Quantitative Research & Investment Strategy

Emma Battellino, Ron Bewley, Tally Dewan, Joanna Nash and Simon Sando

Q Group Colloquium - 23rd October 2007

Does One Size Fit all?

Volatility in the US and Australia

CommSec

Important Information

General Advice Warning: This presentation has been prepared without taking account of the objectives, financial situation or needs of any particular individual. Any individual should, before acting on the information in this presentation, consider the appropriateness of the information, having regard to the individual's objectives, financial situation and needs and, if necessary, seek appropriate professional advice.

Financial Services Guide: Unless agreed separately, we do not charge any fees for any information provided in this presentation. You may be charged fees in relation to the financial products or other services CommSec provides, these are set out in the CommSec Financial Services Guide (FSG) and relevant Product Disclosure Statements (PDS). Our employees may be eligible for an annual bonus payment. Some representatives' bonus payments may be up to 50% of initial fees, and 10% of ongoing fees and commissions that CommSec receives from the placement of a financial product. Bonus payments are discretionary and based on objectives that include business outcomes, customer service, people engagement, special tasks and people principals. Our employees may also receive benefits such as tickets to sporting and cultural events, corporate promotional merchandise and other similar benefits. If you have a complaint, CommSec's dispute resolution process can be accessed on 131519.

No Tax Advice: The examples provided in this presentation are for illustrative and discussion purposes only. In particular, they are not intended as tax advice. You should consult your independent tax adviser with regard to your own tax situation.

Past Performance: Past performance is not a reliable indicator of future performance.

CommSec

Outline of talk

1. Introduction – features of the two markets
2. Clusters or outliers?
3. Switchbacks
4. GARCH models with shifts
5. Conclusions

CommSec

Annualised Volatility Statistics (%)

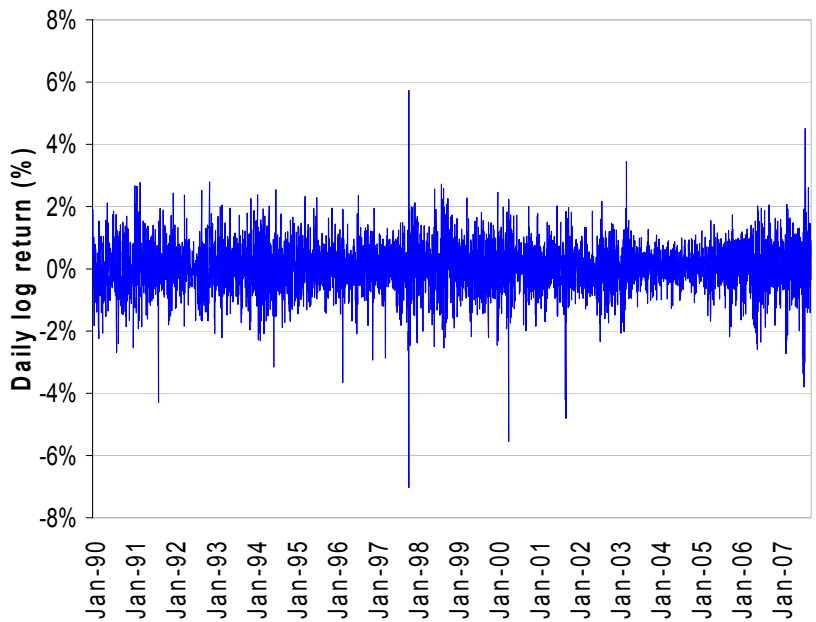
Data Frequency	S&P/ASX 200 Index	S&P 500 Index
Daily	12.83	15.74
Weekly	12.16	14.86
Monthly	12.39	13.69

Source: CommSec Quantitative Research & Investment Strategy

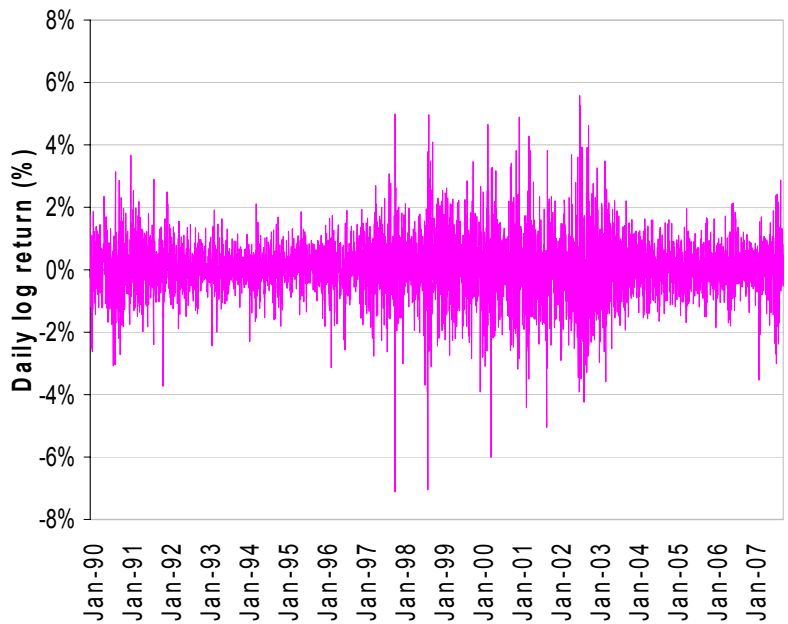
CommSec

Similar regimes? - Daily log returns

S&P/ASX 200 Index



S&P 500 Index



Source: CommSec Quantitative Research & Investment Strategy

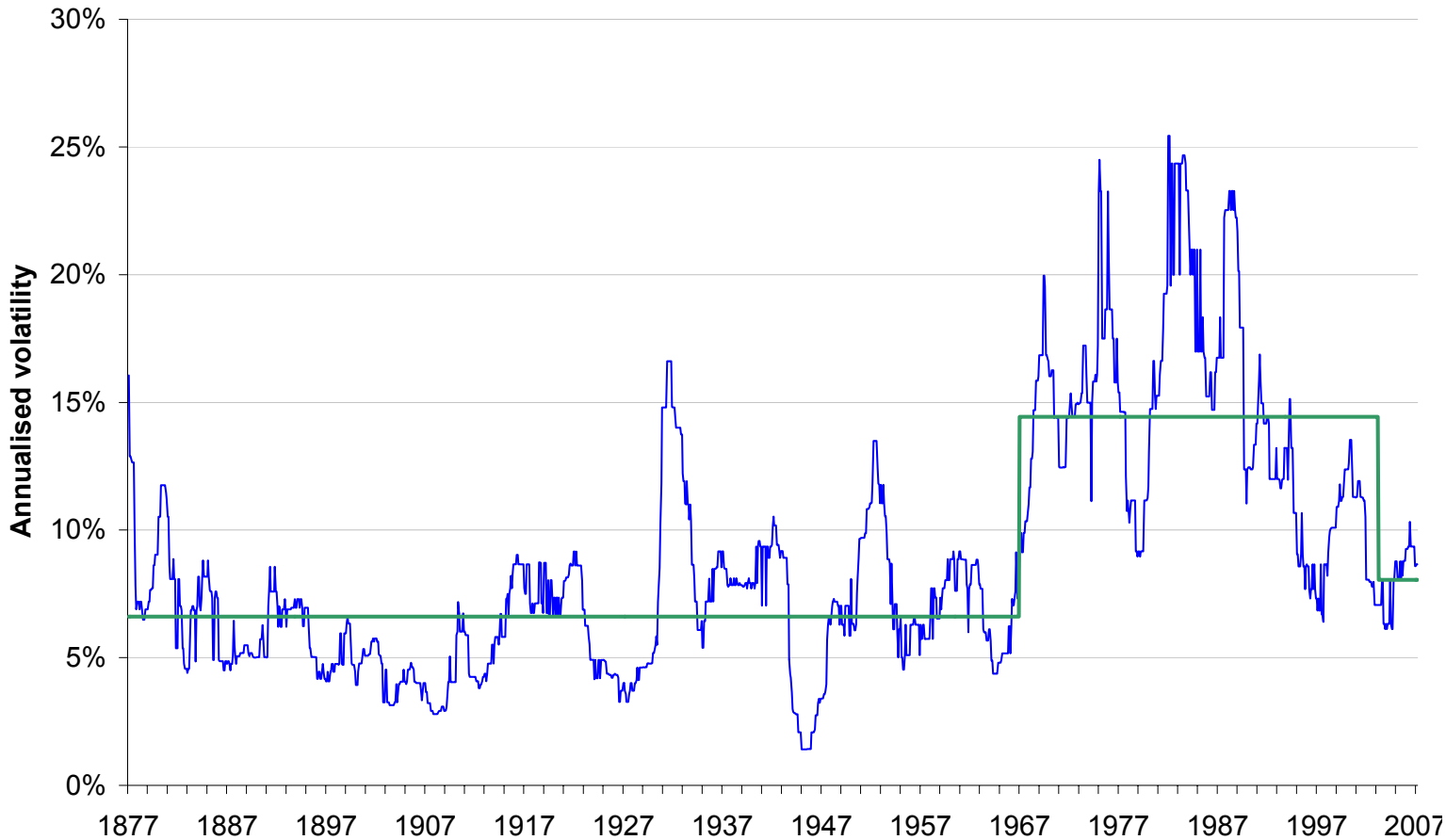
CommSec

Where is long-run volatility heading?

1. Work by Engle and Rangel (2007) has suggested that many countries are in low volatility regimes and will revert back to higher volatility levels
2. We suggest that Australia has already mean reverted – back to a lower level
3. To challenge Engle and Rangel's results we consider the Australian All Ordinaries, the only equities series that we have data back before 1984
4. We take 25-month rolling windows of absolute de-meaned monthly returns and look at the change over time

CommSec

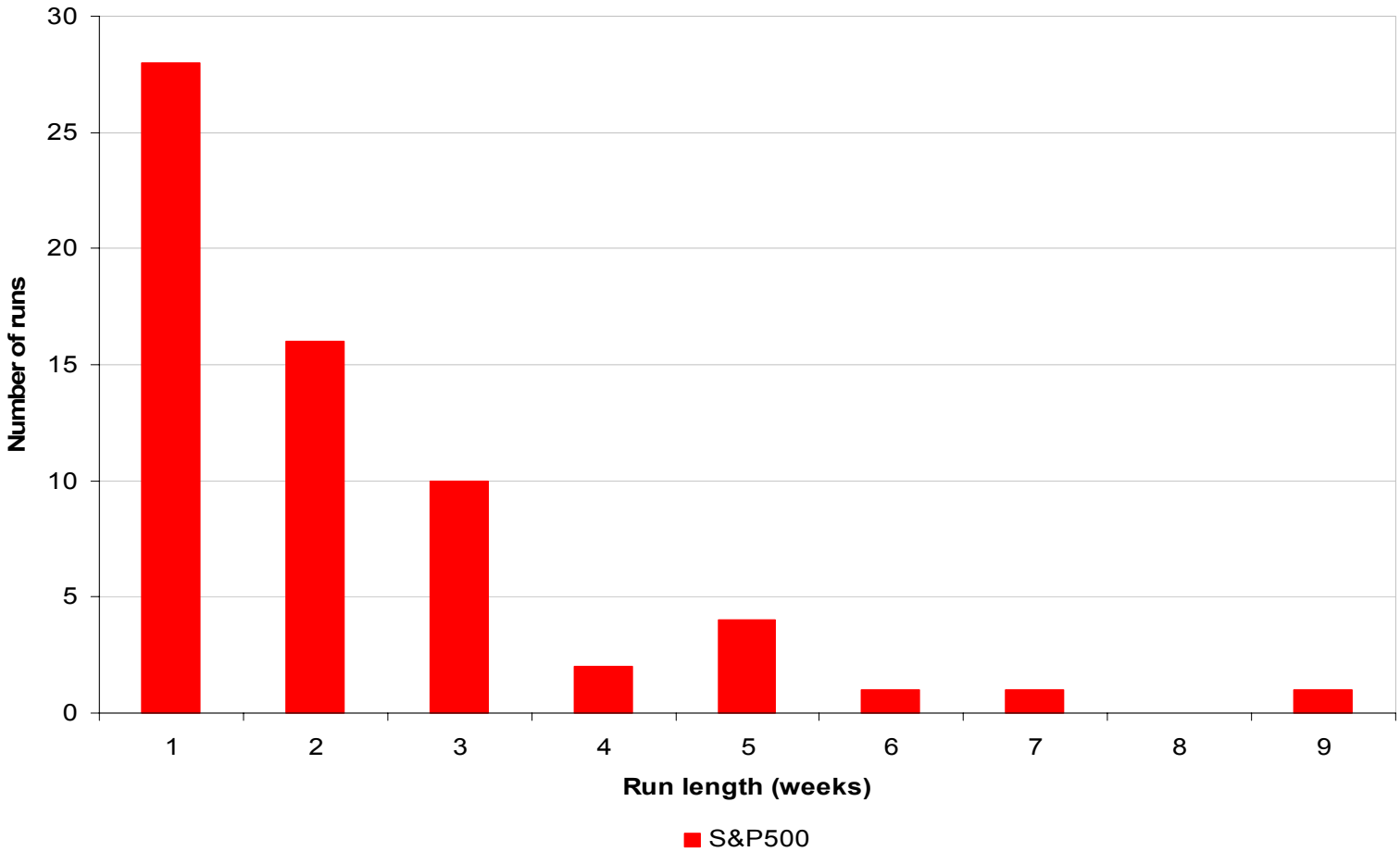
Annualised Volatility of the All Ordinaries



Source: CommSec Quantitative Research & Investment Strategy

CommSec

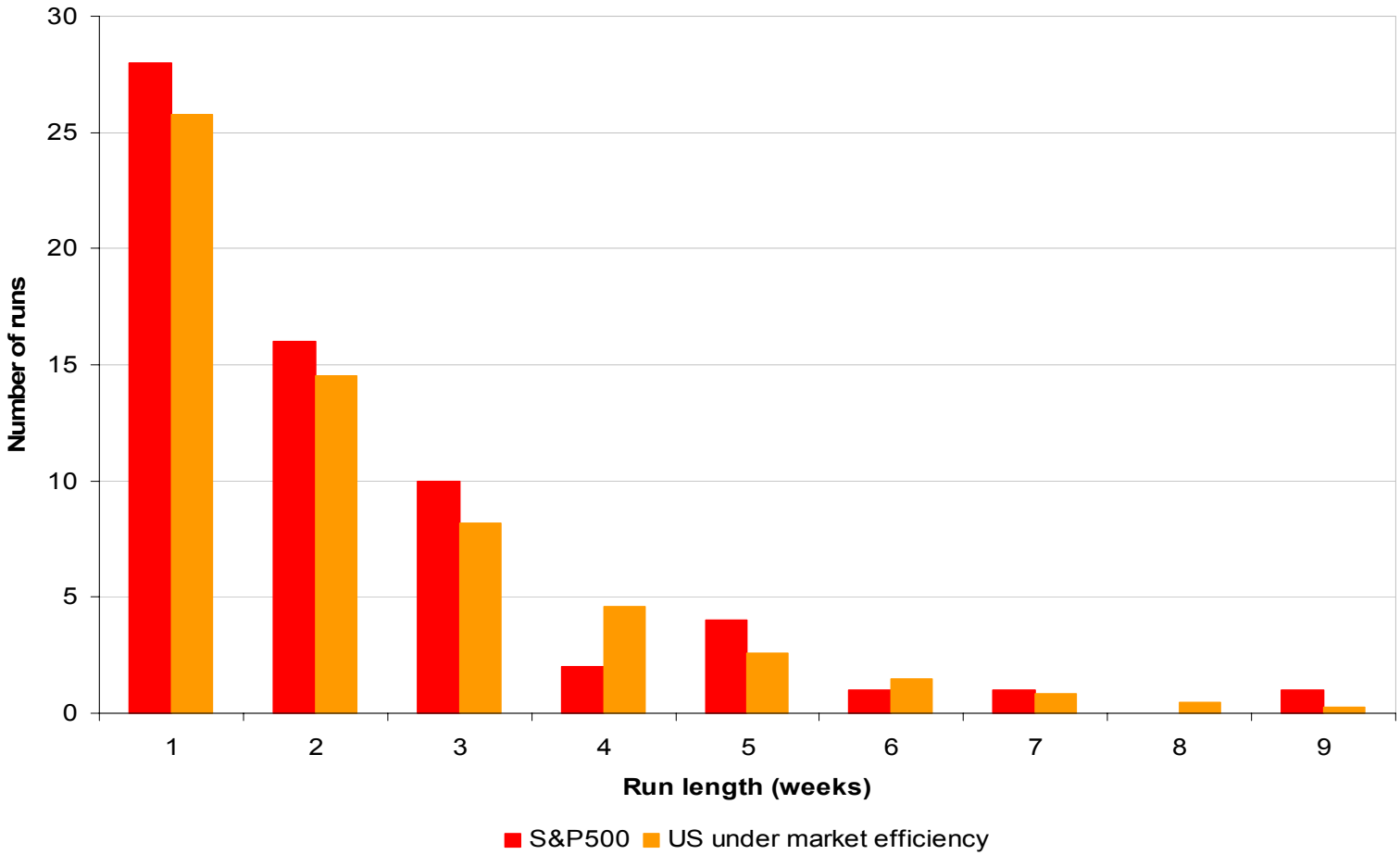
Actual distribution of run-lengths of positive weekly returns: S&P 500



Source: CommSec Quantitative Research & Investment Strategy

CommSec

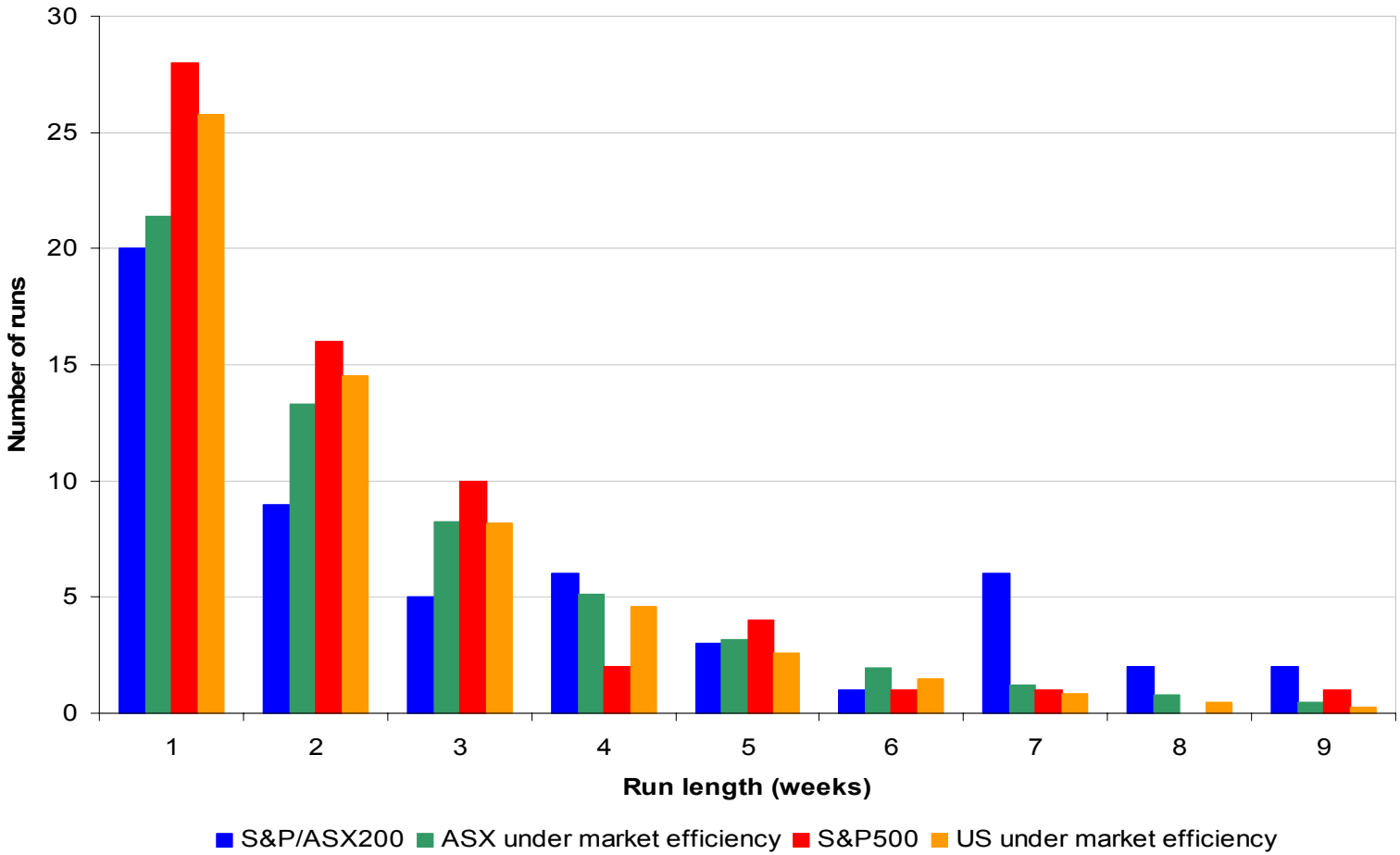
Actual and simulated distributions of run-lengths of positive weekly returns: S&P 500



Source: CommSec Quantitative Research & Investment Strategy

CommSec

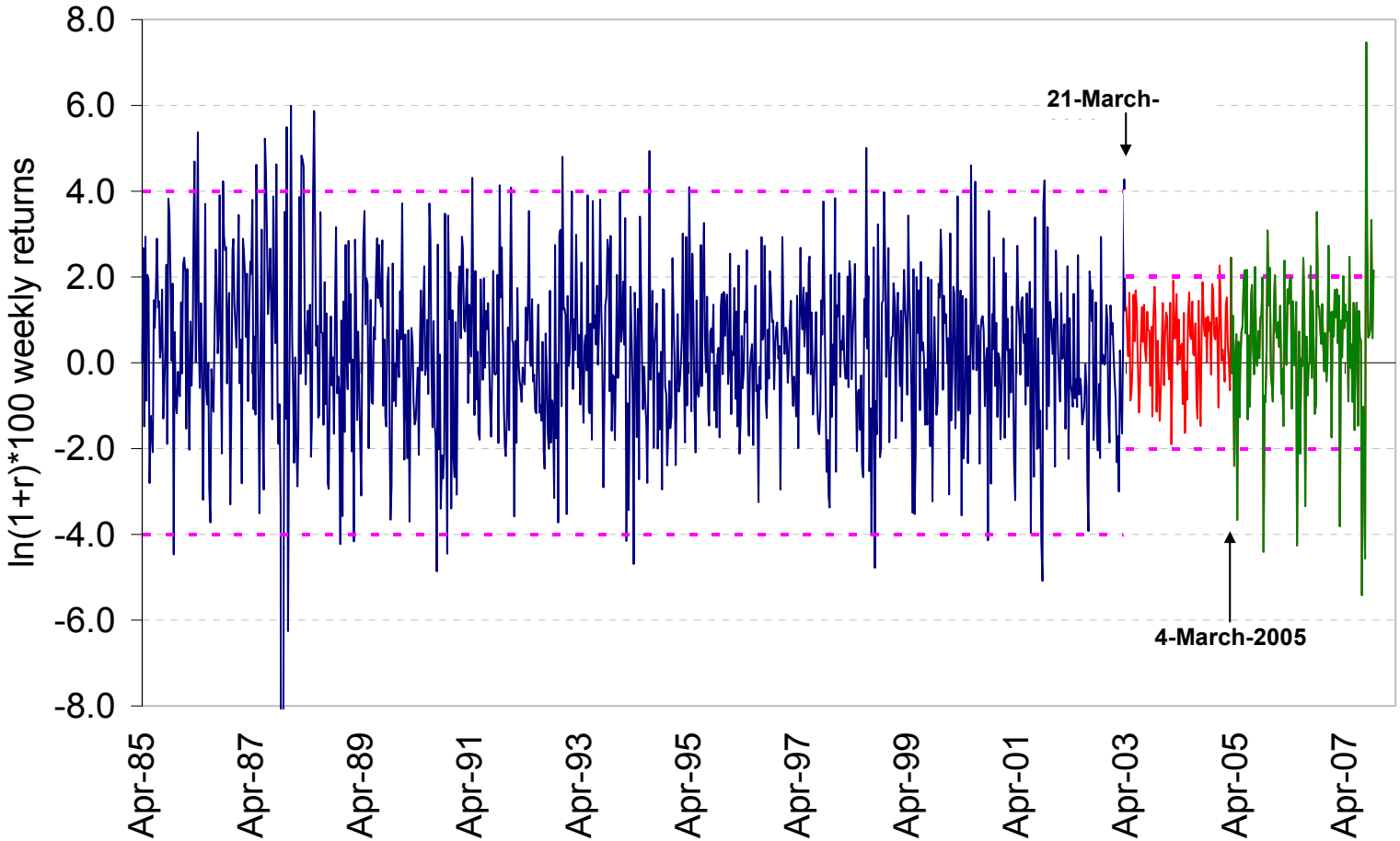
Actual and simulated distributions of run-lengths of positive weekly returns: S&P/ASX 200 and S&P 500



Source: CommSec Quantitative Research & Investment Strategy

CommSec

S&P/ASX 200 Index volatility

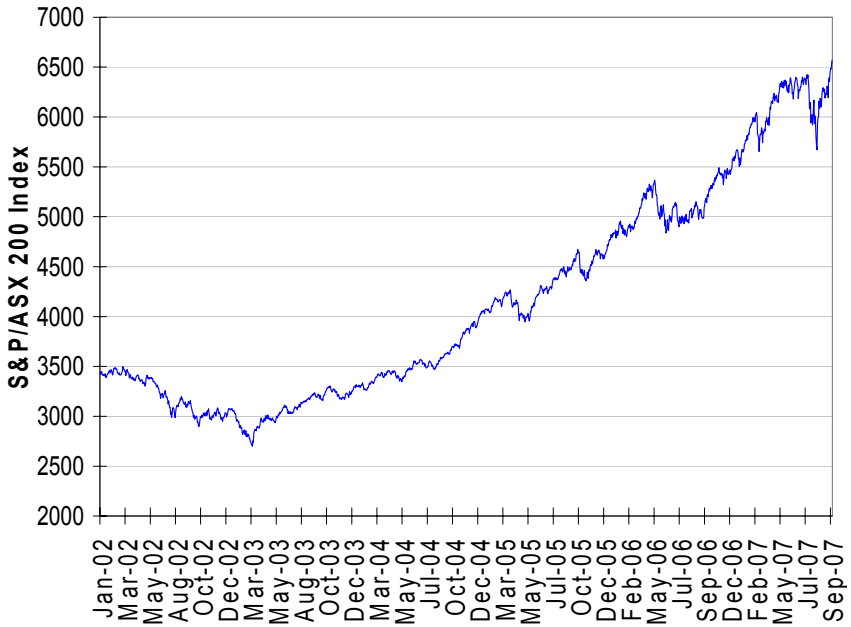


Source: CommSec Quantitative Research & Investment Strategy

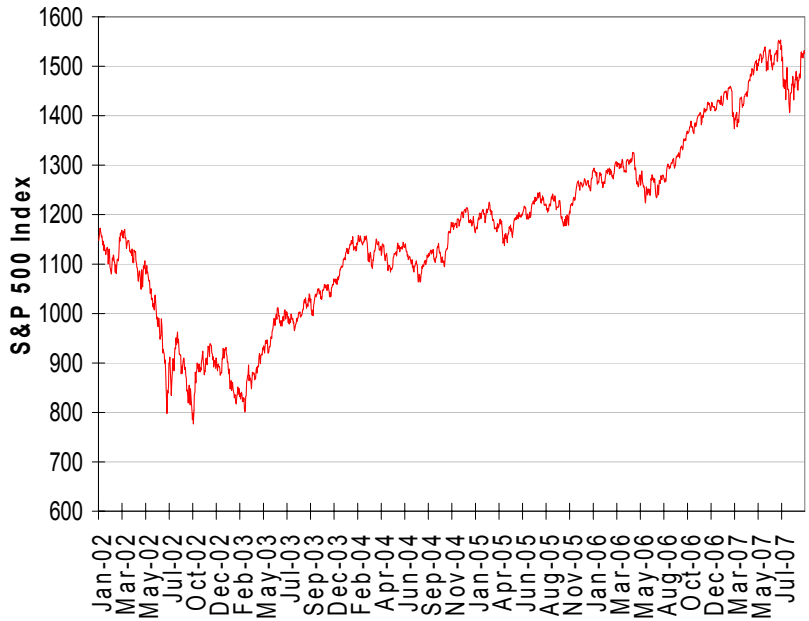
CommSec

Index 2002 - Present

S&P/ASX 200 Index



S&P 500 Index

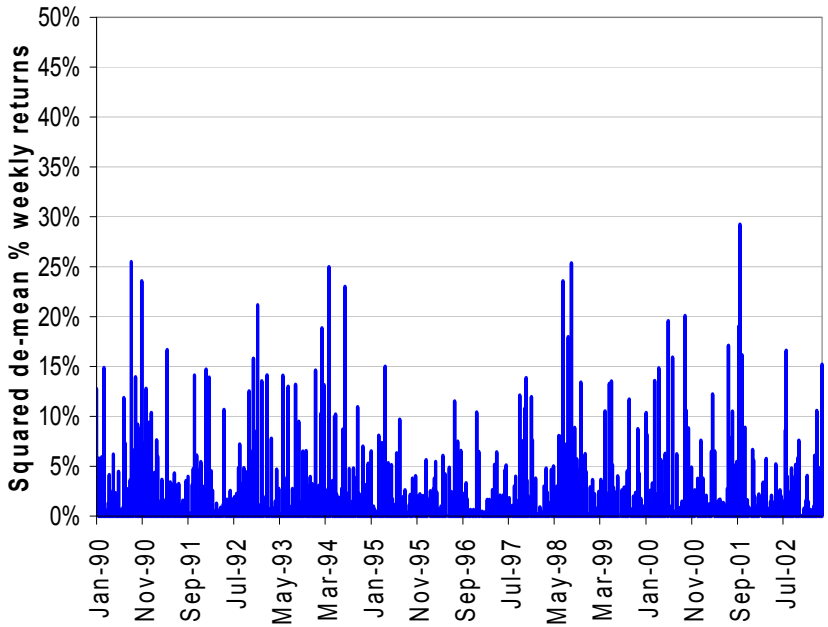


Source: CommSec Quantitative Research & Investment Strategy

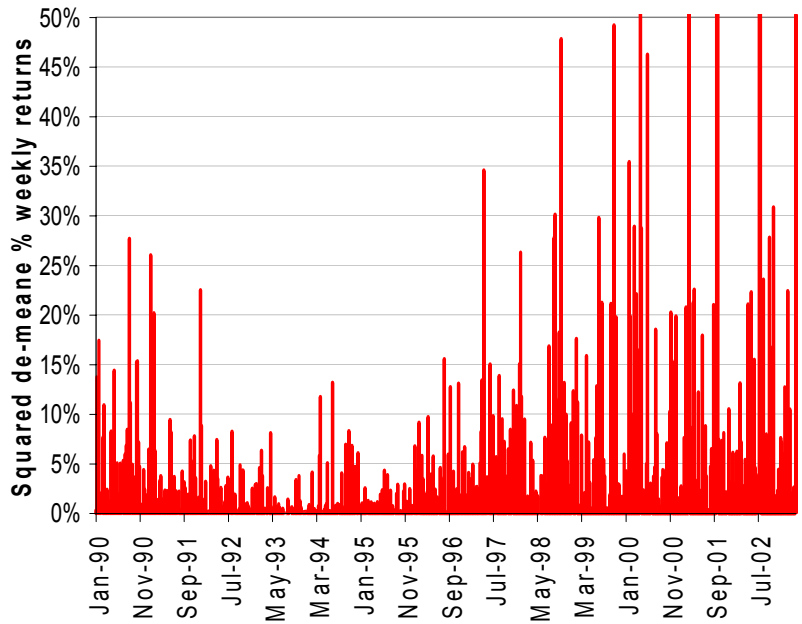
CommSec

Clusters in S&P/ASX 200 Regime 1?

S&P/ASX 200 Index



S&P 500 Index

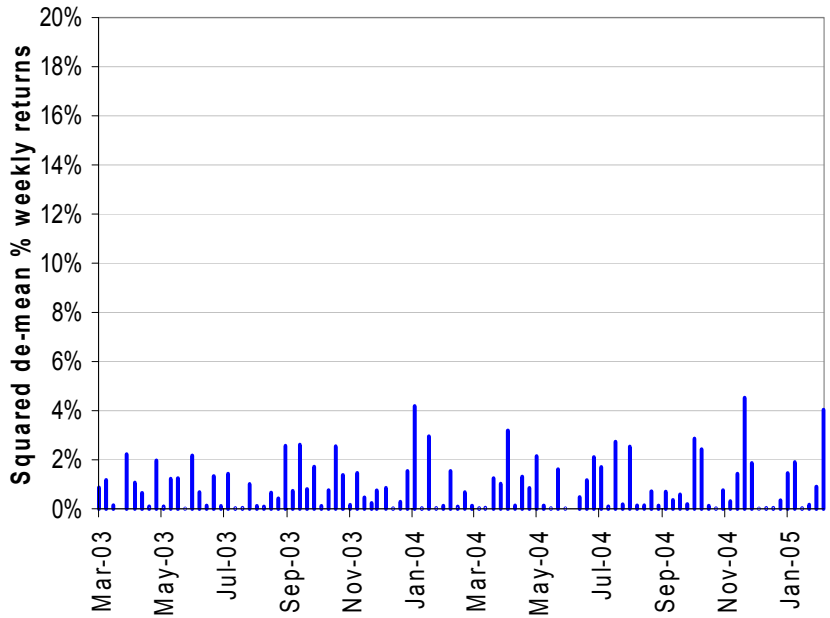


Source: CommSec Quantitative Research & Investment Strategy

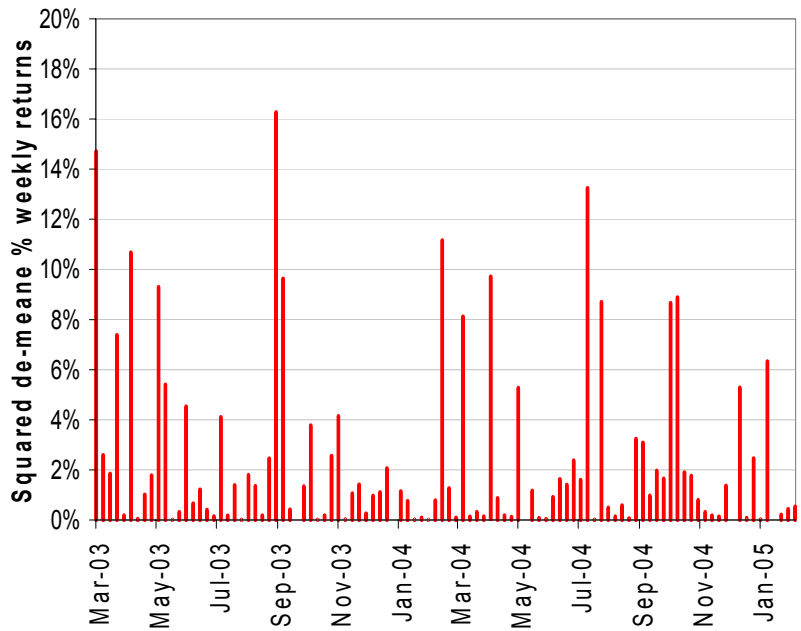
CommSec

Clusters in S&P/ASX 200 Regime 2?

S&P/ASX 200 Index



S&P 500 Index

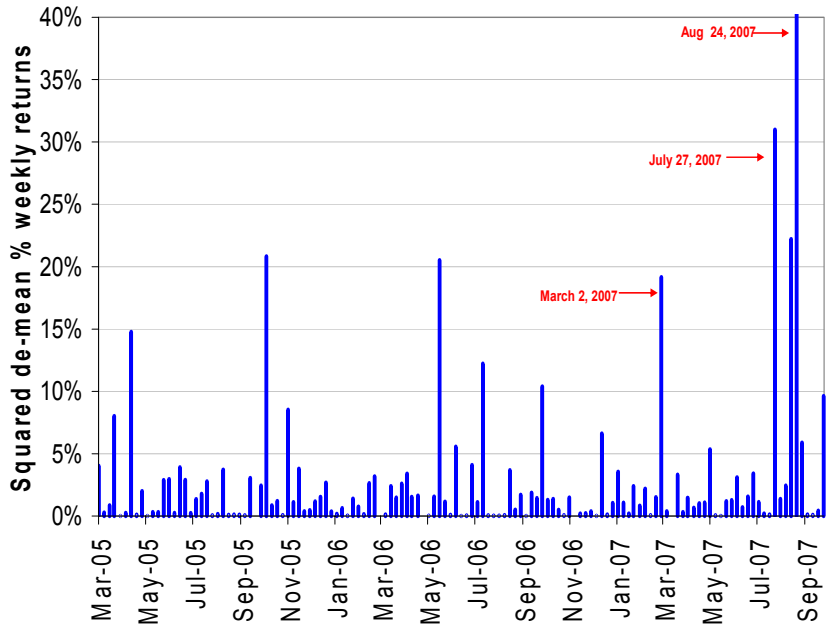


Source: CommSec Quantitative Research & Investment Strategy

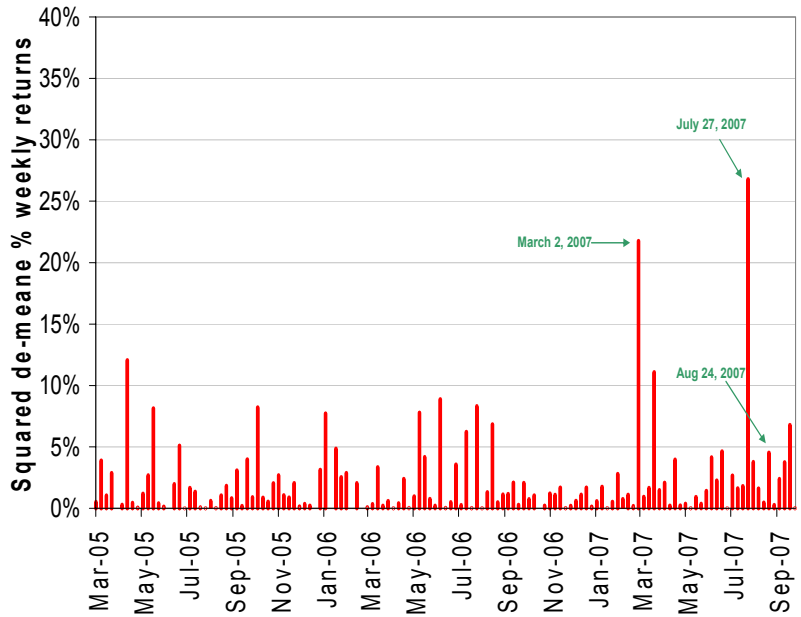
CommSec

Clusters in S&P/ASX 200 Regime 3?

S&P/ASX 200 Index



S&P 500 Index

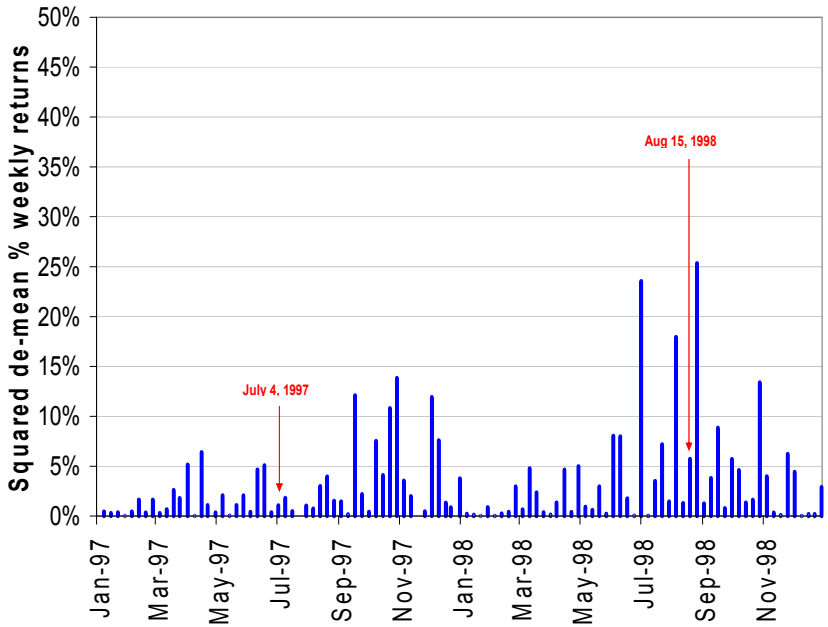


Source: CommSec Quantitative Research & Investment Strategy

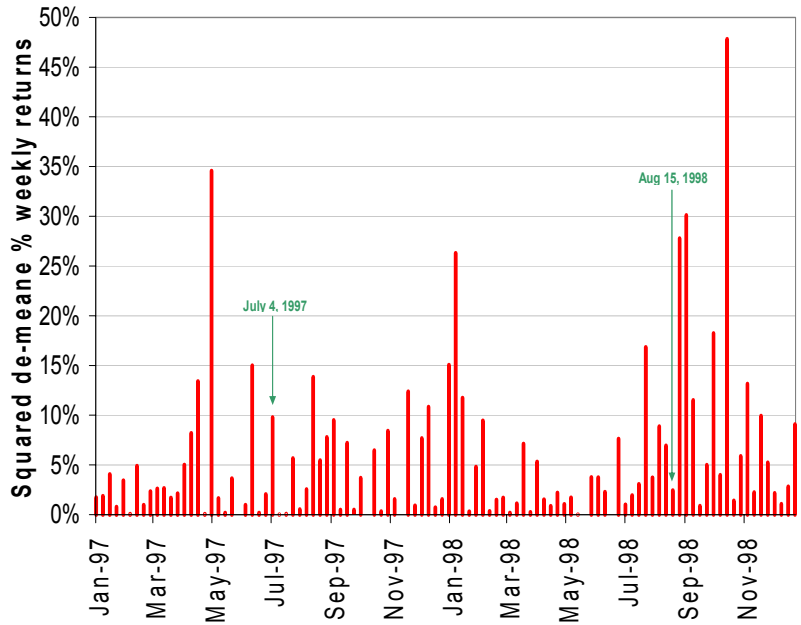
CommSec

Hong Kong handover-1/7/97 & Asian crisis - 15/8/98

S&P/ASX 200 Index



S&P 500 Index

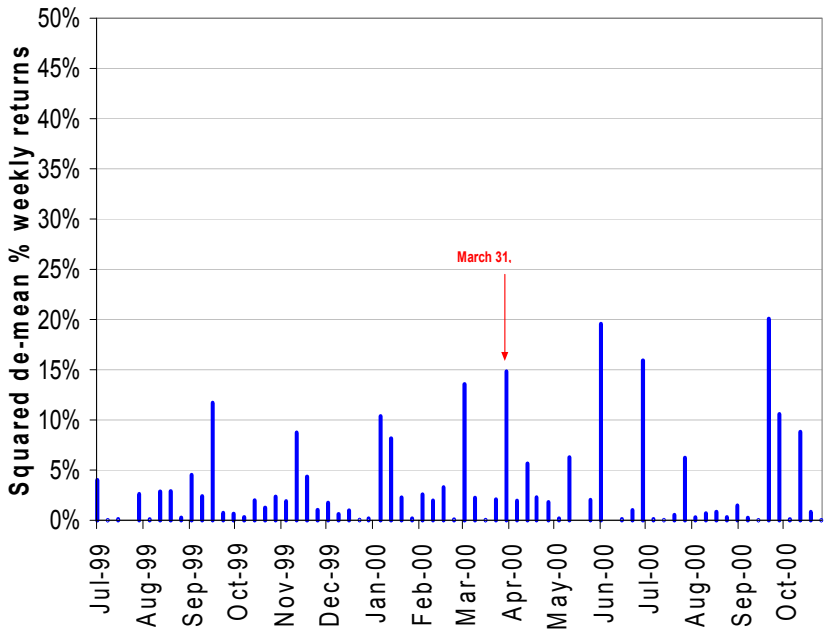


Source: CommSec Quantitative Research & Investment Strategy

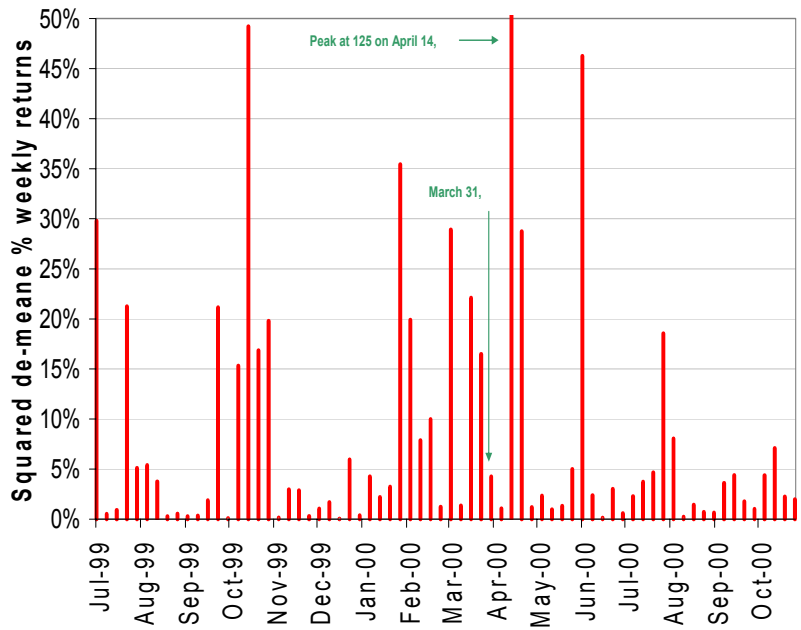
CommSec

Tech wreck bubble - 27/3/00

S&P/ASX 200 Index



S&P 500 Index

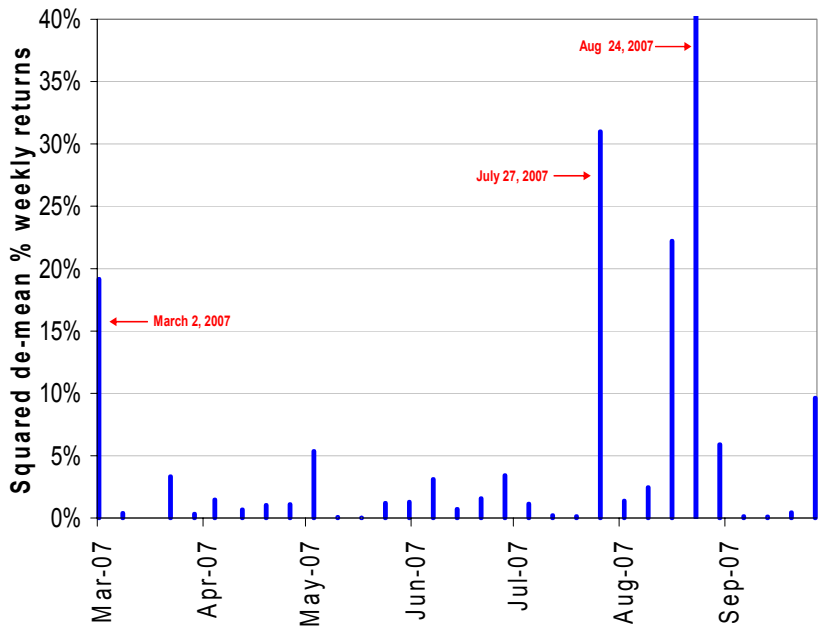


Source: CommSec Quantitative Research & Investment Strategy

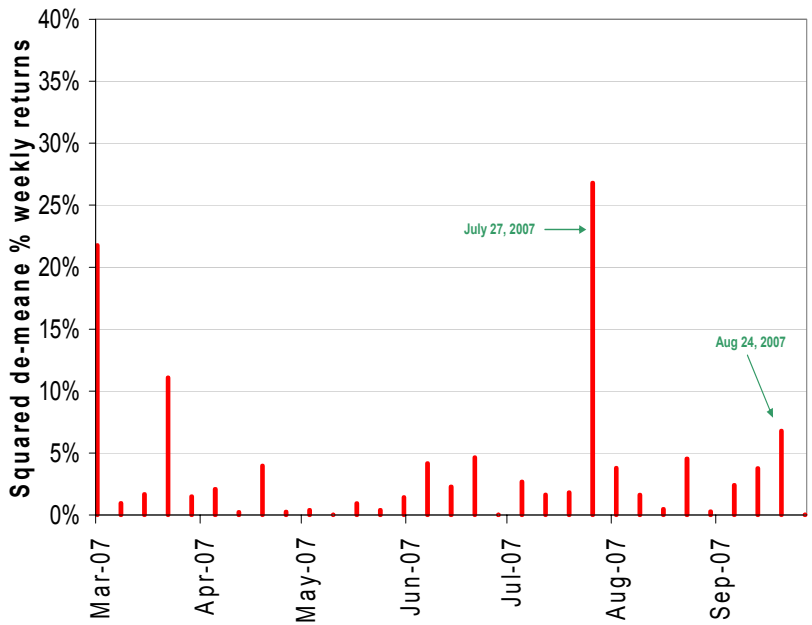
CommSec

Recent sub-prime crisis – weekly returns

S&P/ASX 200 Index



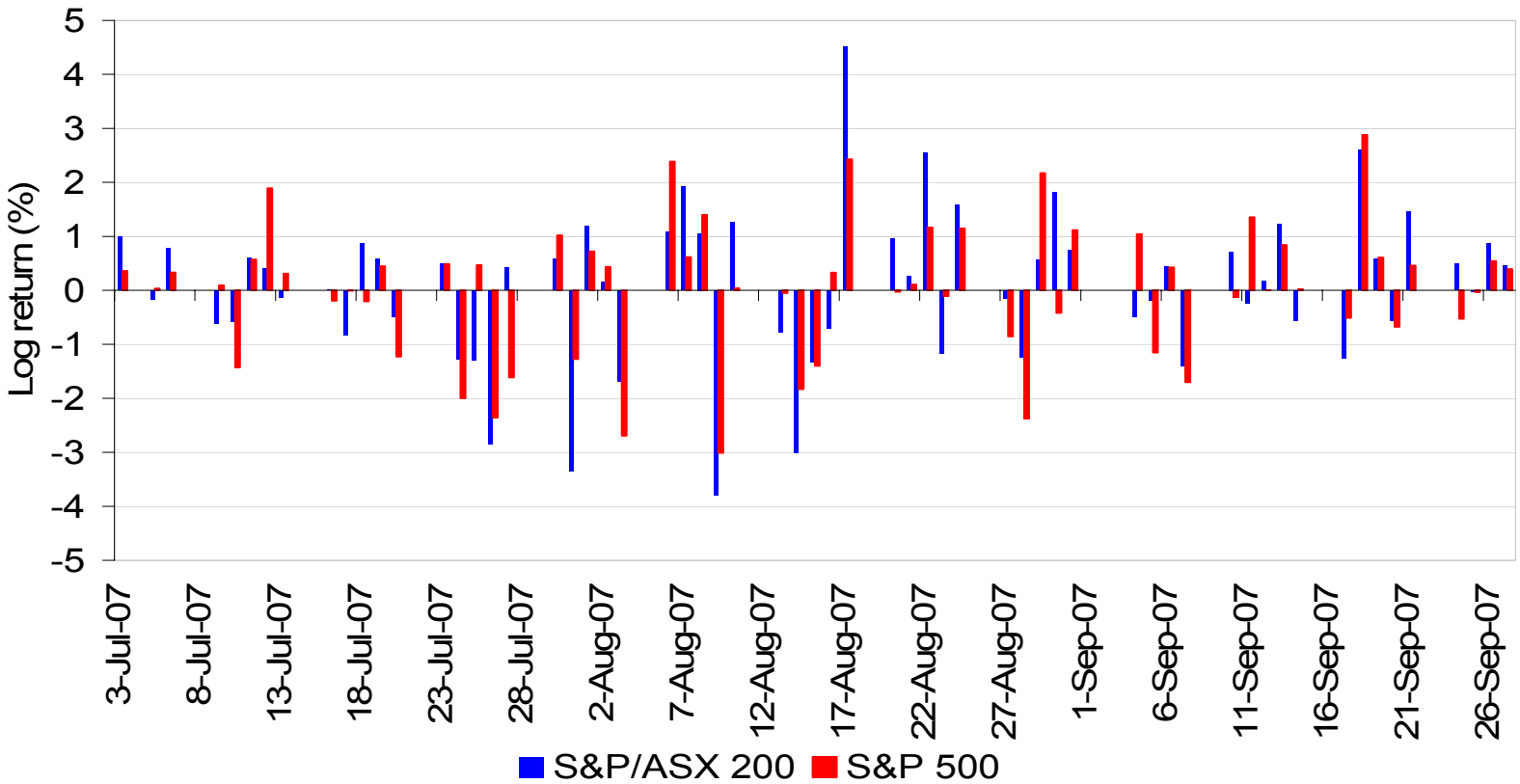
S&P 500 Index



Source: CommSec Quantitative Research & Investment Strategy

CommSec

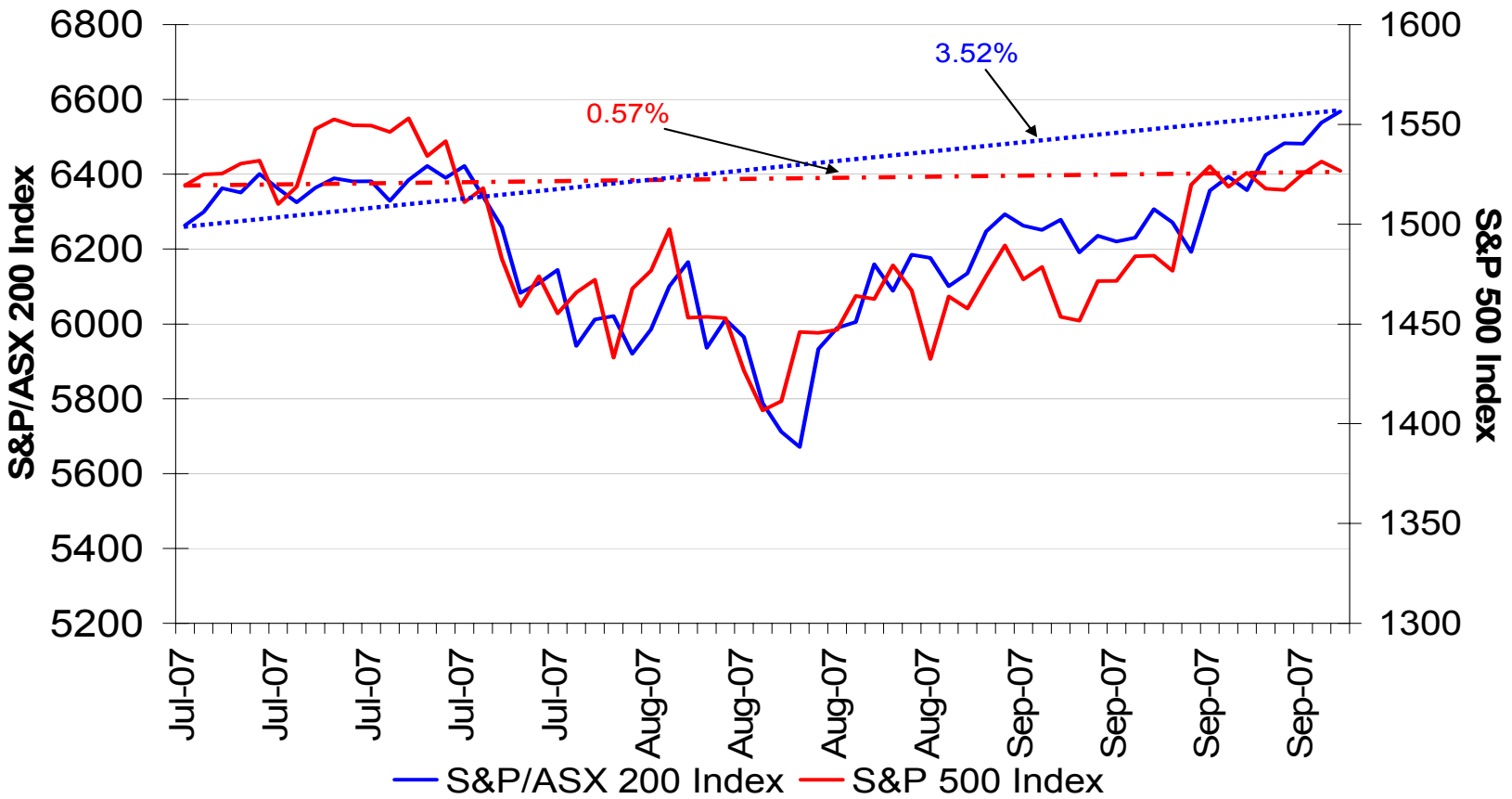
Recent credit crisis - daily returns



Source: CommSec Quantitative Research & Investment Strategy

CommSec

Recent Growth rates in the two markets



Source: CommSec Quantitative Research & Investment Strategy

CommSec

Visual conclusions

1. Changes in the volatility regime for Australia – have moved from volatility clusters to outliers
2. US heavily dominated by clustering in the volatility
3. Have other market factors changed – switchbacks, autocorrelation?
4. What does this mean for modelling volatility?

CommSec

Switchbacks

1. Switchbacks are two consecutive outliers that occur when we observe a large increase (decrease) followed by an approximately equal (in terms of size) decrease (increase) in the data
2. Switchback rules
   - Must be in the top quartile of returns for the previous year
   - Next observation must be of opposite sign
   - Next observation must be within 25% of the original observation of the switchback pair

CommSec

How to correct for switchbacks?

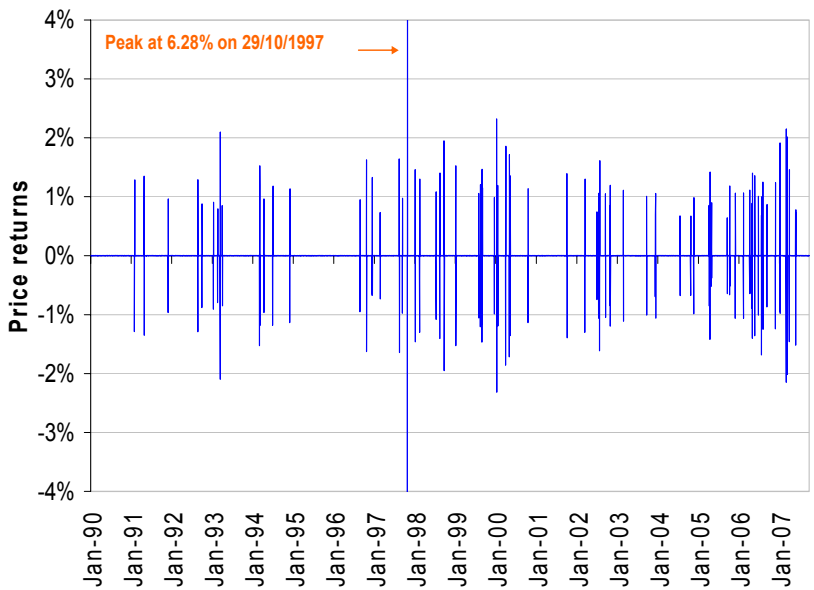
$$AR: y_t = a + by_{t-1} + cD_t + u_t$$

$$Int: y_t = a + b(y_{t-1} - cD_{t-1}) + cD_t + u_t$$

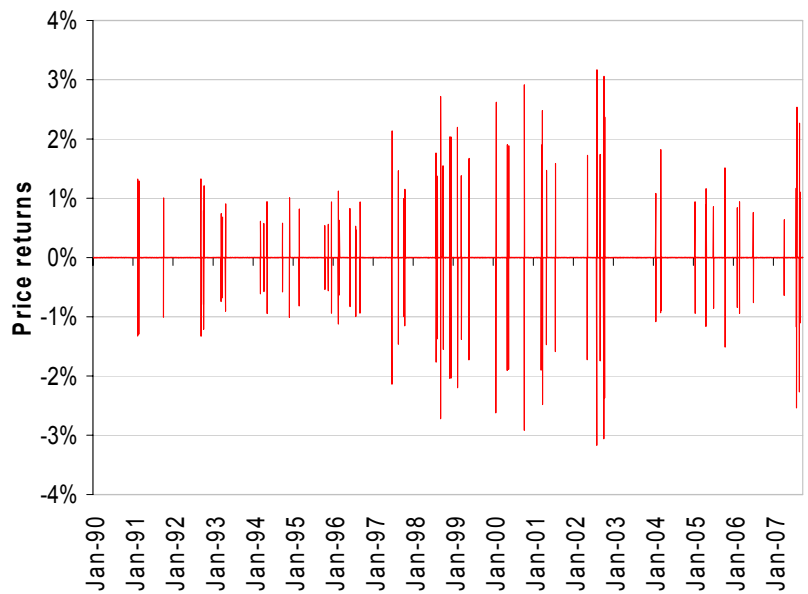
CommSec

Switchbacks

S&P/ASX 200 Index



S&P 500 Index

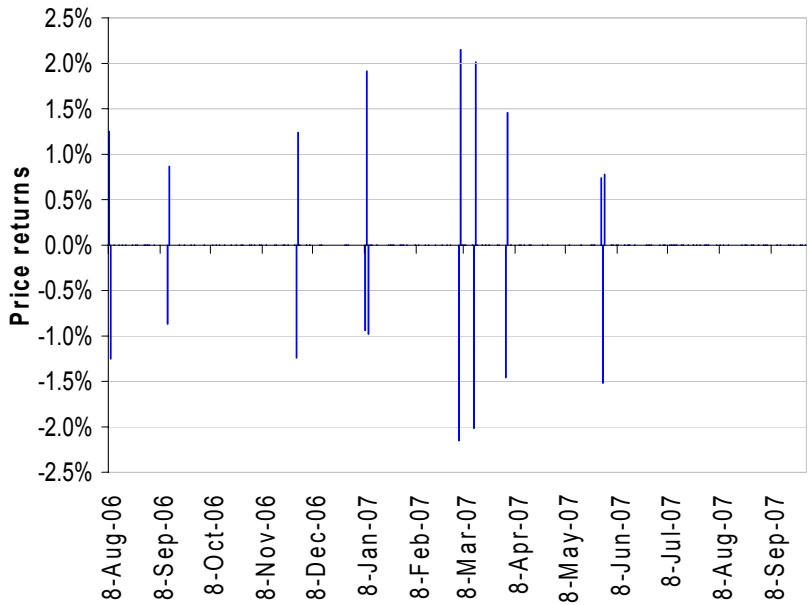


Source: CommSec Quantitative Research & Investment Strategy

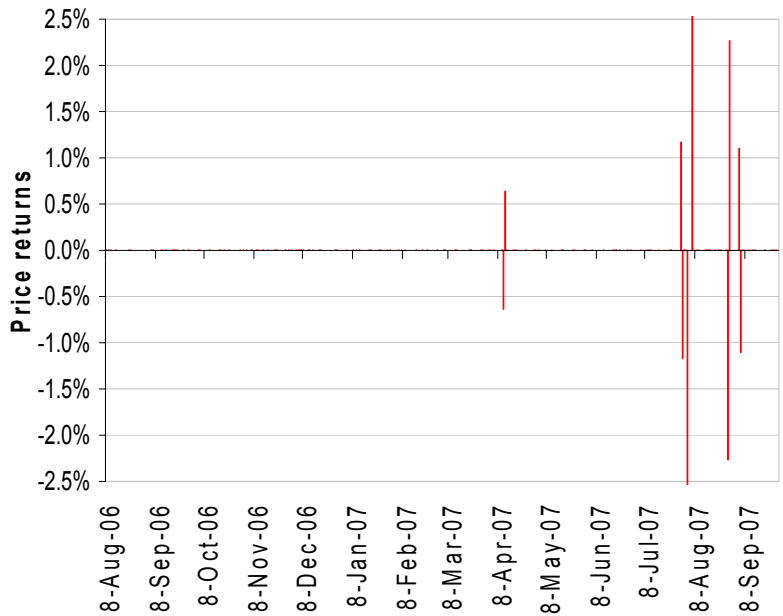
CommSec

Recent switchbacks or ‘news’

S&P/ASX 200 Index



S&P 500 Index

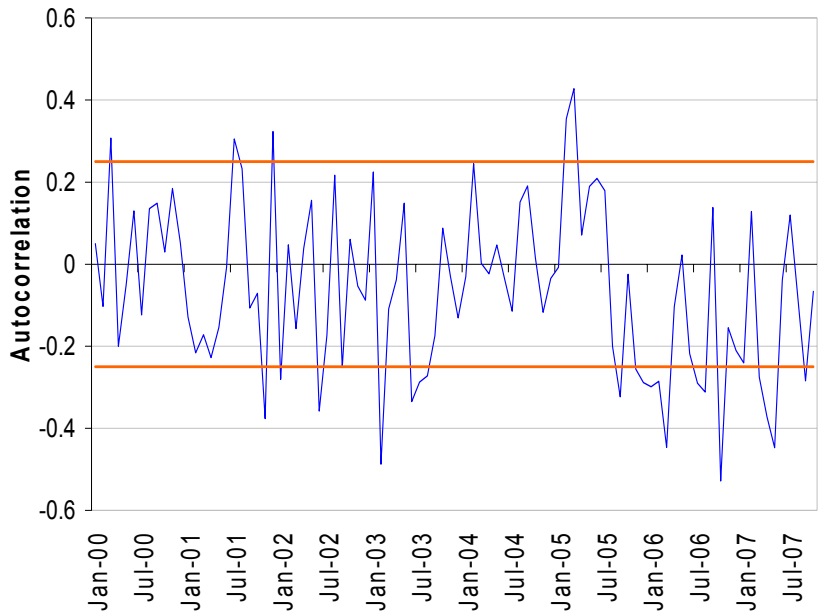


Source: CommSec Quantitative Research & Investment Strategy

CommSec

Autocorrelations

S&P/ASX 200 Index



S&P 500 Index

Source: CommSec Quantitative Research & Investment Strategy

CommSec

Average volatility levels March 2005 - Sept 2007

Type of volatility	S&P/ASX 200 Index	S&P 500 Index
Simple volatility	12.13	10.71
Switchback adjusted	11.45	10.19
Newey-West corrected	10.94	9.78
Switchback-adjusted-Newey-West corrected	10.45	9.57

Source: CommSec Quantitative Research & Investment Strategy

CommSec

Modelling Questions?

1. What will these changes mean for modelling volatility in the two markets?
2. Will one model over the whole time period be able to capture all these dynamics?
3. Are the traditional GARCH volatility models appropriate for both, either markets?

CommSec

GARCH equations

GARCH model with level shifts

$$h_t = \alpha_0 + \alpha_1 v_{t-1}^{\ 2} + \beta_1 h^2{}_{t-1} + \gamma_1 D_1 + \lambda_2 D_2$$

Long-run mean of model

$$\overline{h} = \frac{\alpha_0 + \gamma_1 D_1 + \lambda_2 D_2}{1 - \alpha_1 - \beta_1}$$

Minimum Volatility

$$h_{\min} = \frac{\alpha_0 + \gamma_1 D_1 + \lambda_2 D_2}{1 - \beta_1}$$

Half Life

$$k = \frac{\log(0.5)}{\log(\alpha_1 + \beta_1)}$$

CommSec

GARCH estimates without shifts 1990-2007

	S&P/ASX 200 Index			S&P 500 Index		
Parameter	Estimate	Standard Error	t-statistic	Estimate	Standard Error	t-statistic
Constant	0.0018	0.001	3.196	0.0019	0.001	3.507
ALPHA0	0.0000	0.000	0.706	0.0000	0.000	1.232
ALPHA1	0.0590	0.033	1.806	0.0495	0.017	2.985
BETA1	0.9020	0.086	10.521	0.9455	0.018	53.705

Source: CommSec Quantitative Research & Investment Strategy

CommSec

Detecting shifts in the long-run volatility

1. We look for a break in realised volatilities using the Andrews test
2. We apply the test to an AR (1) model in each market
3. We then place a dummy variable at these break dates to account for level shifts in the long-run levels of the volatility

CommSec

GARCH estimates with shifts up to Regime 2 (March 2005)

	S&P/ASX 200 Index			S&P 500 Index		
Parameter	Estimate	Standard Error	t-statistic	Estimate	Standard Error	t-statistic
Constant	0.00181	0.001	3.183	0.00202	0.001	3.190
ALPHA0	0.00005	0.000	3.183	0.00014	0.000	1.113
ALPHA1	0.05255	0.019	2.836	0.08020	0.035	2.262
BETA1	0.79911	0.042	19.055	0.58313	0.282	2.068
GAMMA1	-0.00003	0.000	-2.963	-0.00008	0.000	-1.060
GAMMA2				0.00019	0.000	1.204
GAMMA3				-0.00017	0.000	-1.156

Source: CommSec Quantitative Research & Investment Strategy

CommSec

GARCH estimates with shifts 1990-2007

	S&P/ASX 200 Index			S&P 500 Index		
Parameter	Estimate	Standard Error	t-statistic	Estimate	Standard Error	t-statistic
Constant	0.0020	0.001	3.801	0.0020	0.001	3.587
ALPHA0	0.0000	0.000	3.596	0.0001	0.000	1.327
ALPHA1	0.0529	0.021	2.550	0.0619	0.032	1.964
BETA1	0.7879	0.042	18.818	0.5989	0.228	2.622
GAMMA1	-0.0000	0.000	-3.314	-0.0001	0.000	-1.244
GAMMA2	0.0000	0.000	2.654	0.0002	0.000	1.449
GAMMA3				-0.0002	0.000	-1.418

Source: CommSec Quantitative Research & Investment Strategy

CommSec

Derived estimates

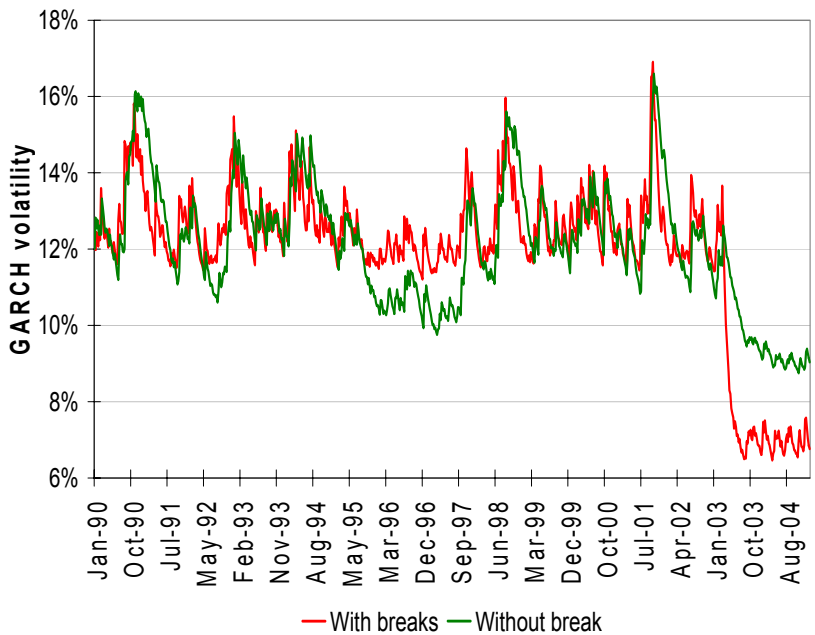
	Entire period no dummy		S&P/ASX 200 Regime 2 (1990-2005 with dummies)		S&P/ASX 200 Regime 3 (1990-2007 with dummies)	
	S&P/ASX 200 Index	S&P 500 Index	S&P/ASX 200 Index	S&P 500 Index	S&P/ASX 200 Index	S&P 500 Index
Long-run mean	12.34%	15.30%	6.95%	10.75%	11.39%	10.79%
Minimum volatility	7.79%	4.65%	5.98%	9.66%	10.45%	9.92%
Half-life (weeks)	17.43	137.48	4.32	1.69	4.00	1.67

Source: CommSec Quantitative Research & Investment Strategy

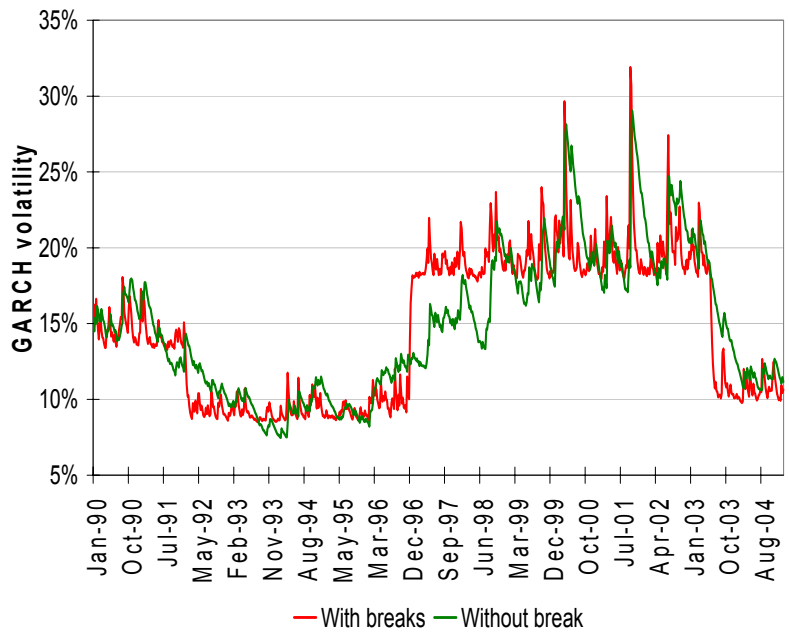
CommSec

GARCH on raw weekly data 1990-2005

S&P/ASX 200 Index



S&P 500 Index

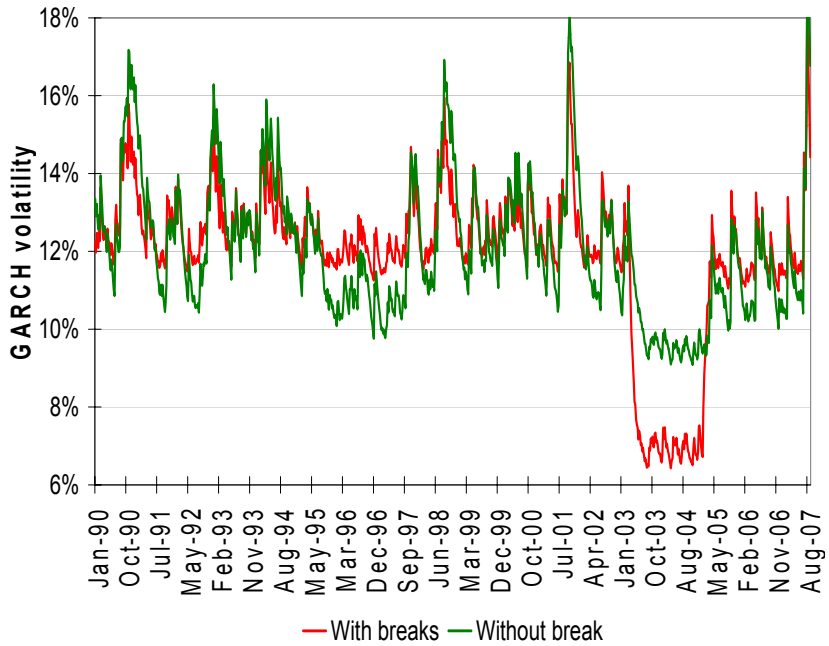


Source: CommSec Quantitative Research & Investment Strategy

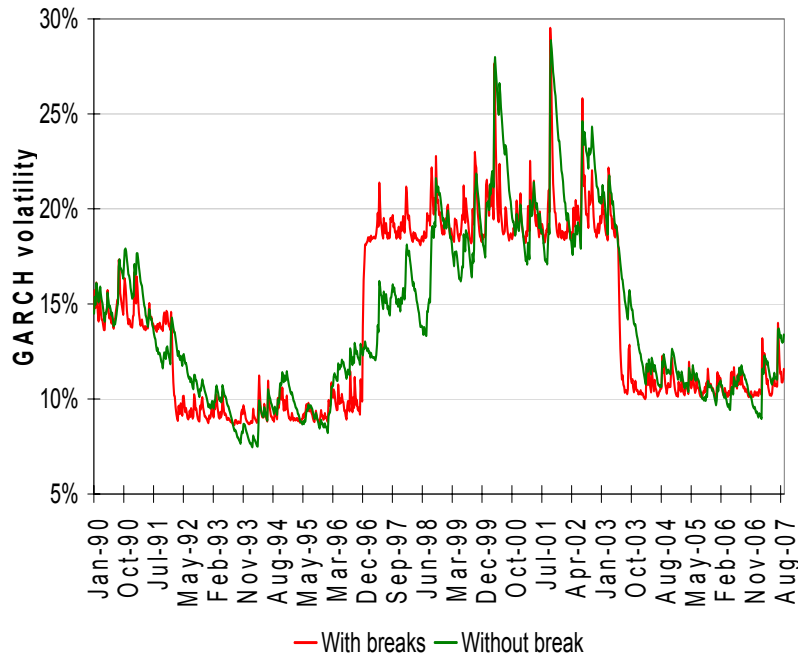
CommSec

GARCH on raw weekly data 1990-to date

S&P/ASX 200 Index



S&P 500 Index

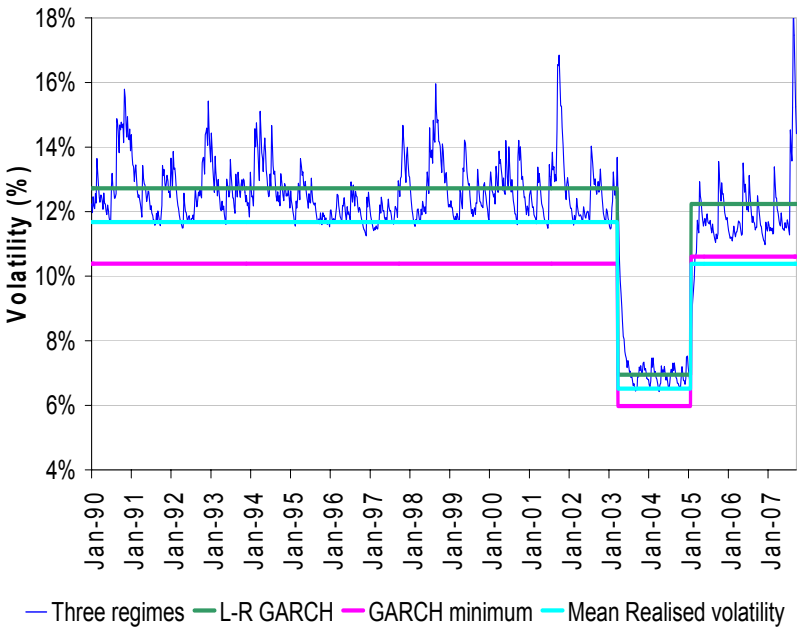


Source: CommSec Quantitative Research & Investment Strategy

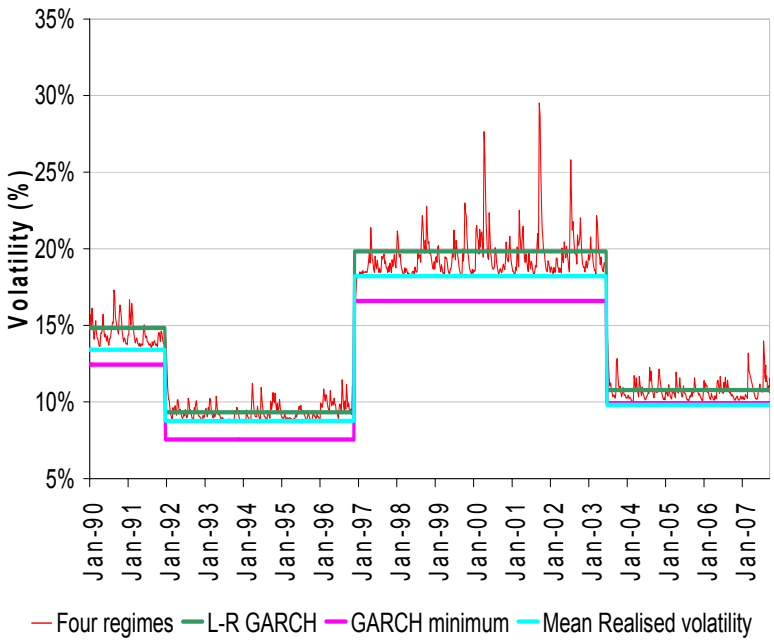
CommSec

Underneath the GARCH's

S&P/ASX 200 Index



S&P 500 Index

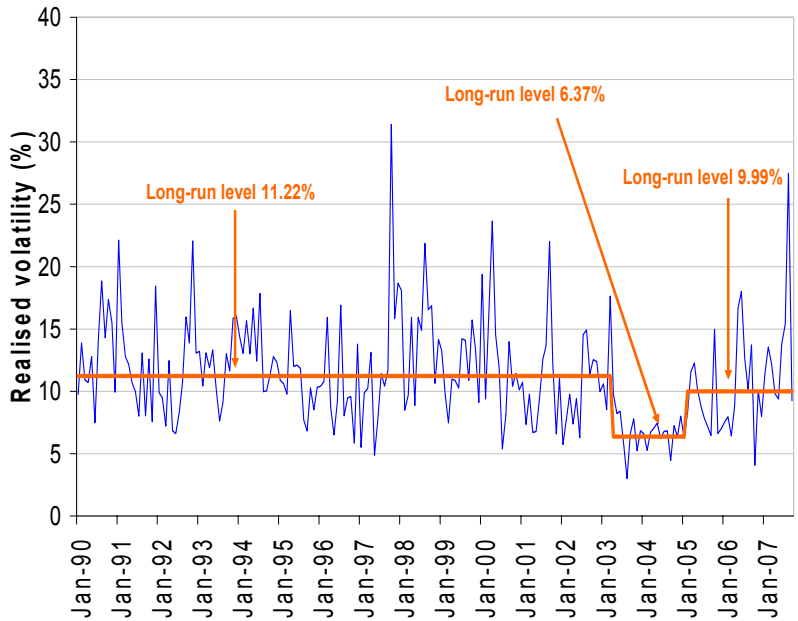


Source: CommSec Quantitative Research & Investment Strategy

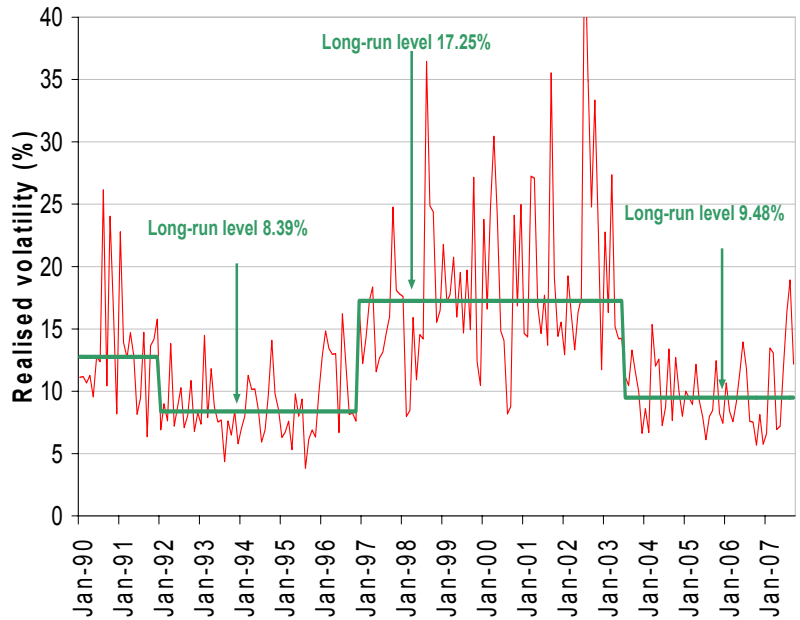
CommSec

Newey-West adjusted realised volatility

S&P/ASX 200 Index



S&P 500 Index



Source: CommSec Quantitative Research & Investment Strategy

CommSec

Similarities between Australian and US volatility

1. Clusters in volatility in the first regime
2. Both markets have different regimes (but not at the same location)
3. Both markets have experienced switchbacks
4. GARCH model works well to model the first regime

CommSec

Dissimilarities between Australian and US volatility

1. Switchbacks appear at different times and are of different magnitudes
2. Genuine clustering more apparent in the US market with Australia experiencing more outliers especially since 2005
3. Breaks in the GARCH process are weaker in the US and GARCH approximation is a better fit in the US
4. Autocorrelation more significant in the Australian market
5. GARCH model no longer appropriate for Australian market
6. Reaction to recent credit crisis very different

CommSec

Conclusions

1. Australia over-reacts to non-Australian problems
2. Australian market inefficient: long exuberance runs and switchbacks
3. GARCH does not work for Australia
4. $\sigma\sqrt{T}$ inappropriate for Australia

CommSec

Disclaimer

Commonwealth Securities Limited ABN 60 067 254 399 AFSL 238814 ("CommSec"), is a wholly owned, but non-guaranteed, subsidiary of the Commonwealth Bank of Australia ABN 48 123 123 124 AFSL 234945 ("the Bank"), both incorporated in Australia with limited liability.

Unless indicated otherwise, references in this presentation to specific shares are for illustrative purposes only and are not provided as product advice. CommSec does not have access to any information concerning Commonwealth Bank or its subsidiaries which is not publicly available or any other confidential information about the Commonwealth Bank or its subsidiaries. We do not make recommendations on the Commonwealth Bank.

This presentation is published, approved and distributed by CommSec.

Commonwealth Research is a unit of the Commonwealth Bank Group of Companies (The Commonwealth Bank Group).

We believe that the information in this presentation is correct and any opinions, conclusions or recommendations are reasonably held or made, based on the information available at the time of its compilation, but no warranty is made as to accuracy, reliability or completeness. To the extent permitted by law, the Commonwealth Bank Group does not accept liability to any person for loss or damage arising from the use of this presentation. Any valuations, projections and forecasts contained in this presentation are based on a number of assumptions and estimates and are subject to contingencies and uncertainties. The inclusion of any such valuations, projections and forecasts in this presentation should not be regarded as a representation or warranty by or on behalf of the Commonwealth Bank Group or any other person that such valuations, projections and forecasts or their underlying assumptions and estimates will be met. Past performance is not a reliable indicator of future performance.

The Commonwealth Bank Group have effected or may effect transactions for their own account in any investments or related investments referred to in this presentation, including selling to or buy from clients on a principal basis. The Commonwealth Bank Group may engage in transactions in a manner inconsistent with this research presentation. In the case of certain products the Bank is or may be the only market maker. No inducement has been or will be received by the Commonwealth Bank Group or the research analyst from the subject of this presentation or its associates to undertake the research or make the recommendation. The research staff responsible for this presentation receive a salary and a bonus that is dependent on a number of factors including their performance and the overall financial performance of the Commonwealth Bank Group. The Commonwealth Bank Group provide, or seek to provide, services to the subject of the presentation and its associates.

This presentation is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction where such distribution, publication, availability or use would be contrary to law or regulation or which would subject the Commonwealth Bank Group to any registration or licensing requirement within such jurisdiction.

CommSec