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AUSTRALIAN LISTED PROPERTY TRUSTS: A COINTEGRATING APPROACH

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Australian Listed Property Trusts: A cointegrating Approach

This exploratory study is limited to the analysis of listed property funds currently (1998) traded on the Australian Stock Exchange. The questions raised here are related to the examination of the relative synchronicity between a porfolio of Australian listed property trusts (ALPT)[1], a notional Market portfolio (The ASX all ordinaries index), a proxy for a risk free asset (Australian 3-month Treasury Bill) and a proxy for general economic activity (The Australian index for industrial production).

A previous study has illustrated and commented upon the long term co-relation of the ALPT index and the ASX cumulated Index[2]. It was also suggested that this co-relation was not perfectly synchronised and that the ALPT could not offer any significant timing advantage for the investor who would try to arbitrage his position between a portfolio ALPT and the Market.

1.1 The questions

- Are seriess of ALPT and ASX idexes stationary?

- If they are not stationary, are they, at least co-integrated?

- If they are conintegrated do they converge to equilibrium once they have received a similar random shock (economic impulse)?

1.2 Some concepts

Time seriess stationarity

Most econometric models on time seriess are conditional to the hypothesis that time seriess are stationary. A time series is said to be stationary when its mean, variance and covariance with other values does not depend on time. Thus information about the mean-variance traits of a time series should suffice to predict any point from any given point: the whole series would be entirely predictable. Unfortunately, many economic and financial seriess are non stationary since they exhibit some form of trends, cyclical, seasonal or random variations.

More formally, a stationary stochastic time series Y is defined as:

$E(Y_t) = \mu$

$Var\ (Y_t) = \sigma^2$

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[2] Achour-Fischer, D " Non parametric evaluation of Australian Listed Property Trusts", 1998

$\gamma_k = E (Y_t - \mu) (Y_{t+k} - \mu)$ (non autocorrelation between periods t and t+k)

An important example of non-stationary seriess are random-walk seriess when the Y_{t+1} value is equal to the Y_t value plus a random shock. The mean-variance traits of such a series cannot be time invariant. The mean, for example, will drift further and further away from the initial mean. In a random-walk model, it is not possible to predict tomorrow on the basis of today.

Non-stationary time seriess create difficulties in econometric treatments and, more simply, they can also lead to spurious correlation problems: variables may be moving together without any particularly satisfactory causal explanation (the random shocks could simply be similar in their patterns and impacts).

A non-stationary series can be turned into a stationary one by taking the difference between successive periods of observations. If stationarity is obtained after one step, the original non-stationary series is said to be integrated of order 1 [I(1)]. If stationaritiy is reached after two differencing, the original non-stationary series is said to be integrated on order 2 [I(2)], etc. until step d (d differencing) when the process becomes stationary. Conventionally a stationary time series is also said to be integrated of order 0 [I(0)] since no differencing is required.

Time series stationarity was traditionally tested by the use of autocorrelation functions, more recently the favoured approach has been the unit root detection.

Unit Root

A time series is said to have "a unit root problem" when the lag function is autocorrelated (the root of the polynomial of the lag operator is equal to 1). Such a time series then behaves according to random-walk pattern (Non-stationarity)

In its simplest form the random walk hypothesis suggests that changes, for example, in ALPT prices cannot be predicted on the basis of the observation of previous changes. Thus the price variations should have a mean value of zero according to the evolution of a stochastic difference equation.

$$P_t = P_{t-1} + \varepsilon_t \qquad (1)$$

or

$$\Delta P_t = \varepsilon_t \qquad (2)$$

where P_t = ALPT prices in period t

ε_t = a random disturbance term that has an expected value of zero

Now consider the more general stochastic first difference equation:

$$\Delta P_t = \alpha + \beta P_{t-1} + \varepsilon_t \qquad (3)$$

The random walk hypothesis requires $\alpha = \beta = 0$ and that the mean of the error term ε_t is equal to zero. Rejecting these restrictions is the same as rejecting the random walk hypothesis. In a non-random walk price series, information on α and β should suffice to predict todays P_t on the basis of yesterday's P_{t-1} and the prediction errors would cancel each others.

Let us rephrase it once more, rejecting the random walk hypothesis means that the time series is stationary and thus that the relationship between two price predictions should be dictated by the mean-variance traits of the time series.

One way to identify the unit root problem is to run a regression on:

$$P_t = \rho . P_{t-1} + \varepsilon_t$$

If $\rho = 1$ then we have a unit root situation. The series is not stationary.

Dividing the estimate of ρ by its standard error provides the so called Dickey Fuller (Dickey and Fuller 1979) τ test for the null hypothesis that $\rho = 1$.

Spurious correlation

If we regress the seriess of ASX index and the ALPT index we obtain nice looking results (R^2 = 96.4%, a t test for the slope of 328 and a standard error of .00297). Almost too good not to raise some suspicion specialy when one goes to the DW statistic which is equal to .0063. Such a low Durbin Watson is a clear indication of first order auto-correlation and a probable cause to suspect spurious correlation:

An $R^2 > d$ is a good rule of thumb to suspect that the estimated regression suffers from spurious correlation. (Granger and Newbold 1974)

When a non-stationary seriess is regressed against another non stationary series the standard tools of regression validation are pointless and one may wonder if the two seriess are simply not random-walking together...

Cointegration Analysis

To test this "random-walking togertheness", the technique of cointegration analysis has been developed in the last 15 years. This technique is now commonly used in economics, less commonly used in Finance and, to this point almost neglected in Property studies.

If we come back to our previous discussion of non stationary time seriess, we explained that a P_t random-walking series integrated of order 1 can be made to behave by taking the first difference of ΔP_t . The resulting new time series would be stationary. Thus it would be tempting to regress the initial series to its now well behaving first difference offspring. The stochastic factors would be eliminated and we could observe clean co-variabilities.

Unfortunately, by limiting the causalities to first-difference measures, this approach would also erase out all the more interesting features of the seriess and their real relationships.

The cointegration solution is avoiding this problem by combining the two seriess into a single "pooled" series. In fact, instead of observing two non-stationary seriess, one may create a linear combination of the two indexes. The resulting twinned series may, or may not be stationary even if the two initial seriess are random. If the resulting combination is stationary one say that the seriess are cointegrated.

Two intuitive analogies may help clarify this concept:

- In elementary statistical treatments it may be convenient to stack (or to pool) the data in order to observe the commonality of the parameters of two random distributions.

- In a modern discotheque, the floor partners are obviously not really dancing together but (probably) their movements are synchronised (at least they start and stop at the same time..).

- The intuitive concept is thus a requirement of synchronicity of seriess that are combined. Two co-integrated random walking seriess are random-walking together. The external random events may affect the two seriess at the same time and with the same impact.

1.3 General background

Recent studies, such as (Quan 1999 (forthcoming)), (He 1998) examine the relationship between real estate prices and stock prices by performing cointegration tests and causality tests. They also study the influence of macro economic variables on real estate returns. (McCue and Kling 1994) employed equity of real estate investment trust (REIT) data as a proxy for real estate returns. They also used the residuals regressed against returns from the Standard and Poors 500 stock index to measure extra-market covariance, which represent pure industry effects. The results of their study show that the major influence of real estate seriess is from nominal rates output and investment. In this paper we discuss the orthogonalised impulse response for listed property trust price index and similar influences on stock market price index, market treasury bill rate and output. The main object of the study is to examine whether any of the common factors prevailing among Australian ordinary equities is useful in explaining the variation in the equities of listed property trust.

Based on the Arbitrage Pricing theory of (Roll and Ross 1980), (Chen, Roll et al. 1986) and (Fama and French 1992) recent studies such as (Che, Hsieh et al. 1998) examined the common factors prevailing among ordinary common equities to explain the cross sectional variation in equity real estate investment trust returns.

Their findings reject the CAPM model that market index is not a relevant variable for explaining cross-sectional variation of returns. They correctly conclude that a simple 2 assets benchmark model (Market and Risk free proxy) is not sufficient to explain the pricing of general equities.

This incapacity has been also been illustrated in the case of Property assets. It seems clear that property prices are determined by many non-variance factors that reflect the specificity of localised and heterogeneous assets. Multi-factor models are also certainly required to explain the price formation of Property based securities (REITs, LPT etc) and will be presented in subsequent paper in the case of Australian funds, nevetheless, at this stage, we would like to concentrate more on the issues of relative dynamic prices formation than on the issue of factor pricing effects.

1.4 The data:

The analysis was done on ALPT traded between 1979 to 1996 on the Australian Stock Exchange. The ALPT information had to be reconstructed from Datastream International data base returns since published data from specialised Australian sources appear to be somewhat different and subject to a higher level of informational noise[3].

The returns are computed to include the reinvestment of distributed profits (dividends for ordinary securities) in the same units of the Trust. Returns are computed on last quoted day of each quaterly periods.

The ASX index is the Australian Stock Exchange accumulation index (Source Datastream). This index includes the distribution of dividends. Redistributions are assumed to be reinvested to purchase additionals units or shares at the redistribution day closing price of the unit or share.

The ALPT accumulated index is a value weighted index of about 30 Australian listed property trusts. It has the same 1979 = 1000 base value than the ASX. The risk free asset used in some computations is the Australian Treasury Bill, 3 Month, middle rate.

The Australian Industrial production index is used as a proxy for output. Industrial production index is also expressed in logarithmic form.

The procedure

The Johansen's Maximum Likelihood procedure has been used[4] here since it appears to be more efficient when there are more than two I(1) variables and provides a satisfactory

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[3] The most visible information about long term performance of ALPTs is provided in specialised publications (eg. BRW publishes returns indicators compiled by SBC Warburg, Dillion, Read). Another available source is the Independent Property Trust Review published monthly by "Property Investment Research Ltd.) based on the same information but using different benchmark periods.

Since the construction of these return seriess is far from being transparent, we reconstructed the LPT individual performances on the basis of DataStream daily price and dividend information. Monthly returns are used in the analysis to smooth out the noise created by the arbitrary choice of a transaction day in day to day index calculations. The difference between our data and published results is visible but not sufficiently large to raise issues about the informational content of the published data on investors decisions.

[4] Here the Johansen's ML option in MICROFIT computer package has been used to determine the number of cointegrating vectors r, using the maximal eigenvalue procedure as given in (Johansen 1988) The number of cointegrating vectors is determined sequentially based on the log-likelihood ratio test statistics.

framework for estimation and testing the cointegrating relations of an autoregressive error correction (VECM) models.

Impulse Response Functions

Simulation models are generally used to study the impact of one variable on another variable in the short run and in the long run. With the introduction of Sim's methodology, simulation models are used as a tool for examining the dynamic responses of one set of economic variables to changes in other sets of variables. As explained in the intuitive interpretation of this exercise, we want to submit the two seriess to similar random events (random impulses) and observe if they react in synchronicity.

The function that is employed to analyse the dynamic behaviour of a vector autoregression is called the impulse response function. The impulse response function traces the response of each endogeneous variable over time to a shock in that variable and in every other endogeneous variable.

If the model is linear and there is no serial correlation of the error terms the changes over time in all the other variables caused by a shock in the error term would give an unbiased simulation of the model. On the other hand if either the model is nonlinear or errors are correlated then there is no unambiguous way to identify the shocks with particular variables. Serial correlation in the error terms will result in common components that affect more than one variable.

Another important aspect that needs to be borne in mind is the stability of the model. The model should be in a stable equilibrium prior to shocking the system. When one introduces a unit shock in the endogenous variable ie. increase error term εt by one standard deviation and this shock affects other endogenous variables, which filters through the model, affecting all the variables. In the subsequent periods it may eventually have a greater effect on the original endogenous variable due to the feedback effects through the other variables. (See Pindyck and Rubinfeld, 1991 for further details.)

The effect of shocking the seriess are tested on the cointegrating relation x_1 = LogP – LogASX . These shocks may have a permanent effect on the cointegrating relationship, which converges over time to reach a plateau (Blanchard and Quah 1989), (King, Plosser et al. 1991).

1.5 Empirical Results

1- Are seriess of ALPT and ASX indexes stationary?

The following summary of the Dickey-Fuller tests indicates, without any doubt that indeed the ASX, ALPT, Risk-Free and Output proxy are non-stationary. They are clearly random-walking.

Table 1: Augmented Dickey-Fuller test results

Variables	ADF (4) Without Trend	ADF(4) With Trend
LOG LISTED	-1.9436 (-2.9069)	-2.0078 (-3.4801)
LOG ASX	-0.4612 (-2.9069)	-2.1131 (-3.4801)
RISK FREE	-1.8989 (-2.9069)	-2.9122 (-3.4801)
OUTPUT	-0.6598 (-2.9069)	-3.5647*(-3.4801)

Note: *Output is not stationary, even with trend since ADF (2) value gives -3.1075 and ADF(3) -1.4654. And without trend, it is undoubtedly not stationary.

- The next table provides the same test for the first difference of the four seriess. Here, we confirm that our initial seriess are integrated of order 1 [I(1)]. The first differenced seriess are stationary.

Table 2

Variables	ADF (4) Without Trend	ADF(4) With Trend
LOG LISTED	-3.5795 (-2.9077)	-3.6360 (-3.4812)
LOG ASX	-4.2389 (-2.9077)	-4.1989 (-3.4812)
RISK FREE	-3.3631 (-2.9077)	-3.3672 (-3.4812)
OUTPUT	-3.4150 (-2.9077)	-3.388*(-3.4812)

2- If the seriess are not stationary, are the original variables, at least co-integrated?

The results presented in table 3 illustrate that our four seriess are clearly co-integrated. We can identify at least three levels of co-integration. Which means that each variable (for example the ALPT index) is integrated with the three other variables).

ALPT = f(ASX, R_f, Output)

ASX = g(ALPT, R_f, Output)

Output = k(ALPT, ASX, R_f)

Table 3: Cointegration Rank Statistics

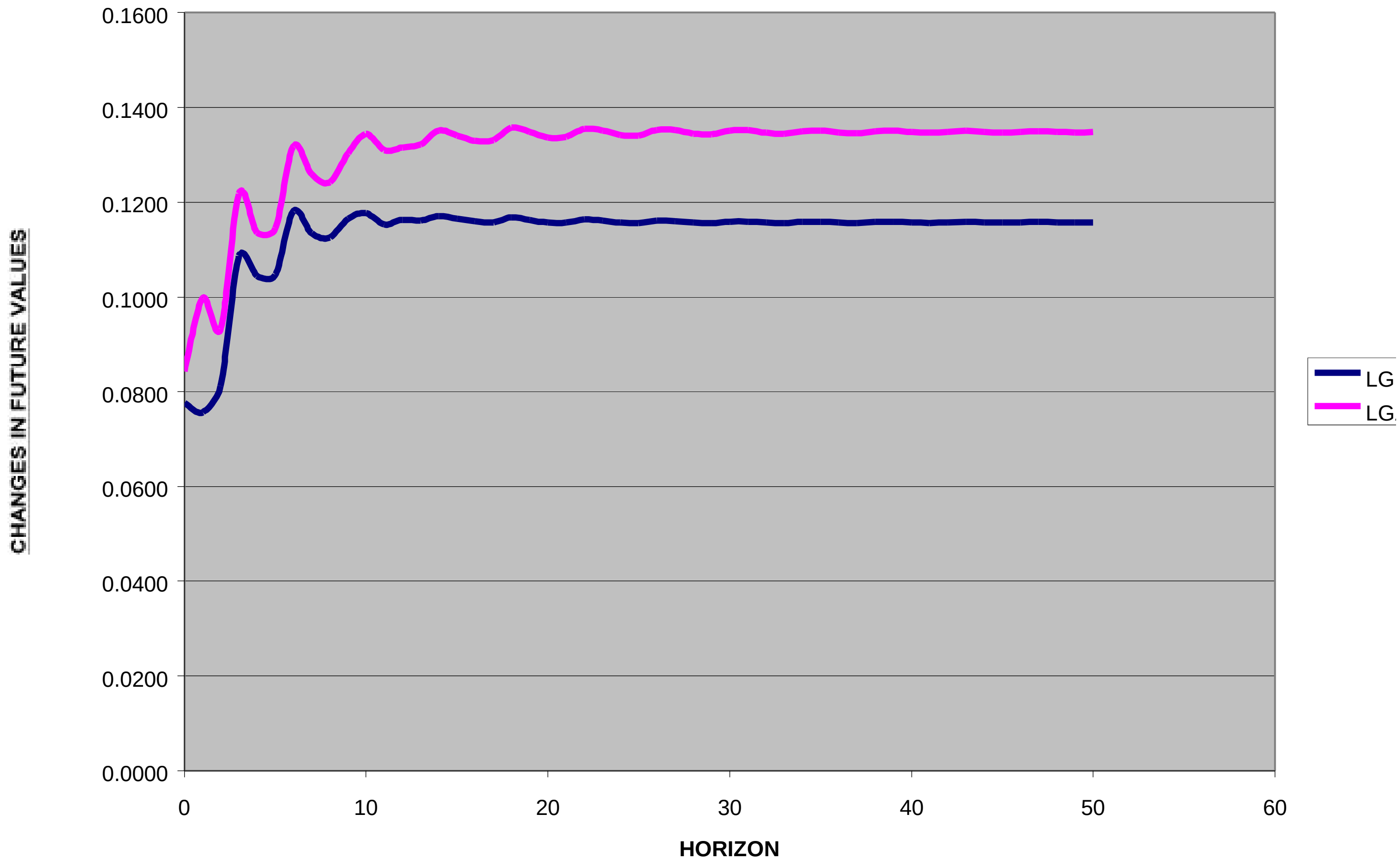
		Maximal Eigenvalue		Trace of the Stochastic Matrix	
Null	Alternative	Statistic	95%Critical	Statistic	95%Critical
r = 0	r = 1	25.1715	23.92	68.2819	39.81
r<= 1	r = 2	23.4964	17.68	43.1104	24.05
r<= 2	r = 3	16.8747	11.03	19.6139	12.36
r<= 3	r = 4	2.7393	4.16	2.7393	4.16

Table 3 provides the long run parameters of Johansen's maximum likelihood estimates with imposed restrictions on LOG LISTED with $a_1=1$. The figures within the brackets are the standard errors. The signs of all the variables are as expected and they are statistically significant. Under maximal eigenvalue and trace statistics the null hypothesis that r=0 is rejected, since the calculated value is much higher than the 95% critical value in both cases. There is concurrence in the test results and they show that there is atleast one cointegrating relationship between these variables.

3- If the seriess are cointegrated do they converge to equilibrium once they have received a similar random shock (economic impulse)?

Table 4 describes the response of ALPT returns to positive, one standard error shocks in each of the other variables over a 50 quarter period. Shocks to nominal rates of interest are negative and to output is positive as expected. These impulse responses are also plotted on a graph (Fig.1) which shows that the response is positive for Australian stock market price as expected. And Figure 2 illustrates the persistence profile of the cointegrating vector: the effects of the shock disappear in the long term.

THE ORTHOGONALISED IMPULSE RESPONSE FUNCTION



Persistence profile ot the cointegrating vector

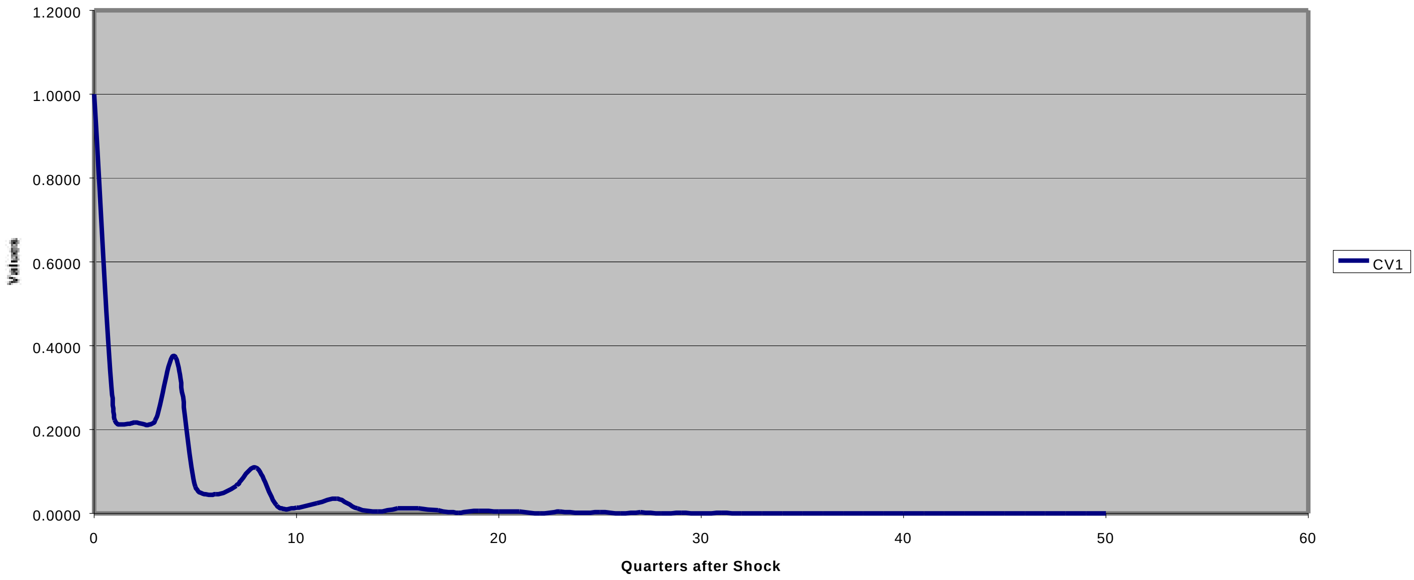


Table 4: The orthogonalised Impulse response function for ALPT Prices

Horizon	LOG LISTED	LOG ASX	LOG OUTPUT	BILLRATE
1	0.0756	0.0997	0.0028	-0.5665
2	0.0812	0.0932	0.0089	-0.6779
3	0.1087	0.1218	0.0137	-1.1043
4	0.1044	0.1136	0.0011	-0.7371
5	0.1046	0.1145	0.0055	-0.9422
6	0.1181	0.1319	0.0128	-1.1176
7	0.1134	0.1259	0.0133	-1.0905
8	0.1126	0.1242	0.0043	-0.9942
9	0.1165	0.1304	0.0068	-1.0989
10	0.1177	0.1344	0.0116	-1.1108
------	------	------	-----	-----
45	0.1157	0.1347	0.0089	-1.1396
46	0.1157	0.1348	0.0089	-1.1396
47	0.1158	0.1350	0.0093	-1.1440
48	0.1157	0.1349	0.0093	-1.1441
49	0.1157	0.1347	0.0090	-1.1405
50	0.1157	0.1348	0.0089	-1.1400

1. Orthogonalised impulse responses to one standard error shock in the equation for listed property stock prices (Orhtogonalised means that one variable is used when the three others are kept constant).

2. The order of vector autoregressive model choosen is using a lag of 4 periods since we dealing with quaterly data.

3. Cointegration with no intercepts or trends in the VAR. Together the four variables do not exhibit a clear trend thus the intercept and the slope of the trend curve are zero.

4. List of imposed restrictions is a_1=1. This is meant to normalise the linear function presented in note….

5. 65 observations from 1980Q4 to 1996Q4.

6. Horizon refers to the quarters after shocking the system.

Impulse Response(s) to one S.E. shock in the price of listed property stocks reveal that there is a positive impact on Austalian stock market price and output while there is a negative influence on interest rate. This is in conformity with earlier studies (Quan 1999 (forthcoming)), (McCue and Kling 1994).

1.6 Conclusions

The answers to our three questions are restated here:

1. Yes, indeed, the four seriess and in particular the ASX index and the ALPT index are non stationary, but they are integrated of order 1.

2. The ASX and ALPT are clearly co-integrated: they do random walk together.

3. The seriess stabilise to equilibrium in the long run when they are subjected to the same random shock.

These answers confirm the conclusions that where reached in the previous paper when we observed that the ALPT investors do not seem to enjoy any selectivity or timing advantages. Here, since the indexes are synchronised we can further conclude that they do not enjoy any benefit of diversification.

Appendix

Table a.1: Johansen's Maximum Likelihood (ML) Estimates

Vector 1	*ML estimates (Standard Error) imposed restriction(s) with a1=1
Log P_t	1.0000 (*NONE*)
Log ASX	-0.5675 (-0.2038)
Log OUTPUT	-0.8647 (-0.4144)
R_f	0.0274 (-0.0123)

1. 65 observations from 1980Q4 to 1996Q4. Order of VAR = 4, chosen r =1
2. Cointegration with no intercepts or trends in the VAR.
3. The signs of the coefficients of LOG ASX, LOG OUTPUT are positive
4. and R_f negative.
5. Estimates of Restricted Cointegrating Relations (SE's in Brackets) Converged
6. after 2 iterations
7. The normalised form of this long run equation is given as

$$\text{Log } P_t = 0.5675 \text{ Log ASX} + 0.8647 \text{ Log OUTPUT} - 0.0274 \text{ RF}.$$

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