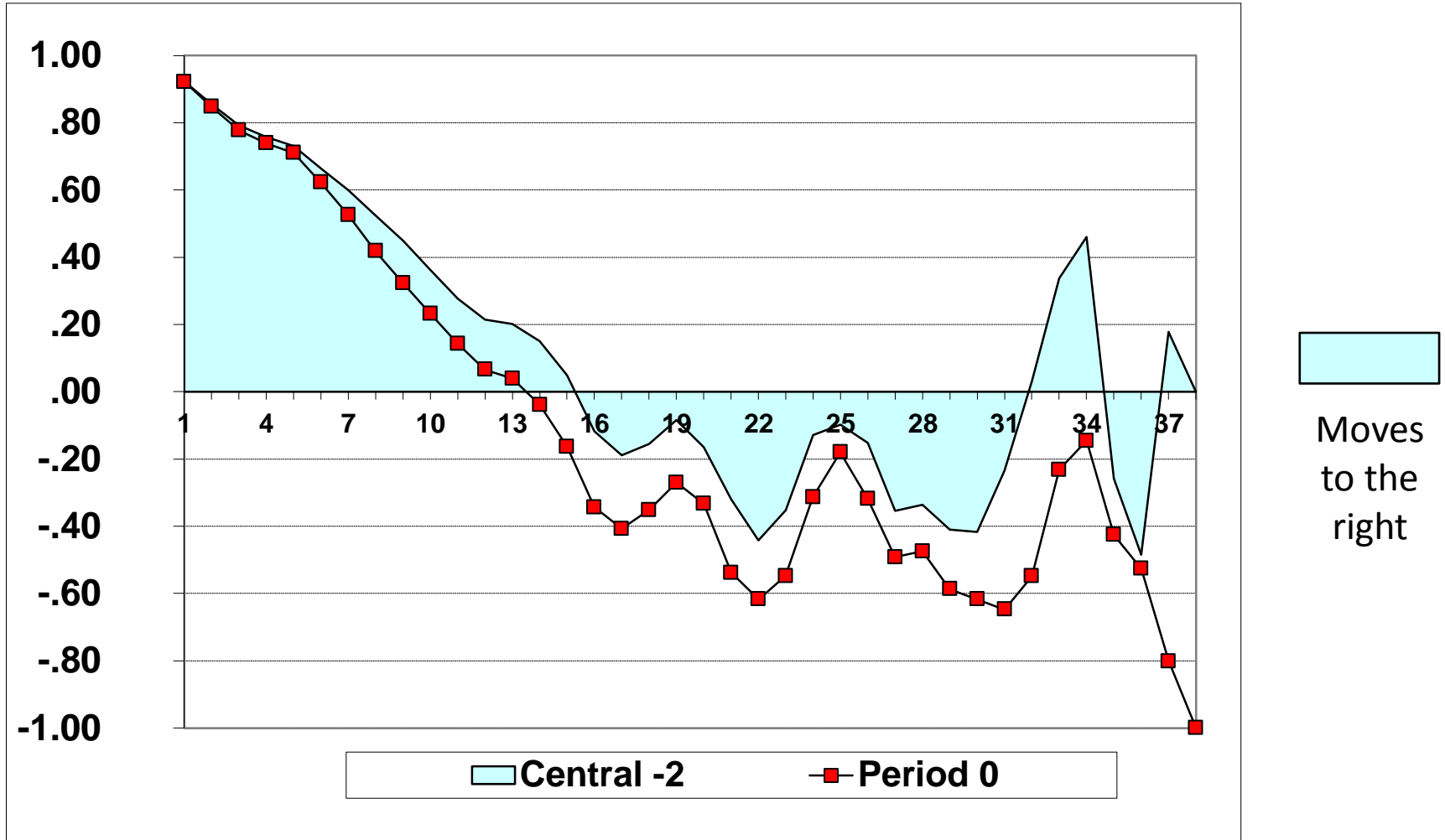
Auto-correlations over 40 years

Australian Shares Figure 15.5



Auto-correlations over 40 years

10-year Bonds Figure 15.6



Assumptions – Changes in Means

Section 6.12

Sector		NEW	OLD	Change
S	Shares	10.0%	10.5%	-0.5%
I	Int'l Shrs	8.6%	9.0%	-0.4%
Q	Prop Trust	8.6%	9.0%	-0.4%
P	Direct Prop	7.5%	8.0%	-0.5%
H	Hedged IS	8.7%	9.2%	-0.5%
L	Loans/credit	7.2%	7.0%	0.2%
F	Fixed Int	6.4%	6.5%	-0.1%
G	Semi-govt	6.4%	6.1%	0.3%
J	Int'l Fxd Int	6.2%	6.2%	0.0%
C	Cash	5.8%	5.7%	0.1%
N	Infln Linked	7.0%	6.6%	0.4%
Balncd	Balanced	8.03%	8.36%	-0.33%
CapStb	Cap Stable	6.81%	6.95%	-0.14%
B	Bills	5.80%	5.70%	0.10%
D	Bonds	6.00%	6.00%	0.00%
W	AWOTE	4.20%	3.75%	0.45%
X	CPI	2.70%	2.50%	0.20%

Arithmetic, before tax, fees and imputation credits

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
S	Shares	4.0%	10.0%	8.8%	1.650	16.5%	-28%	53%
I	Int'l Shrs	2.6%	8.6%	7.6%	1.721	14.8%	-46%	96%
Q	Prop Trust	2.6%	8.6%	7.4%	1.721	14.8%	-237%	963%
P	Direct Prop	1.5%	7.5%	7.3%	0.920	6.9%	-145%	260%
H	Hedged IS	2.7%	8.7%	7.7%	1.690	14.7%	-78%	113%
L	Loans/credit	1.2%	7.2%	7.1%	0.500	3.6%	67%	-3%
F	Fixed Int	0.4%	6.4%	6.3%	0.797	5.1%	-85%	257%
G	Semi-govt	0.4%	6.4%	6.3%	0.593	3.8%	28%	-34%
J	Int'l Fxd Int	0.2%	6.2%	6.1%	0.709	4.4%	-86%	235%
C	Cash	-0.2%	5.8%	5.8%	0.500	2.9%	75%	-56%
N	Infln Linked	1.0%	7.0%	6.9%	0.714	5.0%	-48%	37%
Balncd	Balanced	2.03%	8.03%	7.60%	1.207	9.69%	-73%	111%
CapStb	Cap Stable	0.81%	6.81%	6.69%	0.725	4.94%	-54%	99%
B	Bills	-0.20%	5.80%	5.76%	0.534	3.10%	88%	-13%
D	Bonds		6.00%	5.97%	0.417	2.50%	47%	-98%
W	AWOTE	-1.80%	4.20%	4.16%	0.667	2.80%	182%	393%
X	CPI	-3.30%	2.70%	2.68%	0.740	2.00%	77%	-19%

Before tax, fees and imputation credits

Investment Assumptions

Table 16.1

		Risk margin	Mean rate	Compound	Coefficient	Standard	Skewness	Kurtosis
Sector		(arithmetic average)	(arithmetic average)	average	of variation	deviation of rates	'Moderate'	
							'Extreme'	
S I Q P H L F G J C N	Shares	4.0%	10.0%	8.8%	1.650	16.5%	-28%	53%
	Int'l Shrs	2.6%	8.6%	7.6%	1.721	14.8%	-46%	96%
	Prop Trust	2.6%	8.6%	7.4%	1.721	14.8%	-237%	963%
	Direct Prop	1.5%	7.5%	7.3%	0.920	6.9%	-145%	260%
	Hedged IS	2.7%	8.7%	7.7%	1.690	14.7%	-78%	113%
	Loans/credit	1.2%	7.2%	7.1%	0.500	3.6%	67%	-3%
	Fixed Int	0.4%	6.4%	6.3%	0.797	5.1%	-85%	257%
	Semi-govt	0.4%	6.4%	6.3%	0.593	3.8%	28%	-34%
	Int'l Fxd Int	0.2%	6.2%	6.1%	0.709	4.4%	-86%	235%
Balncd CapStb B D W X	Cash	-0.2%	5.8%	5.8%	0.500	2.9%	75%	-56%
	Infln Linked	1.0%	7.0%	6.9%	0.714	5.0%	-48%	37%
	Balanced	2.03%	8.03%	7.60%	1.207	9.69%	-73%	111%
	Cap Stable	0.81%	6.81%	6.69%	0.725	4.94%	-54%	99%
	Bills	-0.20%	5.80%	5.76%	0.534	3.10%	88%	-13%
	Bonds		6.00%	5.97%	0.417	2.50%	47%	-98%
	AWOTE	-1.80%	4.20%	4.16%	0.667	2.80%	182%	393%
	CPI	-3.30%	2.70%	2.68%	0.740	2.00%	77%	-19%

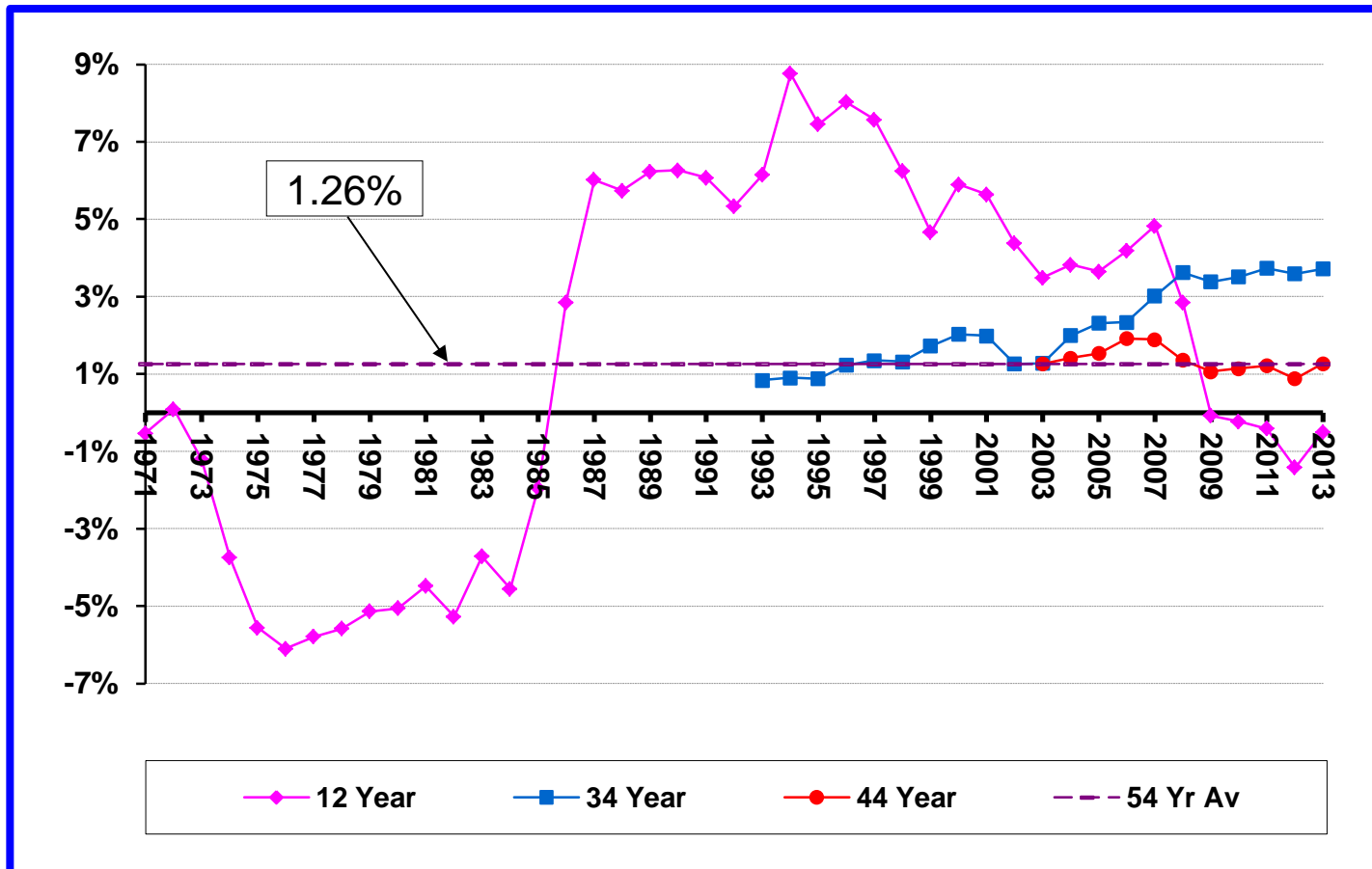
Before tax, fees and imputation credits

Assumptions gross/net tax/fees

Table 18.1

Sector		Mean rate (arithmetic average)			Compound
		Before tax Before fees	Before tax After fees	After tax & IC's After fees	Average rate
					After tax & IC's After fees
S	Shares	10.00%	9.74%	9.43%	8.44%
I	Int'l Shrs	8.60%	8.31%	7.59%	6.77%
Q	Prop Trust	8.60%	8.31%	7.44%	6.42%
P	Direct Prop	7.50%	6.80%	5.81%	5.62%
H	Hedged IS	8.70%	8.41%	7.68%	6.85%
L	Loans	7.20%	6.91%	5.87%	5.83%
F	Fixed Int	6.40%	6.22%	5.29%	5.18%
G	Semi-govt	6.40%	6.22%	5.29%	5.24%
J	Int'l Fxd Int	6.20%	6.02%	5.12%	5.04%
C	Cash	5.80%	5.65%	4.80%	4.77%
N	Infln Linked	7.00%	6.81%	5.86%	5.76%
Balncd	Balanced	8.03%	7.78%	7.19%	6.84%
CapStb	Cap Stable	6.81%	6.60%	5.85%	5.76%
B	Bills	5.80%	5.80%	4.93%	4.90%
D	Bonds	6.00%	6.00%	5.10%	5.08%

Historical Average Real Returns pa. “Balanced” Portfolio Figure 19.1



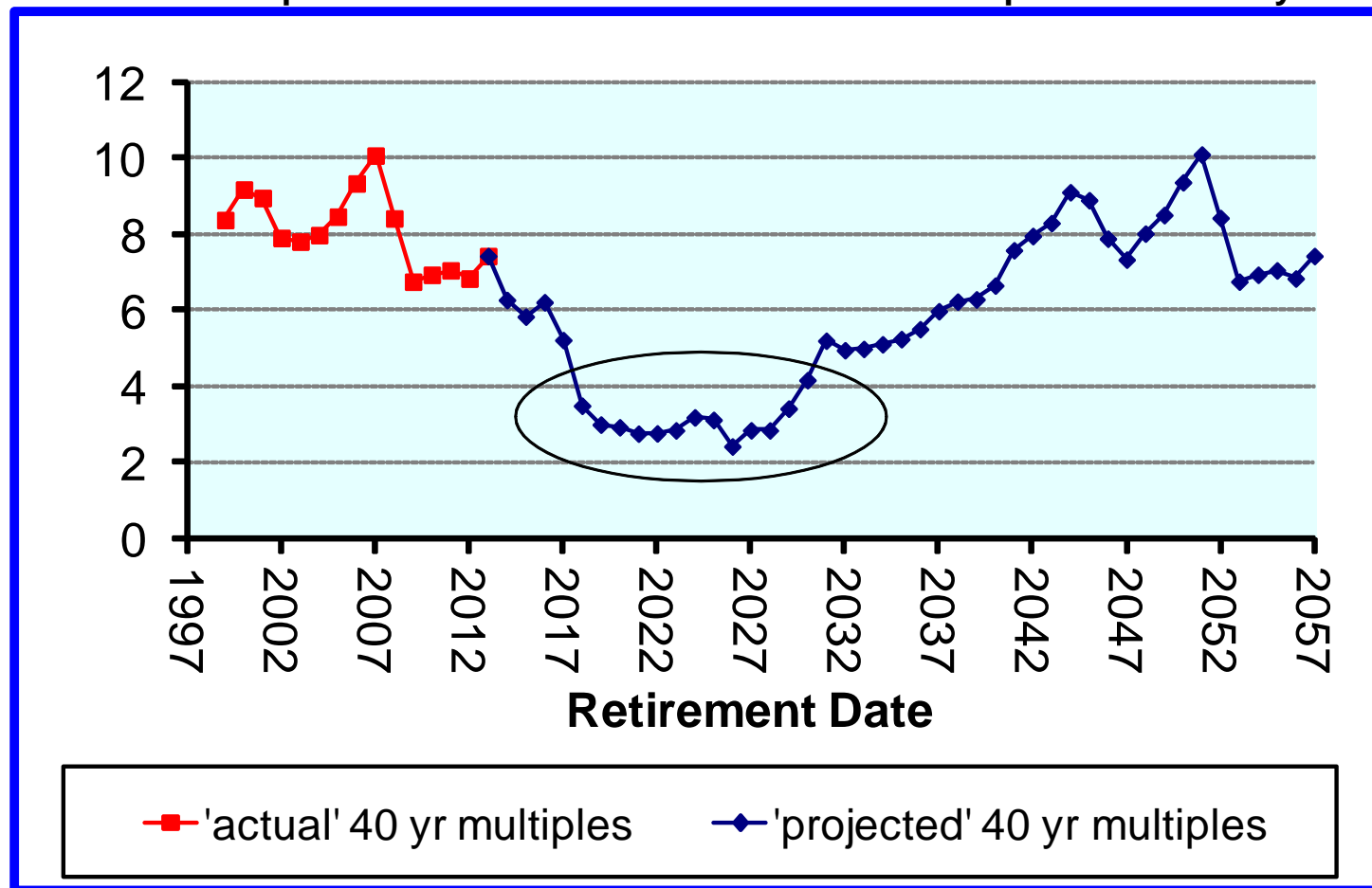
Net of tax and fees, real over AWOTE, to 30/6/13

If the next 44 years equal the last 44 years:
Superannuation Guarantee 12.000%
Net accumulation towards retirement = 8.925%

'Balanced' Portfolio
Net of tax and fees

Figure 19.2

40 Year Supn Guarantee Retirement Benefits as a multiple of Final Salary



If the next 44 years equal the last 44 years:

Superannuation Guarantee 12.000%

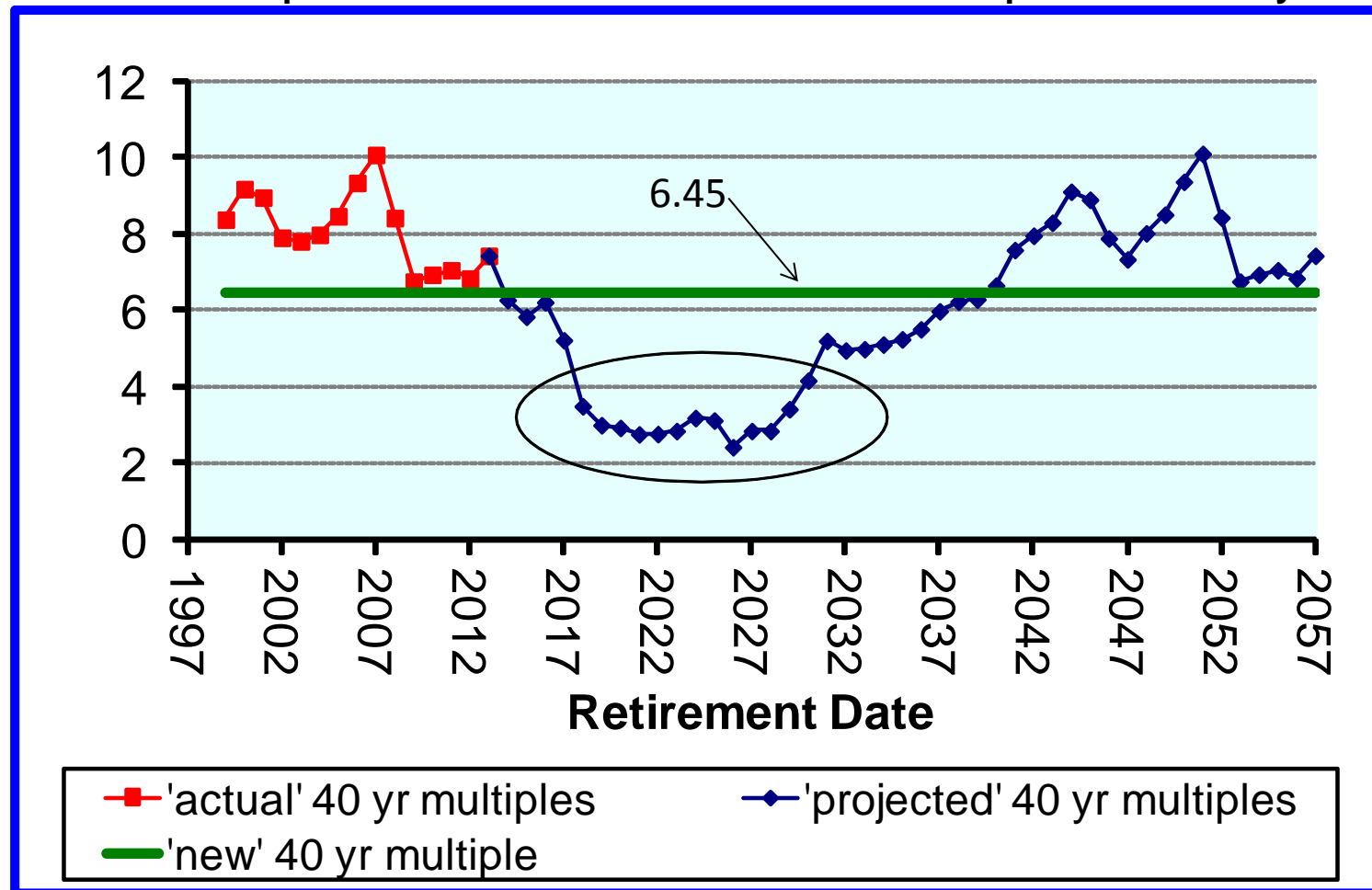
Net accumulation towards retirement = 8.925%

'Balanced' Portfolio

Net of tax and fees

Figure 19.2

40 Year Supn Guarantee Retirement Benefits as a multiple of Final Salary



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 26-year S and D auto-correlations indicate some stability after rescaling the x-axis

Historical net returns can be used to illustrate the adequacy and the inadequacy of Australia's 12% SG contribution rate

A fixed input (such as 12% of salary) will produce a variable output, with significant variation in lump sum retirement benefits depending on your chosen normal retirement date

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Designers of National Mutual EFG investment system

Actuaries Institute Research Grant Program

“Black Swans, Fat Tails and Spherical Cows”
by Jeremy Waite

Paragraph 4.3

“Of major significance was the introduction in 1965 of a selective investment facility known as the EFG system. Evidence of the success and wide acceptance of this concept, which was pioneered by National Mutual in Australia, may now be seen in the fact that it has since been adopted by a number of other financial institutions as a medium for superannuation investment.”

NEXT ?

2014	Quarterly Data Updates
2015	AUSTMOD Model
2016	Paper (s)

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QUESTIONS ?

Methodology
Assumptions
Rank correlations
Auto correlations
Skewness & kurtosis
Real returns
40-year SG multiples
Next ?

