

Consistent Seasonal Adjustment

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Time series analysis

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Outline

1. Definitions, Goals
2. Examples
3. Consistency Tool(s) and Tests
4. BPG and Assessment Strategy
5. Issues and directions

Definitions/Goals

- Important to maintain appropriate consistency in ABS products (e.g. published SA estimates/trends) derived from different but related sources, or the same sources.
- Want to ensure consistent and appropriate seasonal adjustment (SA) between a pair of conceptually related series. 'Conceptually related series' here refers to SA components with similar (correlated) underlying movements, not levels.
- This is because originals could have different intrinsic seasonal patterns, hence leading to different movements in original terms. The degree of relatedness between two series can be seen once seasonality is removed from the originals.
- So a pair of series declared to be related by a SMA will be assumed to be in terms of their underlying SA movements, (i.e. the 'real' story in economic/business-cycle patterns)

A word on "Coherence"

- Coherence:

- A very general term that attempts to maintain/assess an expected behaviour/relationship between series from very different sources.
- Movements can be in opposite directions.
- e.g: as the price of chocolate goes up, number of consumers goes down (well maybe depending on brands).
- Is the underlying relationship maintained after SA?
- Due to its generality and various forms, we don't explicitly enforce consistent SA to maintain 'coherency'.

- Consistency:

- Relates to similar prior corrections, X11 parameter settings and methodology for SA. If not similar, at least appropriate!

How do we do it?

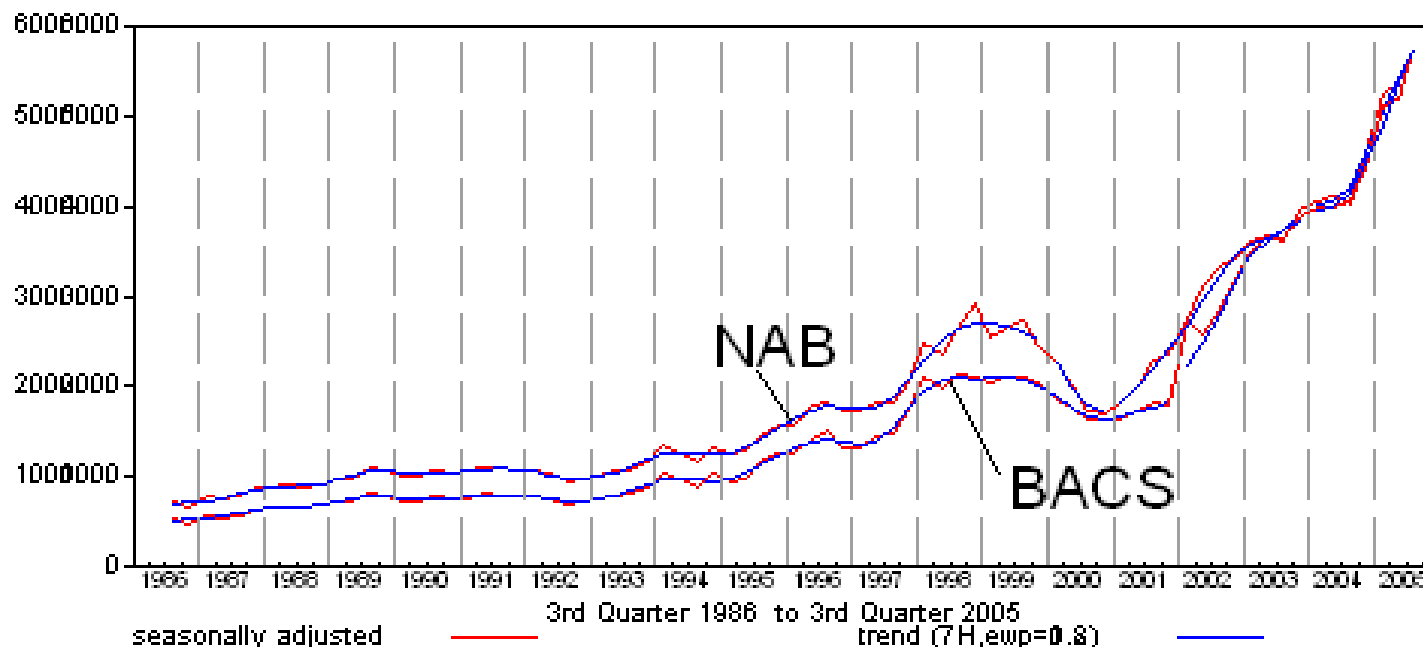
- Consistent and appropriate SA can be achieved by comparing all residual (remaining) priors and systematic differences in seasonally adjusted components.
- Once differences are highlighted, we can proceed to explore whether they are appropriate or inappropriate for each series of a related pair.
- We hope to achieve this at a level where any differences are:
 1. 'appropriately justified' and/or expected, or,
 2. purely stochastic in nature, i.e., dictated by varying degrees of volatility.
- Examples of an 'appropriately justified' inconsistencies:
 - Keeping different SMA filter lengths due to different relative levels of volatility (i.e. I/S ratios) according to SEASABS knowledge/analysis rules. PTO...

Examples

- Keeping different TMA's due to different I/C's.
- Large extreme present in one series but not the other.

(1). Example from conceptually related sources:

[NAB vs. BACS for Seas. Adj. 'Engineering Construction Expenditure':](#)



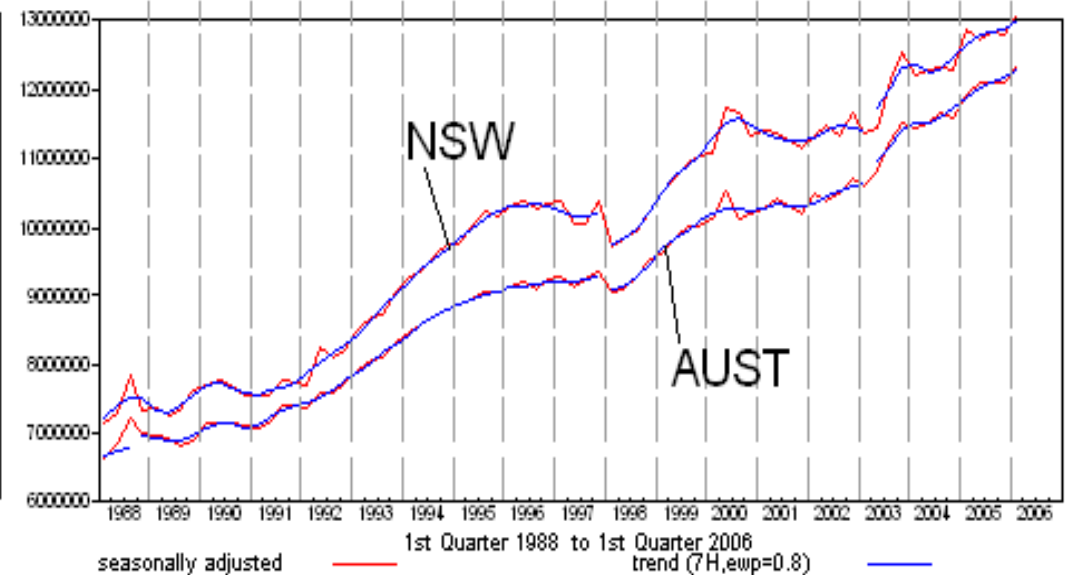
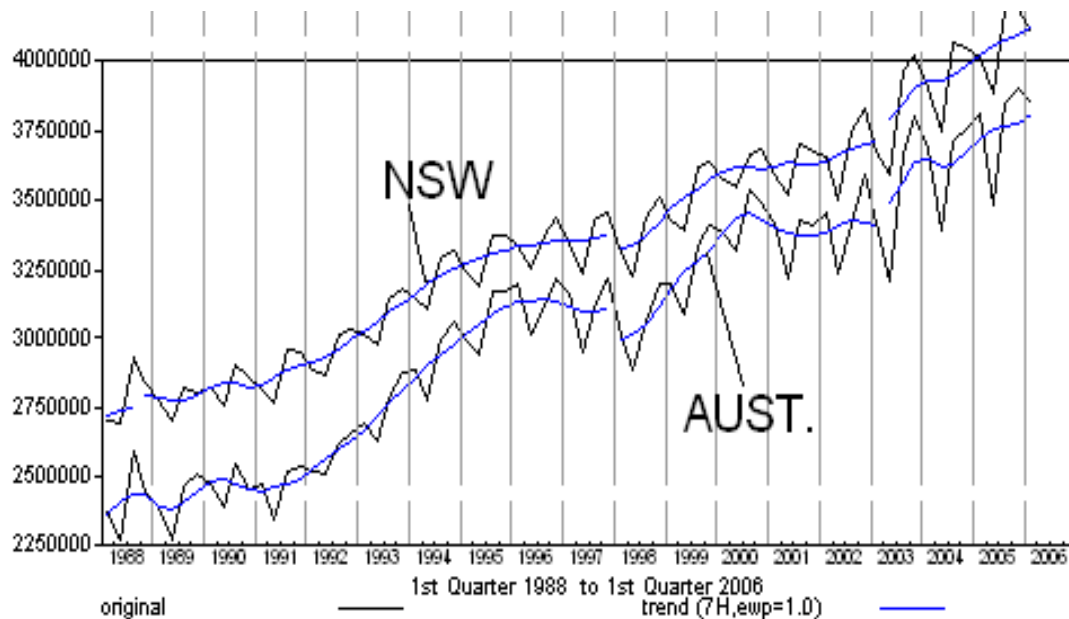
Correction at:	Status
1st Quarter 2000	Active
1st Quarter 2001	Active
1st Quarter 2004	Active

Correction at:	Status
3rd Quarter 1986	Active
1st Quarter 2002	Active
1st Quarter 2004	Active
3rd Quarter 2002(IGNORED)	Disabled

Examples contd...

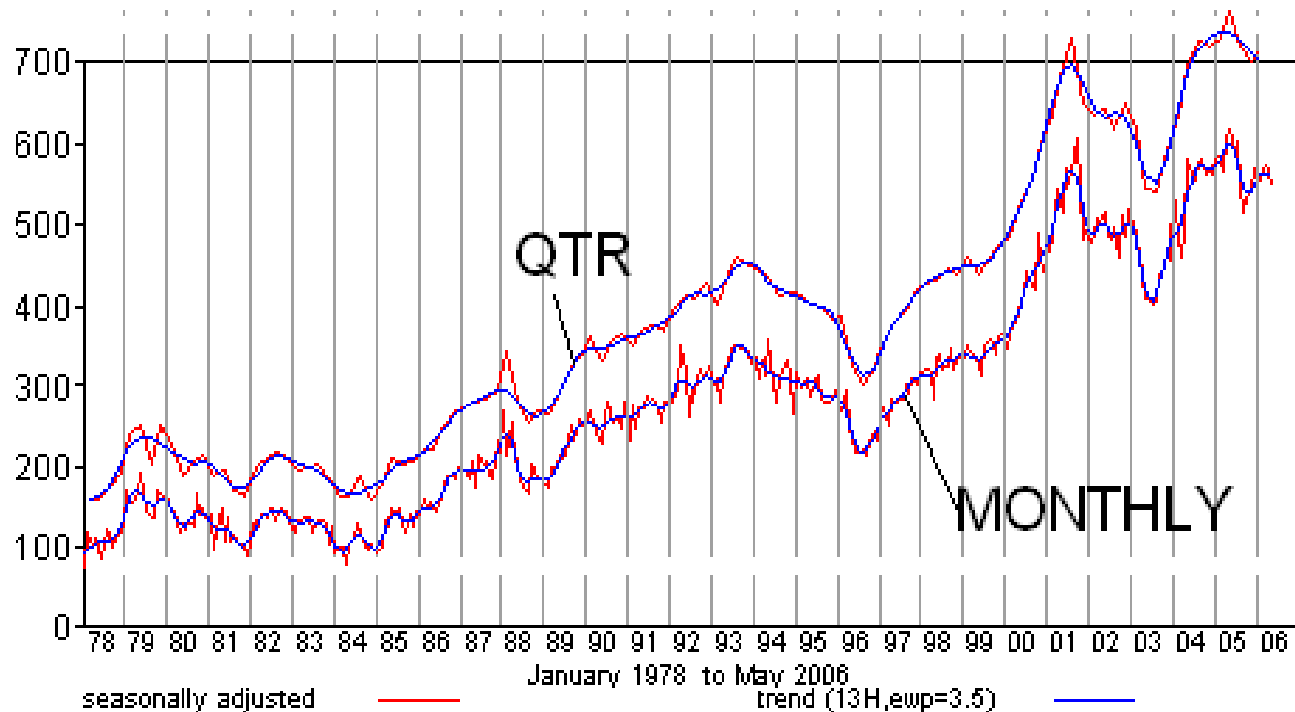
(2). National aggregates versus state component(s):

AUST. TOTAL (indirect) vs. NSW (direct) for "Number of Rooms Occupied" - State Tourism. (Ignore levels).



Examples contd...

(3). SA quarterly estimates from aggregated monthly originals versus SA monthly estimates ([e.g. BOP: "Other.Non-Rural"](#)):



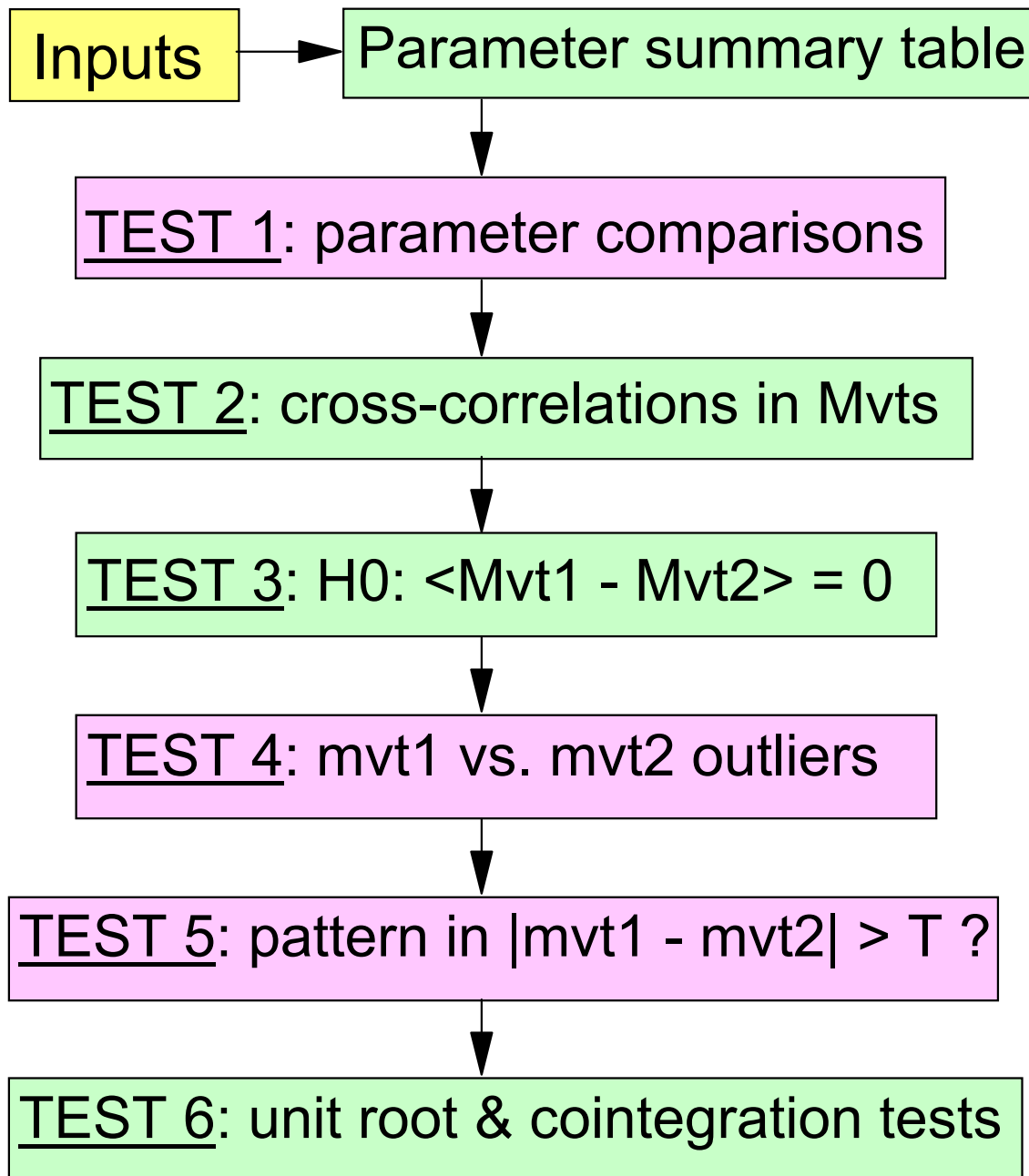
- Monthly case has no priors defined while quarterly has several large extremes defined. Is this appropriate?
- Note also that it's appropriate here to have different TMA's, SMA's, TD corrections etc. Monthly volatility smoothed out.


Consistency Tool

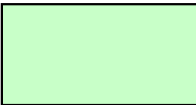
We currently have a prototype (home grown) consistency tool that runs on the DOS command line which:

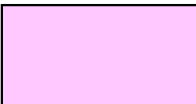
- Assesses degree of 'relatedness' between series pairs.
- Highlights all inconsistencies (and consistencies) in priors and X11/SEASABS settings between series pairs.
- Mapping between conceptually related series (i.e. pairs) is managed via a "map-table":
 - This can be between series across groups and/or owner groups.
 - Currently handled using text files. SEASABS version will store these mappings in the series knowledge.
- Consistency assessed using 6 diagnostic tests.

Tool Inputs/Outputs



 Inputs: (1) map-file; (2) 'TSAdownloaded' group summary file(s).

 For information only, report to client if test outcomes severe.

 Can improve consistency depending on outcomes by modifying settings.

[EXAMPLE](#)

TEST 1

- Reports when there is an inconsistency between the series pair in any one or more of the following "main" processing parameters:
"Method", "Model", "TMA", "PUB_TMA", "PUB_EWP", "SMA", "Trading day", "Easter" and "Father's Day" (+ other?)
- Priors excluded here since treated in more general terms using other tests.
- Only checked if 'periodicities' the same since expect justifiable differences if periodicities different. But ensure appropriate!
- Example warning message for a 'failure':
*** The "X11 TMA, PUB_TMA" parameter settings are not consistent for this series pair. Please review.
- Go back into SEASABS and modify parameters if you think should be the same. Otherwise retain if appropriate.

TEST 2 (FYI only)

- Check that series are indeed conceptually related by testing that their movements are significantly correlated (at some lag h), i.e:

$$H_0 : \rho(M_1, M_2)_h = 0 \quad \text{vs.}$$

$$H_1 : \rho(M_1, M_2)_h \neq 0$$

- Example of a 'success' / 'pass' output message:

*** CROSS-CORRELATION COEFFICIENT (WITHOUT OUTLIERS) SIGNIFICANTLY
DIFFERENT FROM ZERO AT <5% LEVEL => SERIES ARE INDEED RELATED

- Example 'failure' output message:

*** CROSS-CORRELATION COEFFICIENT (WITHOUT OUTLIERS) CONSISTENT
WITH ZERO AT >5% LEVEL => SERIES MAY NOT BE RELATED

- If movements not significantly correlated, notify client if they really expected consistency (provide [plots](#)). If they are adamant, then continue with consistency analysis.

TEST 3 (FYI only)

- Determine whether underlying movement magnitudes and directions of movements are overall mutually consistent between two series. i.e. are the movement magnitudes of S1 larger (or smaller) in a broad sense than those of S2?
- So first we test:

$$H_0 : \langle M1 - M2 \rangle = 0 \quad \text{vs.} \quad H_1 : \langle M1 - M2 \rangle \neq 0$$

- If significantly non-zero, then it would be of interest to determine the nature of this difference using a robust linear regression fit to the movements:

$$M_2 = \alpha M_1 + \beta,$$

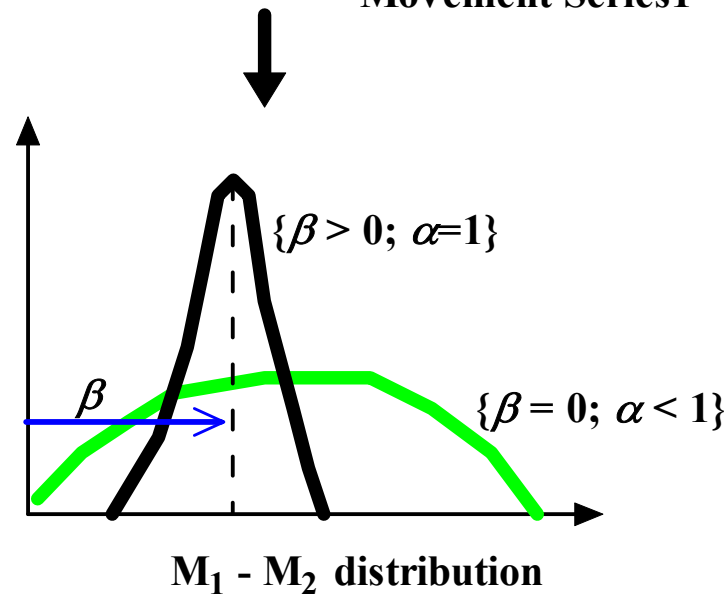
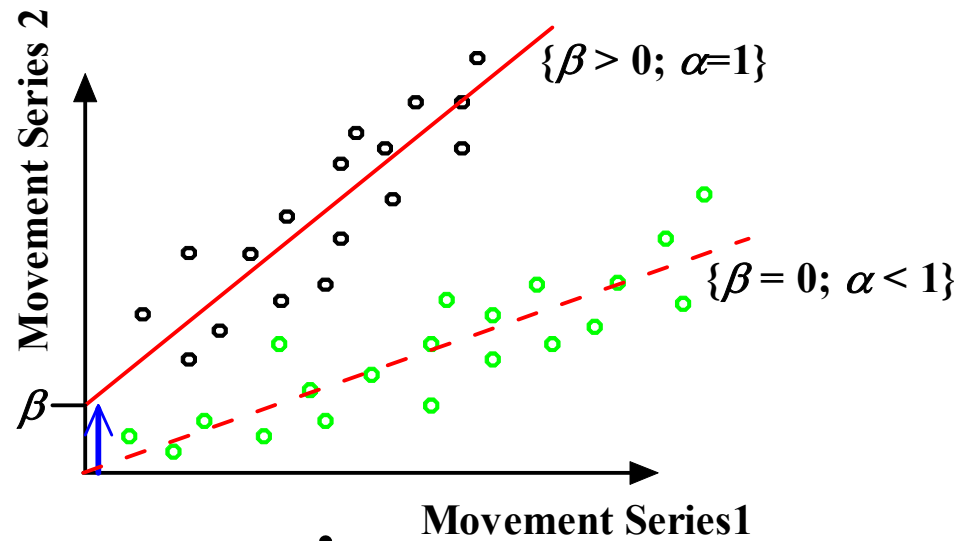
- Is this difference either wholly due to a global relative bias offset (i.e. non-zero intercept β), a scale factor (i.e. non-unit slope α) or both? I.e. we test:

$$H_0 : \alpha = 1 \quad \text{versus} \quad H_1 : \alpha \neq 1 \quad \text{and}$$

$$H_0 : \beta = 0 \quad \text{versus} \quad H_1 : \beta \neq 0$$

TEST 3 contd..

Schematically, in terms of a movement vs. movement plot:



TEST 3 contd..

- A significantly non-zero intercept will have a different interpretation from a significantly non-unit slope. Either or both of these imply an inconsistency in movement magnitudes.
- This test attempts to probe the relationship of the movement magnitudes further. Whether the movement magnitudes from two series are related multiplicatively or additively may be of interest to the client. i.e. have theoretic economic implications!
- Also, note that acceptance of

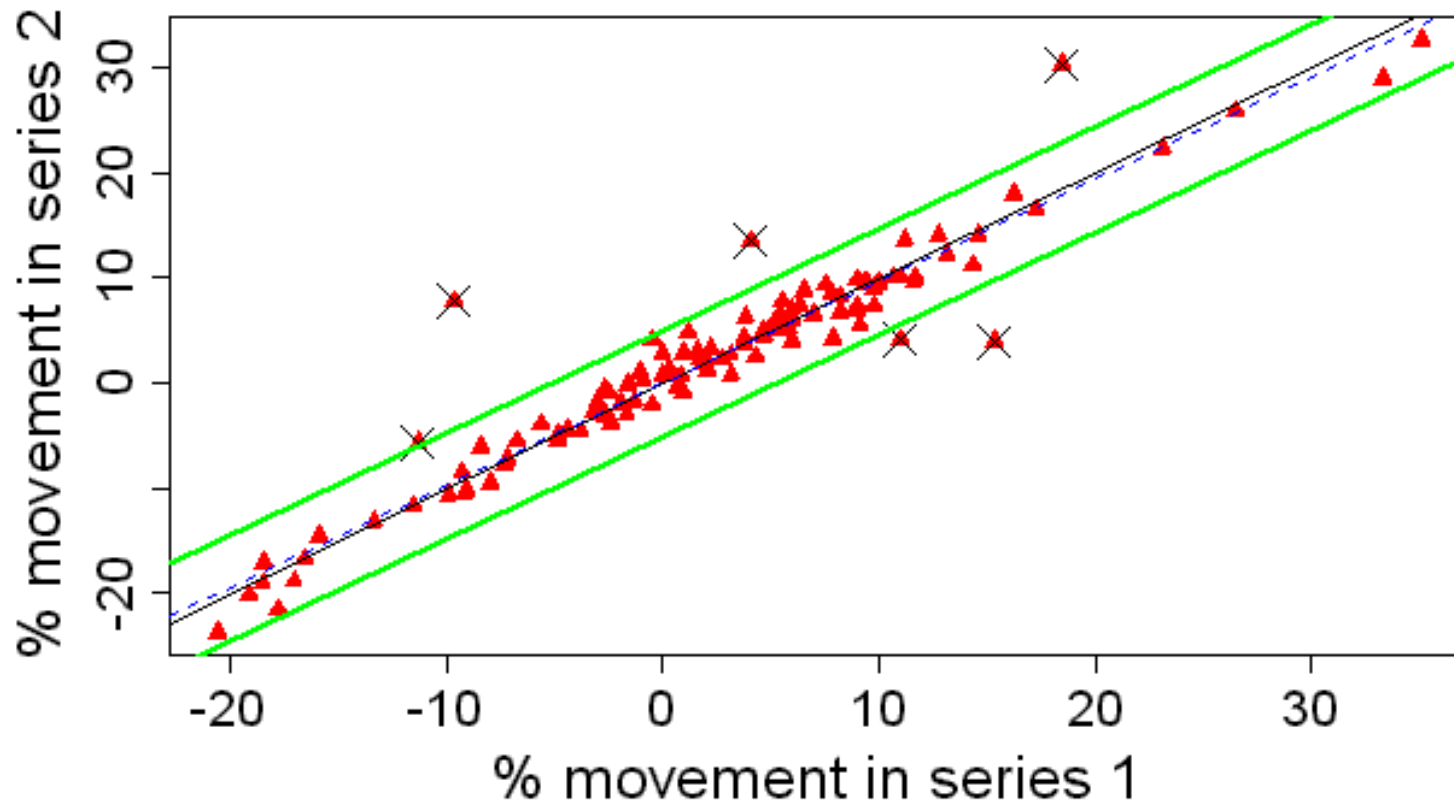
$$H_0 : \alpha = 1 \Rightarrow (M_1, M_2 \text{ significantly correlated!})$$

This reinforces the 'fact' that the input series are conceptually related [in movement terms].

TEST 4

- Highlights inconsistencies in movements at the same time points between two series.
- Based on detecting and reporting outliers in the movement vs. movement plot above some nominal (say 3σ) threshold, e.g:

Movements for series pair at equal times



TEST 4 contd..

- Presence of a large movement in one series but not the other has implications depending on which component is analysed:
- If seas. adjusted mvts (either 'prior-corrected' D11 or ABS) are being compared, then a deviant movement may imply:
 - an inconsistent prior correction was applied to one of the series: e.g. LGEX, AO, TB,... **or**,
 - actual originals are conceptually different at that timepoint.

- Example output table of outlier mvts:

*** NUMBER OF > 3 SIGMA OUTLIERS DETECTED IN MOVEMENT VS MOVEMENT PLOT = 6 :

* ALL OUTLIERS:

* MNTH or QTR/YEAR | MVT1(%) | MVT2(%) | approx.#SIGMA | P-VALUE:

* -----

* 3/1977	-9.61	7.78	10.12	4.307e-024
* 4/1977	15.35	3.97	-6.32	2.539e-010
* 3/1978	4.09	13.46	5.65	1.609e-008
* 3/1979	18.47	30.30	7.35	2.039e-013

* -----

- Ensure appropriately represented amongst SEASABS priors.

TEST 5

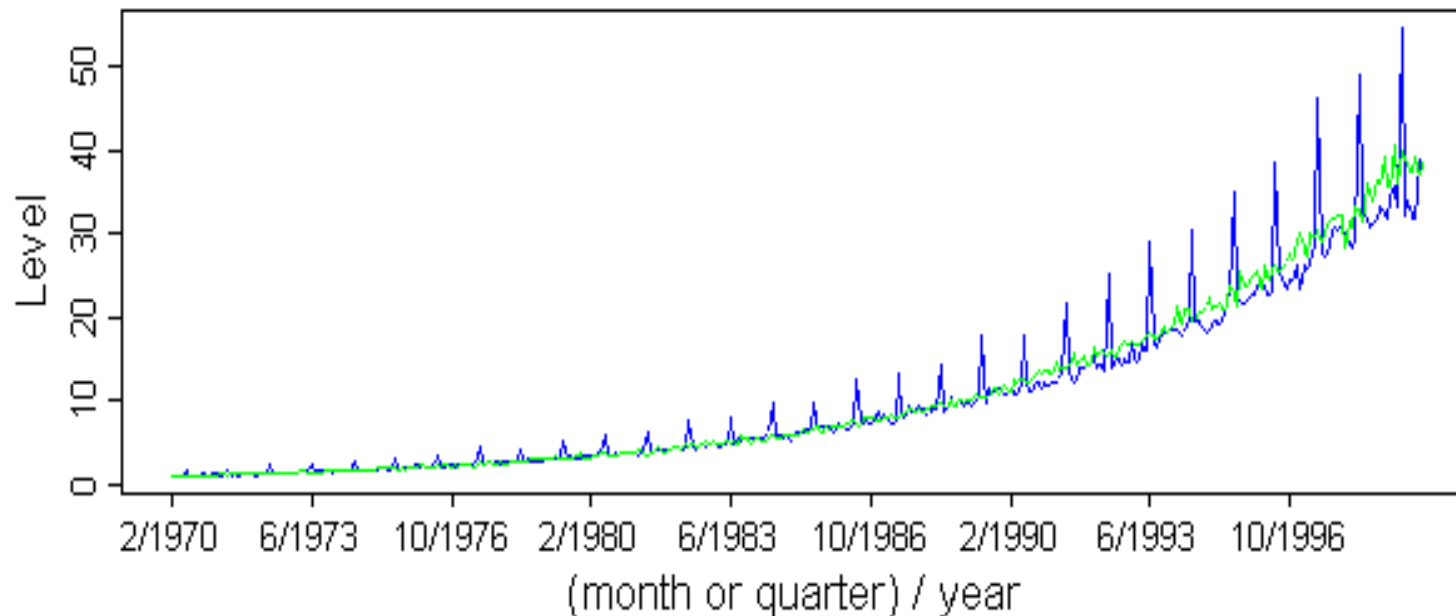
- Test for a pattern in "excess" movement difference "M1 - M2" as a function of time. By excess, we mean absolute values of mvt differences that exceed some threshold (currently 2σ).
- Purpose:
 - if we are comparing original components, then a significant pattern in "thresholded $|M1 - M2|$ " may imply different seasonal patterns and/or strengths.
 - if comparing SA components, then a significant pattern in "thresholded $|M1 - M2|$ " may imply residual seasonality is present in one series but not the other. i.e. inconsistent SA
- **N.B:** this test is not sensitive at detecting significant residual seasonal movements of the same magnitude in both series.

TEST 5 contd..

- Pattern in "thresholded $|M1 - M2|$ " is tested for by computing the ACF and PACF of the temporal indicator sequence:

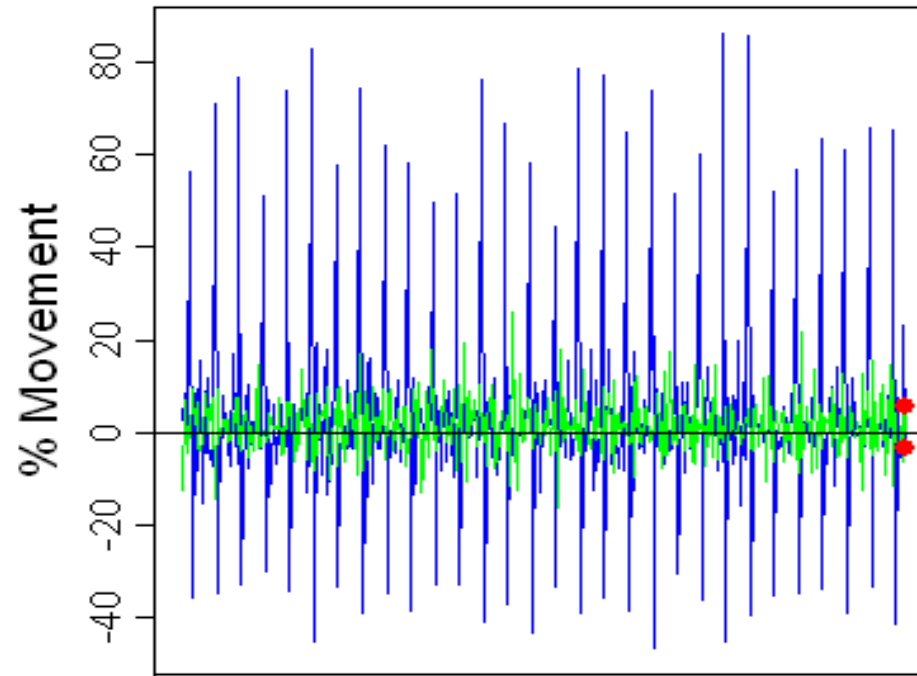
$$\text{if } (|M1_t - M2_t| > \text{thres}) \{ i(t) = 1 \} \text{ else } \{ i(t) = 0 \}$$

- Example (simulation): suppose we have two series: **green** has good SA, **blue** series has (exaggerated) residual seasonality:

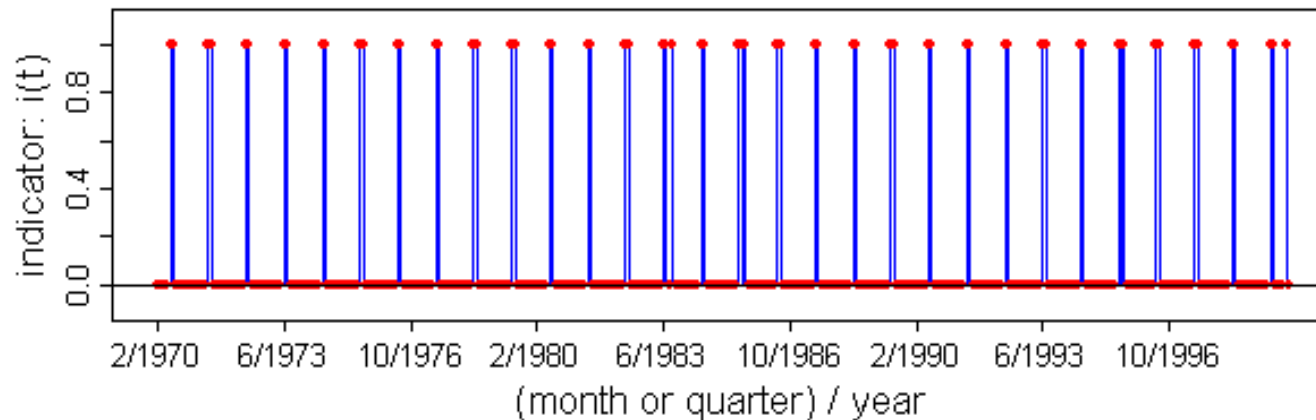


TEST 5 contd..

- Movements versus time:

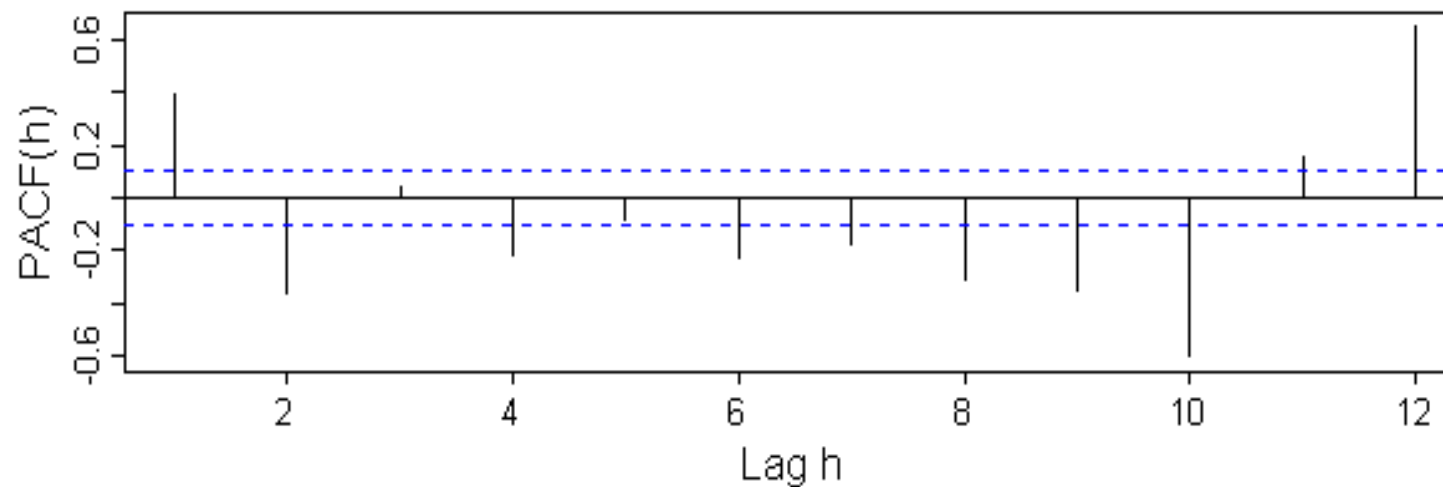
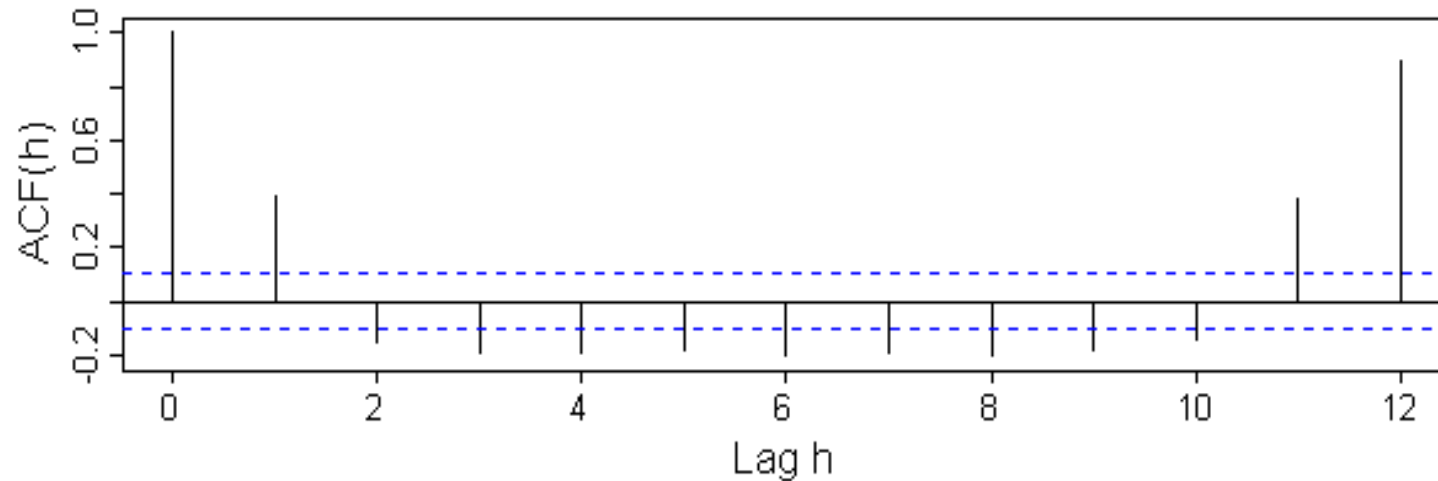


- Indicator sequence "i(t)" after thresholding on $|M1(t) - M2(t)|$:



TEST 5 contd..

- ACF and PACF of indicator sequence suggests a strong temporal pattern in excess movement difference:



TEST 5 contd..

- Output diagnostics for this test case:
 - * MOVEMENT DIFFERENCE THRESHOLD = 2 SIGMA
 - * NUMBER OF $|M1 - M2|$ VALUES ABOVE THRESHOLD = 64
 - * LAGS WHERE ACF & PACF $[i(t)]$ ARE GREATER THAN 95% CL VALUE: $h = 11 ; 12$
 - * => REJECT "H0: ACF & PACF $[i(t)]=0$ " OF NO PATTERN IN MOVEMENT DIFFERENCES
 - * => SYSTEMATIC INCONSISTENCY EXISTS AT ABOVE (LAG) PERIODICITIES
(CHECK ACF PLOTS)
- It's important to never believe these conclusions outright. As the last line implies: "CHECK ACF PLOTS". You want to ensure that there is indeed a systematic pattern in the indicator $\{ i(t) \}$ sequence. Also, residual seasonality may only exist for a sub-span of the series.
- Action: peruse seasonal factors / S*I charts and ensure that seasonality is eradicated as much as possible in SA compts.
- Note: a pattern at a non-annual lag would be intriguing since this will suggest behaviour on some underlying business cycle

TEST 6 (FYI only)

Unit Root and Cointegration tests: more powerful test for 'conceptual relatedness'.

- Above tests focused exclusively on movements, since first differences are likely to be stationary. Stationarity implies correlation (ρ) and regression estimates will be unbiased.
- If attempt to correlate levels directly, then ρ measures may be spurious due to the presence of non-stationarity (a feature common in economic series since most show an upwards trend). ρ measures will be biased towards explaining long-term relationships in trend, not underlying short timescale behaviour.
- Condition which enables us to correlate levels directly is that two series have to be "cointegrated". In a nutshell, this means that two series have common "long-term" trends, i.e. they track each other consistently in the long run. Two series X_t and Y_t are cointegrated if a linear combination of them is stationary:
$$u_t = Y_t - \beta X_t - \alpha \sim iid$$

TEST 6 contd..

- Before testing for cointegration, need to first ensure that two series are integrated with the same non-zero order d .
- 'integrated' \Rightarrow a cumulative sum of repeated stochastic disturbances over time. We need the two series to have underlying 'non-stationary' stochastic trends (just like a classic random walk).
- A series which needs to be differenced d times before it is stationary is called 'integrated of order d ', denoted " $I(d)$ ".
- We test for $I(1)$ processes using "unit-root" tests. In general, these are based on the regression:

$$Y_t = \rho Y_{t-1} + mt + c + e_t$$

and we test for:

$H_0 : \rho = 1 \Rightarrow y_t$ contains a unit root, " $I(1)$ " vs. $H_1 : -1 < \rho < 1 \Rightarrow y_t$ stationary " $I(0)$ "

- Note: we explicitly assume the deterministic trend slope: $m=0$ to avoid explaining away stochastic compt. giving misleading $I(0)$.

TEST 6 contd..

- If two series are $I(0)$ (already stationary), then there will be no 'common' long-term trends to correlate and we cannot infer any long-run equilibrium relationship between them. This is the basis of cointegration.
- If two series are not integrated with the same order, then series cannot be conceptually related! E.g. warning message:

*** WARNING: series pair not integrated with same order: [0 1]

- If they are integrated with same order then we proceed with a linear regression between series levels and compute $\rho(s_1, s_2)$.
- If residuals from this regression are stationary, then series are cointegrated. This implies stronger evidence that series are related. Otherwise if not cointegrated, you'll see:

*** According to both AEG and Johansen tests, series pair is not cointegrating

- Please check diagnostic and plots for marginal cases (e.g. outliers/breaks skewing results). Inform client of no relationship

[Example 1](#) ; [Example 2](#).

More Information?

- Specifics on each of the tests in TSA-WDB document:

Research → **Quality** →

📎 16/02/2006 ▶ Quantifying and Improving Consistency: version 3 (Frank Masci)

- Instructions on how to run and use the tool are in a draft Best Practice Guideline (BPG):

Documentation → **Policy and Guidelines** →

23/05/2005 ▼ Best Practices Guidelines (Framework) (Lisa Apted)

23/05/2005 ▼ Theory (header) (Lisa Apted)

....

26/07/2005 ▶ Coherence and Consistency (draft in progress) (Frank)

Assessment Strategy in BPG

- Each of the above diagnostic tests is assigned a "Pass" or "Fail" according to specific criteria that makes a series pair either 'consistent' or 'inconsistent' under that test.
- Having generated a consistency table for a list of series pairs, the procedure now is to work your way through tests 1-6 and weed out and analyse all tests that "failed".
- Recall that you can attempt to "fix" failures from tests 1,4 and 5 only by appropriately modifying SEASABS settings and parameters.
- **But note: a test failure does not imply strict inconsistency. It highlights a possible inconsistency that needs to be looked at!**
Appropriate SA is the key, not strictly consistent SA!

Procedure is in BPG

The BPG contains a very useful table that summarises:

- the goals of each test,
- what makes a test pass/fail (i.e. what diagnostic messages to look out for), and most importantly,
- what to do in case of a failure.

E.g. table header:

TEST NUMBER - eg TEST1 used as reference in this topic	GOAL(S) - the goal(s) of test and what it hopes to achieve	MAIN DIAGNOSTIC OUTPUTS -the main output summary/conclusion to look for in the diagnostics section of the consistency table.	PASSES IF - what makes the test pass?	FAILS IF - what makes the test fail?	IF FAILS, THEN - a reference to the relevant section in this topic which suggests "what to do" in case of a failure. A quick solution to the fix is also given.
1	Report when there is an inconsistency between the series pair in any one or more of the following "main" processing	Under TEST1 banner in output look for warnings after the three asterisks. These summarise the results from the	If periodicities the same ie monthly vs. monthly or quarterly vs. quarterly, and all the "main" processing	If periodicities the same ie monthly vs. monthly or quarterly vs. quarterly, and if one of more of the "main"	<i>see section ???</i> <u>Quick fix:</u> Go back and fix the inconsistent parameter

Group/Aggregation Tool

- Just hot off the press: I have written a 'quick look' consistency summary tool which compares SEASABS settings/priors for aggregate series to (and across) their components in a group.
- This could be useful to forward to clients (since it doesn't contain all those computed consistency diagnostics).
- Priors can be optionally included/excluded.
- Type following on DOS command prompt for tutorial:
`"S:\data\STA\Coherence\Frank'sCode\groupcompare.pl"`

[Example output.](#)

When do we Assess it?

- At each ASR by team member delegated by the CSM.
- Repeated/iterated as necessary to ensure most appropriate consistency before closure of ASR.
- When a client requests an ad-hoc consistency check for a list of conceptually related series.
- Recently from Nick: when TSA makes a change to one series in an ASR in one group that has more data than its corresponding related series from another group (i.e. since data compiled at different times across different areas).
 - need to assess consistency in all other related series when their estimates become available.

Issues and To Do List

- Make BPG more 'coherent' (almost there! - thanks Lisa)
- Improve layout of consistency table, make easier to read [e.g. FM thinking of using the group/aggregate layout, see pg. 29]
- How do we include/train SMA's in discussions about consistency issues? Include these as queries (query BPG)?
- Can we send SMAs the full consistency table, or parts thereof (e.g. just the SEASABS parameter summary, no diagnostics), or gzip all plots with table and help file included?
- Need an efficient way of monitoring of consistency maps and keeping them up to date? Need to liaise with specific people from each SMA. Do we need something in the initial contact proforma to advise of any changes since last year?
- Management of consistency maps? Now it's done via files kept in different directories on S:\drive. Craig created a central repository on the TSA-WDB [PTO..].

Issues contd..

Client Support → 1. Client Support:

1. Coherence		
📎	24/05/2006	National Accounts Consistency Maps (please add to as are formed) (Theresa Nunan)
📎	24/05/2006	SEE Consistency Map and 2006 ASR Results (Theresa Nunan)
📎	16/03/2006	AWE 2006 ASR consistency maps and tables.. (Frank Masci)
📎	24/02/2006	agriculture coherence map file (Lisa Apted)
	24/01/2006	Help file for new consistency code: consistency.pl (Frank Masci)
	03/01/2006	▶ NAB Coherence maps (Nick Von Sanden)
	25/11/2005	principle of coherence maps (Craig McLaren)
📎	25/11/2005	balance of payments coherence map (Craig McLaren)

- Management of maps and history of changes will be easier when implemented in SEASABS vsn 2.6. i.e. via an interface. Also our existing map files can be imported/uploaded into the SEASABS knowledge. So all work until now is not lost.
- Work on SEASABS and SMA help files.