WHETHER YIELD ON INVESTMENTS ON GOLD AND SENSEX IN INDIA ARE COINTEGRATED?

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ABSTRACT

India is the world's largest consumer of gold and second largest supplier of gold. Whether yield on gold prices can be used to predict the yield of Sensex 30 securities is a justifiable question. To find answer for this question, we need considerable time series data of both Gold and Sensex. The cointegration is the statistical and econometric tool which is used to clarify those doubts. If there exists a stationary linear combination of non stationary random variables, the variables combined are said to be co-integrated. To understand the phrase co-integrated of order zero, we should first define integrated series. Non-stationary series that become stationary when differenced n times are called integrated of order n. For a set of series to be co-integrated, each member of the set must be integrated of the same order n; thus the term co-integration. Various econometric tests like Augmented Dickey-Fuller, Engel-Granger, Johansen, GARCH model are conducted to verify the relationship between the linear relationship between non stationary variables called yield on gold investments (Yg) and yield on capital investments (Yc). Total yield on Gold is significantly lower than yield on capital investments. At the same time, yield on gold investments is less volatile than yield on capital investments. Two variables Yg and Yc are not stationary since the means of their yield are varying. Johansen test arrives in a greater p value. It indicates that we can accept Ho and it follows that Yield on gold investments and Yield on capital investments are not co integrated.

Keywords: Co-integration, ADF Test, Johansen Test, GARCH, Gold prices, Sensex

INTRODUCTION

India is the world's largest consumer of gold and second largest supplier of gold. Most of the Indian functions are adorned with gold jewels. It is the only material widely bought in rural, urban and metropolitan as well. Whether yield on gold prices can be used to predict the yield of Sensex 30 securities is a justifiable question. To find answer for this question, we need considerable time series data of both Gold and Sensex. Middle income group investors choose to invest in Gold rather than Sensex. The reasons are many. First, gold has been bought since long ago. Second gold is used by even least qualified Indians. Third they have the custom of following gold prices. Now the query is whether these traits can be used to predict the yield of Sensex securities or not. If yield on gold prices is a good scale for measurement, then they will be intrepid to invest in Sensex. This will increase their awareness over the yield on capital market securities. As comparing the yield of all securities is cumbersome, it is decided to compare the yield on Sensex securities and the yield on Gold investments. So the investors or investor-in-near-future may be interested to find or study the relationship between the yield on gold investments and the yield on capital market investments.

The cointegration is the statistical and econometric tool which is used to clarify those doubts. If there exists a stationary linear combination of non stationary random variables, the variables combined are said to be co-integrated. To understand the phrase co-integrated of order zero, we should first define integrated series. Non-stationary series that become stationary when differenced n times are called integrated of order n. For a set of series to be co-integrated, each member of the set must be integrated of the same order n; thus the term co-integration. A set of series, all integrated of order n, are said to be co-integrated if and only if some linear combination of the series – with non zero weights only – is integrated of order less than n. Such a linear combination is called a co-integrating relationship. So if xt and yt are said to be cointegrated if there exists a parameter α such that

$Ut = y_t - \alpha x_t$

REVIEW OF LITERATURE:

Co-integration theory is definitely the innovation in theoretical econometrics that has created the most interest among economists in the last decade. A vector of I(1) variables yt is said to be cointegrated if there exist at vector βi such that βiyt is trend stationary. If there exist r such linearly independent vectors βi, i =1,...,r, then yt is said to be cointegrated with cointegrating rank r. The matrix β = (β1,…βr) is called the cointegrating matrix. Cointegrating relationships between the sequences are ruled out through Johansen's (1988) cointegration tests. Although there exists a number of cointegration tests, such as the Engle and Granger (1987) method and the Stock and Watson (1988) test, Johansen's test has a number of desirable properties, including the fact that all test variables are treated as endogenous variables. Engle and Granger (1987) compared different tests and recommended the CADF test. They supplied critical values based on Monte Carlo simulations for the case of just one regressor. Engle and Yoo (1987) extend those tables to the case of more than one regressor, and MacKinnon (1991) has the most complete tables available so far. New tests for unit roots in residuals from a potentially cointegrating relation (like the Phillips- Perron tests) have been suggested since the publication of Engle and Granger (1987) and critical values have been simulated for some of those (see Phillips and Ouliaris (1990) for critical values for the PP test - these values are built into the COINT package), but it seems that the CADF test stands up pretty well. Again, you have to be

careful if the series contains trends. If the xt series contain a trend (or may contain a trend) then we should be careful to include a trend in the co integrating regression, otherwise the asymptotic critical values will be different. The best way of testing for unit roots is by using the system ML estimator of Johansen (1988, 1991) is a test for cointegration restrictions in a VAR representation. \Johansen" estimation is treated in much detail in the book by Johansen (1995). This estimator also gives you asymptotically efficient estimates of the co integrating vectors (the β's) and of the adjustment parameters (the α's). Johansen's method" is the maximum likelihood estimator of the so-called reduced rank model. Even though there is a constant in the error correction representation (eqn. (3)), this may not translate into a deterministic trend in yt. Note that this is not the same as what Campbell and Perron (1992) refer to as \deterministic cointegration", namely the case where there is trend in yt but no trend in αyt. Johansen (1991) derives the likelihood ratio test (which we will denote H*) for reduced rank in the case where there is a constant in the ECM but no trend in yt, see Johansen (1991) or Johansen (1995) for the full explanation. Johansen (1992b) discusses how to obtain a consistent test for the number of stochastic trends and for trend in yt at the same time. See Johansen (1991) for the derivation of the maximum likelihood estimator when there may or may not be trend. It turns out to be very convenient to program the Maximum Likelihood estimator in this case: all you have to do is to move the vector of ones in to Zkt and delete if from Z1t.

DATA AND METHODOLOGY

The primary objective of the study is to determine whether the yield on Gold investments and yield on BSE 30 securities are related as stationary linear combination or not. If so, it means that both variables are cointegrated. So this study focuses on finding out whether there is co integrating relationship between the variables Yg (Yield on gold investments) and Yc (Yield on capital investments). The data is taken from BSE's official website http://www.bseindia.com/stockinfo/indices.aspx. The formula used for finding out capital yield is ln (P_t / P_{t-1}). The dividend yield is already available in the website. Total yield = dividend yield, which is taken directly from the official website of BSE + Capital yield which is found from the formula. The Augmented Dickey-Fuller test, Engle Granger co-integration test and Johansen co-integration test. Yearly data are used for calculation and the period is from 1991 and 2011 (till July).

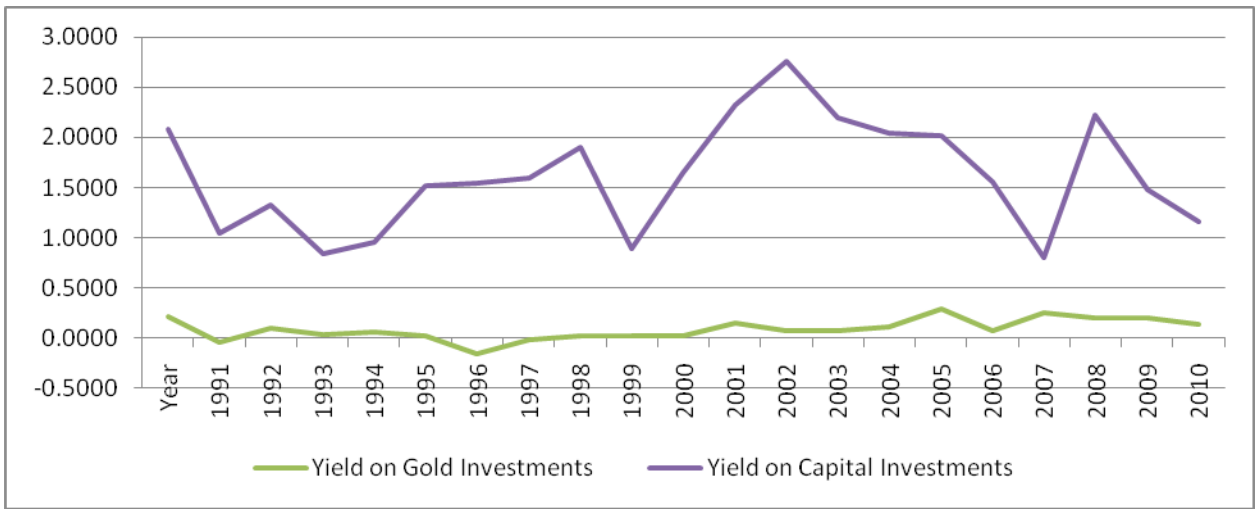
Table 1: Yield on both gold investments and capital market investments since 1991

Year	Yield on Gold Investments	Yield on Capital Investments
1991	0.2192	1.8595
1992	-0.0462	1.0898
1993	0.0993	1.2255
1994	0.0294	0.8133
1995	0.0604	0.9012
1996	0.0226	1.4907
1997	-0.1540	1.6969
1998	-0.0184	1.6199
1999	0.0290	1.8706
2000	0.0181	0.8688
2001	0.0233	1.6285
2002	0.1523	2.1747
2003	0.0700	2.6855
2004	0.0719	2.1272
2005	0.1159	1.9294
2006	0.2920	1.7306
2007	0.0786	1.4833
2008	0.2543	0.5448
2009	0.2008	2.0159
2010	0.1997	1.2802
2011	0.1317	1.0268

Source: Bombay Stock exchange official website, Bombay bullion association

Table provides the details about the yield on gold investments and yield on Capital market investments. Yield on Capital market investments include both dividend yield and capital gain yield. Yield on gold investments include only yield on capital gain. FY 2003 is a good year for capital market which sees its performance reaches the zenith and FY 2008 is the worrisome year for capital market investors where the capital prices faced debacle. It is interesting to underline that on the same year- FY 2008, yield on gold prices manifolds.

Chart 1: Comparative chart on the movement of yield on gold investments and capital market investments



Source: official website of Bombay Stock Exchange, Bombay bullion Association

The two variables are related. Total yield on Gold is significantly lower than yield on capital investments. At the same time, yield on gold investments is less volatile than yield on capital investments. Yield on gold investments are almost stagnant it fluctuates between -0.5 and 0.5. Two variables Yg and Yc are not stationary since the means of their yield are varying. Both variable appears to be I(1), though we should test for unit root tests.

ANALYSIS AND DISCUSSION:

The results of Augmented Dickey – Fuller test for the random variable- Yg

Statistics	Value
estimated value of (a - 1)	-0.311368
test statistic: tau_c(1)	-1.3
asymptotic p-value	0.6319

This is the unit root test for Yg. The p value is greater than 0.05 and therefore we cannot reject Ho. This means Yg is probably I(1).

The results of Augmented Dickey – Fuller test for the random variable- Yc

Statistics	Value
estimated value of (a - 1)	-0.613462
test statistic: tau_c(1)	-2.12372
asymptotic p-value	0.2354

This is the unit root test for Yc. The p value is greater than 0.05 and therefore we cannot reject Ho. This means Yc is probably I(1).

Particulars	Coefficient	Std Error	t-ratio	p-value
Constant	0.0786937	0.073810	1.066	0.2997
Yc	0.0061518	0.045737	0.134	0.8944

Particulars	Value	Particulars	Value
Mean dependent	0.088086	S.D. dependent	0.106818
Sum squared residual	0.227986	S.E. of regression	0.109541
R-squared	0.000951	Adjusted R-	-0.051630
Log-likelihood	17.69374	Akaike criterion	-31.38748
Schwarz criterion	-	Hannan-Quinn	-30.93410
rho	0.323459	Durbin-Watson	1.276577

It is unlikely that Feldstein's (1996) estimates suffer by problems of spurious correlation due to R squared not exceeding 0.99, as reported by Feldstein.

The following is the result of the Dickey- Fuller test on variables

Statistics	Value
estimated value of (a - 1)	-0.315821
test statistic: tau_c(1)	-1.35712
asymptotic p-value	0.8136

The p value is greater than 0.05 and therefore we can accept Ho and it follows that Yg and Yc are not co-integrated during the period between January 1991 and July 2011.

Johansen Test results

Number of equations = 2; Lag order = 1; Estimation period: 1992 - 2011 (T = 20)
Case 3: Unrestricted constant
Log-likelihood = 60.5842 (including c: 3.82664)

Rank	Eigenvalue	Tracetest [p value]	Lmax Test [p value]
0	0.36624	16.800 [0.0299]	9.1218 [0.2826]
1	0.3182	7.6785 [0.0056]	7.6785 [0.0056]

Corrected for sample size (df = 17)

Rank	Trace test p-value
0	16.800 [0.0485]
1	7.6785 [0.0107]

eigenvalue 0.36624 0.31882

Based on the Johansen test results, the null hypothesis that is there is no cointegrating relationship between Yield on gold investment and Yield on Capital investment is rejected.

GARCH, using observations 1991-2011 (T = 21)

Dependent variable: Yield_on_Gold_Investment
Standard errors based on Hessian

	coefficient	std. error	z	p-value
const	0.0786937	0.0702073	1.121	0.2623
Yield_on_Capital investment	0.00615183	0.0435046	0.1414	0.8875
alpha(0)	0.0108565	0.00335038	3.240	0.0012 ***

Mean dependent var	0.088086	S.D. dependent var	0.106818
Log-likelihood	17.69374	Akaike criterion	-27.38748
Schwarz criterion	-23.20939	Hannan-Quinn	-26.48073

Unconditional error variance = 0.0108565

ESS is minimum for rho = 0.35

Fine-tune rho using the CORC procedure...

ITER	RHO	ESS
1	0.3500	0.199145

2	0.34582	0.19914
3	0.34539	0.19914

Rho is the rate of change of the value of yield on capital investment with respect to the yield on gold investments. It is mostly 0.35 that indicates there is no much impact on the yield on capital investments based on yield on gold investments.

Hildreth-Lu, using observations 1992-2011 (T = 20)

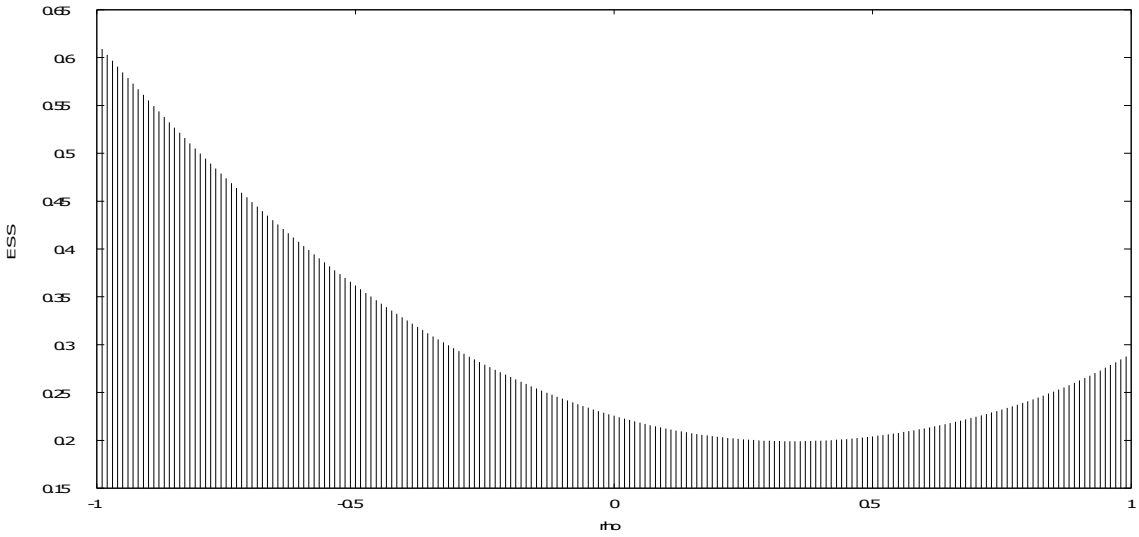
Dependent variable: Yield_on_Gold_Investment

	Coefficient	Std error	T ratio	P value
Yield on capital investment	0.0415635	0.0208988	1.989	0.0613

Statistics based on the rho-differenced data:

Mean dependent var	0.081528	S.D. dependent var	0.105166
Sum squared resid	0.199140	S.E. of regression	0.102377
R-squared	0.080087	Adjusted R-squared	0.080087
F(1, 19)	3.955334	P-value(F)	0.061320
rho	-0.056051	Durbin-Watson	2.004686

Chart 2: Rho values of Hildreth-Lu statistical test



A coefficient of 0.04 defines the impact of yield on gold investments on yield on capital investments. Moreover, p value is more or less equal to 0.05. So yield on gold investment and yield on capital investment are not well cointegrated.

ARMAX, using observations 1991-2011 (T = 21)

Estimated using Kalman filter (exact ML)
Dependent variable: Yield_on_Gold_Investment
Standard errors based on Hessian

	Coefficient	std. error	z	p-value
const	0.0926014	0.0748789	1.237	0.2162
phi_1	0.810257	0.181257	4.470	7.81e-06 ***
theta_1	-0.524639	0.229449	-2.287	0.0222 **
Yield_on_Capital investment	0.00469345	0.0399229	0.1176	0.9064

Mean dependent var 0.088086 S.D. dependent var 0.106818
Mean of innovations -0.001260 S.D. of innovations 0.092822
Log-likelihood 19.97905 Akaike criterion -29.95811
Schwarz criterion -24.73549 Hannan-Quinn -28.82467

	Real	Imaginary	Modulus	Frequency
ARRoot1	1.2342	0.0000	1.2342	0.0000
MA Root 1	1.9061	0.0000	1.9061	0.0000

Performing iterative calculation of rho...

ITER	RHO	ESS
1	0.32535	0.215022
2	0.32668	0.215008
3	0.32669	0.215008

Rhos is the change in yield on capital investment based on the impact of yield on gold investments. As it is mostly 0.33, it can be interpreted that there is no much impact on yield on capital investments based on yield on gold investments.

Prais-Winsten, using observations 1991-2011 (T = 21)

Dependent variable: Yield_on_Gold_Investment

	Coefficient	Std error	t ratio	P value
Yield on capital investment	0.054269	0.019513 5	2.584	0.0177

Statistics based on the rho-differenced data:

Mean dependent var	0.088086	S.D. dependent var	0.106818
Sum squared resid	0.215008	S.E. of regression	0.103684
R-squared	0.078579	Adjusted R-squared	0.078579
F(1, 20)	6.678085	P-value(F)	0.017722
rho	-0.129074	Durbin-Watson	2.185221

Since p value is less than 0.05, the null hypothesis which says there is no linear relationship between yield on gold investments and yield on capital investments is not accepted.

CONCLUSION

As the purpose of the study is to find the relationship between yield on gold investments and yield on capital investments, our focus is following various econometric tests to arrive a solution. Most of the econometric tests result almost predict the same.

There is evidence for a co integrating relationship if:
(a) The unit-root hypothesis is not rejected for the individual variables.
(b) The unit-root hypothesis is accepted for the residuals (uhat) from the co integrating regression.

Johansen test, which is a major econometric test for finding out the linear co integrating relationship between two non-stationary variables, arrives in a greater p value. It indicates that we can accept Ho and it follows that Yield on gold investments and Yield on capital investments are not co integrated. Rhos is the change in yield on capital investment based on the impact of yield on gold investments. As it is 0.33, it can be interpreted that there is no much impact on yield on capital investments based on yield on gold investments. A coefficient of 0.04 defines the impact of yield on gold investments on yield on capital investments. Moreover, p value is more or less equal to 0.05. So yield on gold investments and yield on capital investments are not cointegrated.

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