Relationship between Economic Development and General Insurance in India: Co-integration and Causality Evidence

Mahesh Chand Garg* and Deepti**

*Reader, Haryana School of Business, Guru Jhambheshwar University, Hisar
**Research Scholar, Haryana School of Business, Guru Jhambheshwar University, Hisar

Abstract

The present study discerns the relationship between GDP and the general insurance premium by employing Johansen Co-integration test, Granger Causality test and Vector Auto Regression (VAR) for the period 1973-74 to 2005-06 for India. The Impulse Response Functions (IRF$_s$) have also been used to investigate the effect of an impulse shock of one of the innovation on the current and future values of the same or other time series variable. Johansen Co-integration test results do not provide evidence of a long-run causal relationship between GDP and general insurance premium. Granger test established unidirectional causality from general insurance premium to GDP confirming the unquestionable importance of general insurance in nation's growth. VAR results indicate that growth in GDP cause general insurance premium to increase in short term period. Further, the effect of the increase in general insurance premium can be seen to effect the GDP positively only after a lag of one year. IRF graphs shows that there is a transient response immediately or after some lag on the application of a positive shock (impulse) which gradually dies out.

INTRODUCTION

The relationship between the growth of financial system such as insurance sector and economic development has gained great deal of importance in modern economic system. Insurance sector facilitates economic activities by the process of pooling and transferring of risks and indemnification, thereby enabling to carry out commerce and entrepreneurial activities and boosting the financial confidence. Insurance ensures the stable and smooth functioning of economic development by encouraging loss mitigation. Insurers also acts as the intermediaries by investing the funds into Government and socially oriented sectors and stock market and thus contributing to nation's growth. However, the relationship between economic development and general insurance sector is not single sided. The growth in economy too directly contributes to the development in insurance sector. As the economy grows, the insurance premium also get boosted up with the increase in trade, better standard of living and entrepreneurial activities.

The purpose of this research paper is to investigate the relationship between Gross Domestic Product (GDP) and general insurance premium in India for the period 1973-74 to 2005-06. The remainder of this paper is as follows: The following section describes the research methodology used in the study. The next section provides the correlation between economic development indicators and premium underwritten under various general insurance categories. The subsequent section deals with empirical assessment of interdependence between GDP and general insurance premium in India and the final section provides the concluding annotations.

RESEARCH METHODOLOGY

With the growing complexities in the modern economic system, the performance of insurance sector and economic development is highly interdependent. The causality direction between the two is a highly debatable and interesting topic. There are two theories describing the direction of causality namely supply-leading theory and demand-following theory. Supply-leading theory assumes the development of financial sector, here insurance, as the prerequisite for the economic development. In contrast to this, demand-following theory considers the development of the financial sector as the direct and obvious outcome of the economic development.

An attempt is made to empirically analyze dependence between development of insurance sector and the Indian economy. The research paper investigates the relationship between GDP and general insurance premium in India for the time period 1973-74 to 2005-06. For the purpose of analysis the term 'GDP' used is at constant price. General insurance premium series is obtained by adjusting the premium at current price with GDP deflator. Both the series represents the annual data. Since there is a significant difference in the range of the two series, all the tests are applied on their natural log transformations. Data is complied from various issues of Annual Reports of general insurers, IRDA Annual Reports, Malhotra Committee Report and RBI database.

In order to establish the relationship between economic development indicators and premium underwritten under different general insurance categories, Pearson's correlation coefficient has been calculated. The correlation between the investment by general insurers and the economic growth as indicated by GDP is also analysed. In addition, Granger Causality Test, Augmented Dickey-Fuller Test and Johnson Co-integration Test have been applied.

Granger Causality Test, Augmented Dickey-Fuller Test and Johnson Co-integration Test

Granger Causality test is employed for determining the direction of causality between GDP and general insurance premium. The test uses the linear regression modeling of the stochastic processes.

Mathematically,

$$X(t) = \sum_{j=1}^{L} A_{11,j} X(t-j) + \sum_{j=1}^{L} A_{12,j} Y(t-j) + E_x(t)$$

$$Y(t) = \sum_{j=1}^{L} A_{21,j} X(t-j) + \sum_{j=1}^{L} A_{22,j} Y(t-j) + E_y(t)$$

where, L is the maximum number of lags (order).

Granger Causality test depending on the time series X and Y can give any of the following results:

Case 1: Y causing X. In this case change in X has no effect on Y but change in Y makes X to change.

Case 2: X causing Y. In this case change in Y has no effect on X but change in X make Y to change.

Case 3: Bilateral causality. In this case both the time series are interdependent.

Case 4: Independence. This is the case where none of the variable depends on the other.

It is in principle to predict a variable in a time series X from the past values of another time series Y in addition to the past values of same series X. This essentially means that the two time series needs to be stationary to allow such prediction. However, in case the two are not stationary, they are made so by inserting appropriate level of differencing before applying the test. Augmented Dickey-Fuller (ADF) test is used to establish the order of integration and the degree of differencing to introduce stationary. The null hypothesis in ADF test is that there exists a unit root and the time series is non-stationary. The lag is chosen at minimum Akaike Information Criteria (AIC) value. Co-integration means some linear combination of the two series must be stationary. This can be tested by using Johansen Co-integration test. To satisfy this test the probability likelihood value should be lesser than that of critical value. The lag value calculated from ADF test is used for determining co-integration in Johansen test.

Vector Auto Regression and Impulse Response Functions

The mathematical dependence of one time series over another can be obtained by unrestricted Vector Auto Regression (VAR) or restricted Vector Error Correction (VEC) model. This choice of VAR or VEC model depends on the fact that whether the two time series are co-integrated at least, if not stationary. If the two series are not co-integrated restricted VEC model cannot be applied. However, in this case VAR model is used to mathematically represent the system.

VAR is commonly used for predication of interrelated time series and for analyzing the impact of random disturbances on the system. Mathematically, VAR is represented by:

$$y_t = A_1 y_{t-1} + ---- + A_p y_{t-p} + Bx_t + \varepsilon_t$$

where, y_t is vector of endogenous variables, while x_t is exogenous variable vector. ε_t is innovation vector uncorrelated with x_t and lagged values of itself and y_t. A_1 ---- A_p and B are matrices of coefficient to be estimated.

The Impulse Response Functions (IRFs) have also been employed to investigate the effect of an impulse (shock) of one of the innovations on the current and the future values of the same or the other time series variable.

The following are the hypothesis of the present research paper:

1. The null hypothesis in ADF test is that there exists a unit root.
2. The null hypothesis of Johansen Co-integration test is that series are not co-integrated.
3. The null hypotheses examined by the Granger test in the research paper are: (a) DLPREM does not Granger cause DLGDP and (b) DLGDP does not Granger cause DLPREM. LPREM stand for natural log transformation on real general insurance premium and LGDP stand for natural log transformation on real GDP.

Economic Development Indicators and Component-wise Premium

The general insurance business is divided into various categories for the purpose of comparative analysis with various economic development indicators. The general insurance premium is classified into fire insurance, marine insurance, motor insurance and mediclaim insurance premium. Similarly, for the economic development, the indicators selected are industrial production, exports, number of registration of vehicles and human development index. The relation between the general insurers' investments and the economic development, as indicated by gross domestic product has also been analyzed.

General insurance industry plays a vital role in the process of industrial development and

development of entrepreneurship. During all phases of production, starting from raw material to finished goods, both infrastructure and the product are exposed to several risks. The general insurance industry, in addition to providing financial covering for such risks, provides skills and prevention techniques to minimize the losses. In high risk prone areas, the general insurance companies even monitor the measures regularly taken by the insured to minimize the accidents. With such financial confidence, the entrepreneurs need not fear financial instability or maintain large reserve for any unaccounted and uninsured

losses. This encourages the expansion of business by directing funds to more productive uses. Table 1 shows the comparative analysis of industrial production and fire insurance premium in India. High correlation value of 0.987 speaks about the eminent relationship between industrial production and fire insurance premium. The relation between the industrial production development and the consumption of fire insurance premium, limned by Figure 1 clearly reflects the presence of linear relationship among variables.
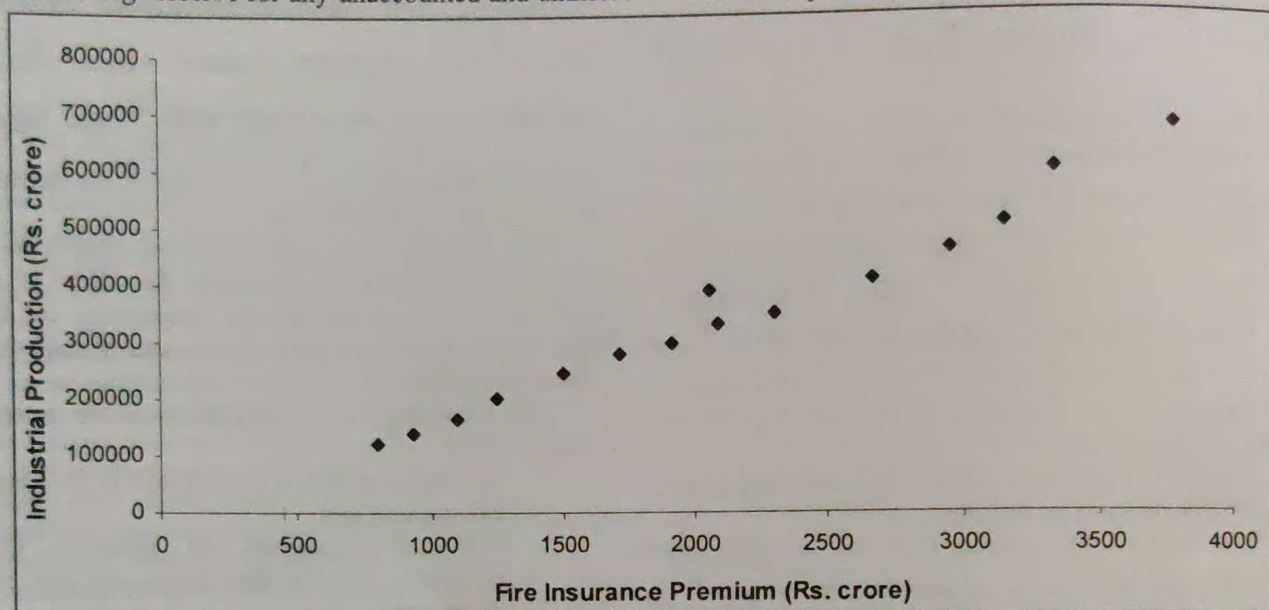

Fig. 1: Fire Insurance Premium and Industrial Production

TABLE 1: ECONOMIC DEVELOPMENT INDICATORS AND GENERAL INSURANCE PREMIUM

Year	GDP (Rs. Crores)	Investment (Rs. Crores)	Industrial Production (Rs. Crores)	Fire Premium (Rs. Crores)	HDI	Mediclaim Premium (Rs. Lakhs)	Vehicles Registered (Thousand)	Motor Premium (Rs. Crores)	Exports (Rs. Crores)	Marine Premium (Rs. Crores)
1991-92	594168	6335	121918	795	N.A	N.A	N.A	N.A	44042	634
1992-93	681517	7640	142566	932	N.A	N.A	N.A	N.A	53688	771
1993-94	792150	9030	165663	1096	N.A	N.A	N.A	N.A	69751	832
1994-95	925239	10486	202888	1248	N.A	N.A	N.A	N.A	82674	827
1995-96	1083289	12833	248450	1501	N.A	N.A	N.A	N.A	106353	961
1996-97	1260710	14893	280247	1719	N.A	N.A	N.A	N.A	118817	991
1997-98	1401934	17276	300389	1916	N.A	N.A	N.A	N.A	130101	1126
1998-99	1616082	19739	332464	2087	N.A	N.A	N.A	N.A	139753	1023
1999-00	1786526	22659	350233	2299	0.571	37583.02	N.A	N.A	159561	977
2000-01	1925415	24009	392138	2057	0.577	51898.19	54991	3811	203571	950
2001-02	2100187	19574	410667	2667	0.590	74204.45	58924	4001	209018	1053
2002-03	2265304	21859	463302	2950	0.595	99955.08	67007	5441	255137	1215
2003-04	2549418	24227	509106	3150	0.602	112925.85	72718	6457	293367	1118
2004-05	2855933	26519	598674	3331	0.611	132117.26	81715	7504	375340	1228
2005-06	3250932	29803	676207	3774	0.619	163442.29	90621	8702	456418	1284
Correlation	0.958		0.987			0.995		0.996		0.859

Source: Various issues of RBI Annual Reports, Annual Reports of general insurers, IRDA Annual Reports, Data from Department of Road Transport and Highways, GOI and Society of Indian Automobile Manufacturers (SIAM), Human Development Index Report.
Note: Mediclaim premium represents the premium of public insurers only.
N.A: Not Available

With the rapid growth in the medical technology and increase in medical cost, the health care has turned as highly expensive function and treatment expenses particularly involving hospitalization have become

unaffordable to the masses. By the health insurance, such a risk can be pooled among the large set of individuals through indemnification, otherwise cost could be catastrophic. Individual health insurance also

reduces the Government burden of public health expenditure. On saving this expenditure, the same fund can be utilized for development elsewhere, thereby improving the standard of living directly or indirectly. For such reason health insurance is recognized as the class of utmost importance for the individuals and thus forms the only category in general insurance, where tax benefit is given for its premium. Table 1 compares the mediclaim insurance premium and Human Development Index (HDI). Most of the contribution in health insurance comes through mediclaim policy, which covers the expenses during hospitalization. HDI summarizes the measurers of human development, broadly comprising of life expectancy, literacy and standard of living. Correlation value of 0.995 depicts the firm relationship between mediclaim insurance premium and HDI. Figure 2 further shows that mediclaim insurance premium and HDI have grown linearly over the years.
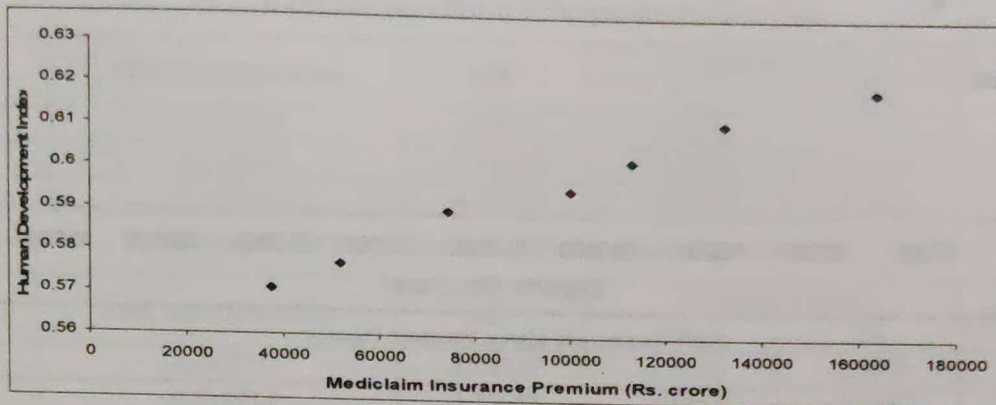

Fig. 2: Mediclaim Insurance Premium and Human Development Index

With the increase in purchasing power and amount of demand for automobiles almost matching with that of supply during the past few years, India has witnessed a rapid growth in registration of motor vehicles. The motor insurance being compulsory in India for third party, the insurance industry has directly gained from this scenario and has observed an almost similar growth in total motor insurance premium. Table 1 shows that increase in the number of vehicles in a nation is highly correlated with growth of motor insurance premium, correlation value being 0.996. Further, Figure 3 depicts that number of vehicles registered in India and motor insurance premium have grown in concert over years.
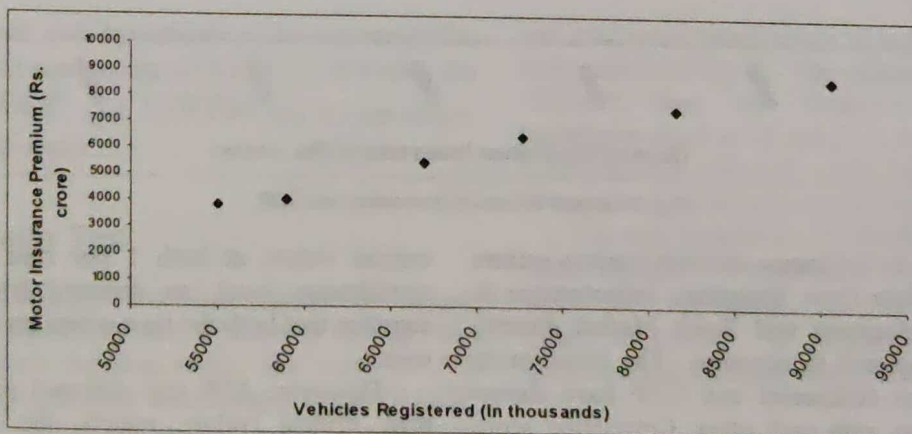

Fig. 3: Vehicles Registered and Motor Insurance Premium

Marine insurance is broadly composed of two categories namely hull and cargo. Since the losses in case of uninsured marine accidents can be huge, it is always preferred to insure both hull and cargo. This way amount of marine insurance premium directly relates with that of marine transportation. As the large portion of India exports is through sea route, Table 1 shows the high correlation of 0.859 among the exports and marine insurance premium. Further, Figure 4 depicts the impregnable linear relationship between exports and marine insurance premium.

The insurance companies receive premium for providing the covers and carrying out underwriting business. This way, insurance companies amass huge funds which are to be properly invested. General insurers build up such large pools of funds that are known as economy's investment reservoirs'.
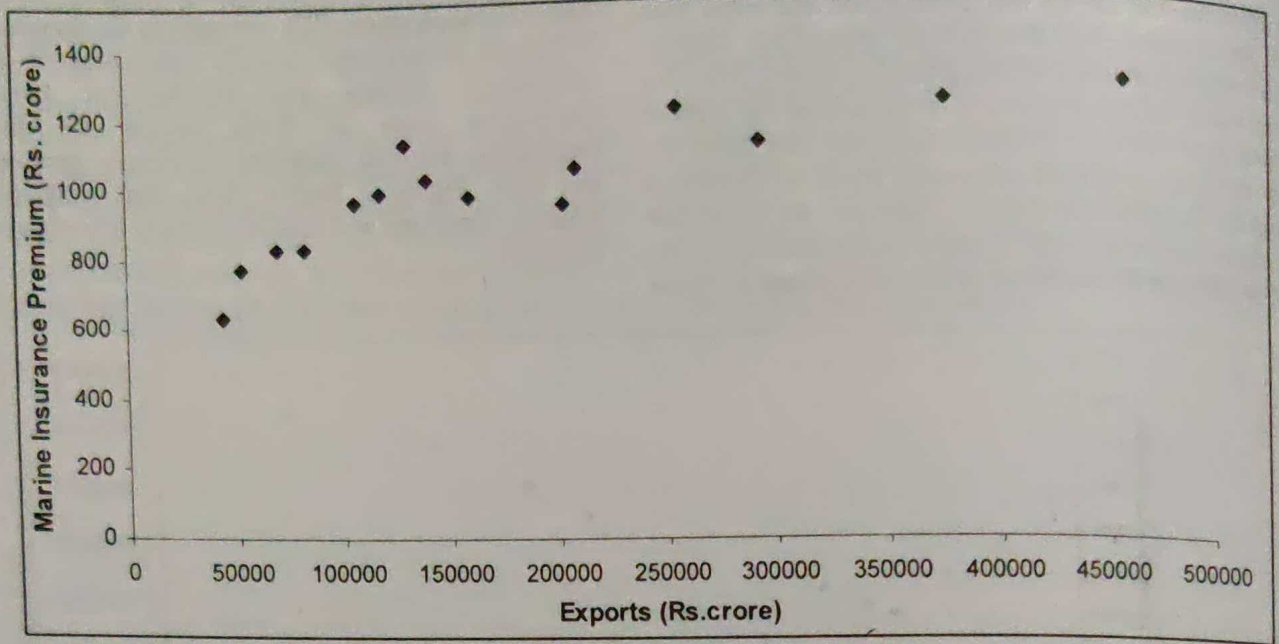
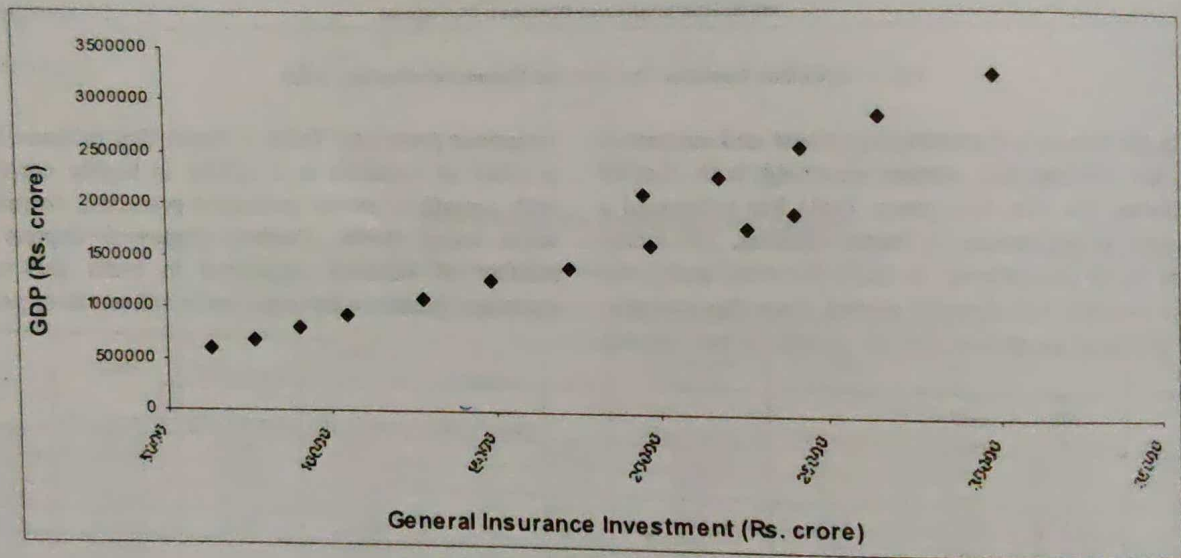Fig. 4: Exports and Marine Insurance Premium

Fig. 5: General Insurance Investment and GDP

The investment by insurance sector in various sectors such as Central & State Govt. Securities, Infrastructure & Social Sector Development and Stock Market directly signifies the development in economy. The investments by general insurance companies and GDP have shown inviolable correlation with each other. Correlation score among the variables stood at 0.958 as indicted by Table 1. Further, Figure 5 portrays the linear relationship among investments by general insurance companies and GDP.

Interdependence between Economic Development and General Insurance

Augmented Dickey-Fuller and Johansen Co-integration Tests

Satisfying ADF test for both the series is the first prerequisite for Granger Causality test. ADF test null hypothesis has been accepted at level for both the time series at all the lags, as ADF test statistics is greater than

critical values at both 1 per cent and 5 per cent significance level, as depicted by Table 2. This signifies that both the time series are non-stationary at level.

However, ADF test statistics value being lower than critical value, rejects the null hypothesis suggesting that both LGDP and LPREM are stationary at first difference. Table 3 discerns that at first difference of LGDP, lag 0 and 1 are the only two lags where null hypothesis can be rejected. Since the AIC value is lower at lag 1, 1st difference at lag 1 is selected for LGDP. The null hypothesis for LPREM at 1st difference is rejected for all the lags from 0 to 3 (Table 4). AIC value being minimum at lag 1, LPREM is also selected at lag 1 of 1st difference time series.

TABLE 2: ADF TEST AT VARIOUS DIFFERENCES (LAG 0)

Difference	ADF Test	LGDP*	LPREM**	Critical Values at	
				1%	5%
Level	Statistics	1.686219	-0.030705	-3.6496	-2.9558
	Null Hypothesis	Accept	Accept		
1st Difference	Statistics	-6.977657	-6.36271	-3.6576	-2.9591
	Null Hypothesis	Reject	Reject		

* LGDP stands for natural log transformation on real GDP.

** LPREM stands for natural log transformation on real general insurance premium.

TABLE 3: ADF TEST FOR LGDP AT 1ST DIFFERENCE (VARIOUS LAGS)

Lag	ADF Test Statistics	AIC	Critical Value		Null Hypothesis
			1%	5%	
0	-6.977657	-4.1045	-3.6576	-2.9591	Reject
1	**-4.232672**	**-4.11275**	**-3.6661**	**-2.9627**	**Reject**
2	-2.470587	-4.09822	-3.6752	-2.9665	Accept

TABLE 4: ADF TEST FOR LPREM AT 1ST DIFFERENCE (VARIOUS LAGS)

Lag	ADF Test Statistics	AIC	Critical Value		Null Hypothesis
			1%	5%	
0	-6.36271	-3.16327	-3.6576	-2.9591	Reject
1	**-5.174413**	**-3.25653**	**-3.6661**	**-2.9627**	**Reject**
2	-3.473699	-3.14747	-3.6752	-2.9665	Reject
3	-3.79316	-3.19401	-3.6852	-2.9705	Reject

Johansen Co-integration test is applied on LGDP and LPREM series for testing long term relationship at the lagged values computed from ADF test.

TABLE 5: JOHANSEN CO-INTEGRATION TEST

r	Trace Statistics	5% Critical Value	1% Critical Value
0	8.93	15.41	20.04
1	0.61	3.76	6.65

Acceptance of null hypothesis of no co-integration ($r = 0$) and one co-integrating vector ($r = 1$) provides the evidence that LGDP and LPREM are the set of non co-integrated time series.

Granger Causality Test

The Granger Causality test investigates the causal relationship between LGDP and LPREM at the lag value of 1 and 2 for both the time series. The value for AIC criteria for 'DLPREM does not Granger cause DLGDP' stood at 70 and 62 at the lag value of 1 and 2 respectively and AIC value being lower at lag 2, Granger test has been tested for lag 2. The value for AIC criteria for 'DLGDP does not Granger cause DLPREM' hypothesis stood at 51 and 50 at the lag value of 1 and 2 respectively and AIC value being lower at lag 2, Granger test has been tested for the same lag value 2.

The null hypothesis 'DLPREM does not Granger cause DLGDP' is rejected at 5% significance value while null hypothesis 'DLGDP does not Granger cause DLPREM' is accepted. This gives the unidirectional causality from premium to GDP.

TABLE 6: GRANGER CAUSALITY TEST

Null Hypothesis	F-test	Probability	AIC
At Lag 1			
DLPREM does not Granger Cause DLGDP	5.49	0.02	70
DLGDP does not Granger Cause DLPREM	0.109	0.743	51
At Lag 2			
DLPREM does not Granger Cause DLGDP	3.96	0.049	62
DLGDP does not Granger Cause DLPREM	0.0006	0.99	50

Vector Auto Regression

The two time series being neither stationary nor co-integrated as established by ADF test and co-integration test, first difference of time series is used in analyzing

VAR. VAR behavior between premium termed as 'LPREM' and GDP termed as 'LGDP' is described by the following relationship:

$$D(LPREM) = 0.038 * D(LGDP(-1)) - 0.138 * D(LGDP(-2)) + 0.112 * D(LPREM(-1))$$
$$- 0.211 * D(LPREM(-2)) + 0.102$$

$$D(LGDP) = 0.097 * D(LGDP(-1)) - 0.0961 * D(LGDP(-2)) - 0.242 * D(LPREM(-1))$$
$$+ 0.195 D(LPREM(-2)) + 0.055$$

The result indicates that general insurance premium is dependent on GDP at lag value of 1, but GDP value at lag 2 negatively effects premium. This depicts that growth in GDP causes premium to increase only in very short run. In contrast to this, effect of increase in premium can be seen to positively affect the GDP at lag value of 2, while it shows a negative effect for very short run as shown for lag 1.

VAR also allows further analyzing the system by generating Impulse Response Functions (IRFs). These graphs essentially shows the effect of an impulse shock of one of the innovation on the current and future values of the same or other time series variable.

All IRF graphs at lag 2 shown in Figure 6 indicates that there is a transient response immediately after application of a positive shock (impulse) which gradually dies out. Analyzing the effect of impulse of premium on GDP is on the lines of the causal relationship indicated by

Granger Causality test. GDP does not show any effect to impulse of premium initially and then increases and finally dies out in an oscillatory manner. This is quite intuitive also as the economic development is not affected immediately by the increase in insurance but shows a lagged response. Thus result obtained by the IRFs is consistent with result shown by co-integration test, both of which indicate that there does not exist long-term relation among the general insurance premium and GDP. (Figure 6(b))

Further, results gathered by VAR equations are also in line with the IRFs, both of which shows that increase in GDP, cause GDP to increase only initially and effect of increase dies out afterwards as indicated by Figure 6(a). Figure 6(b), shows that, increase in premium cause GDP to increase after gap of some time, same is indicated by VAR equation.
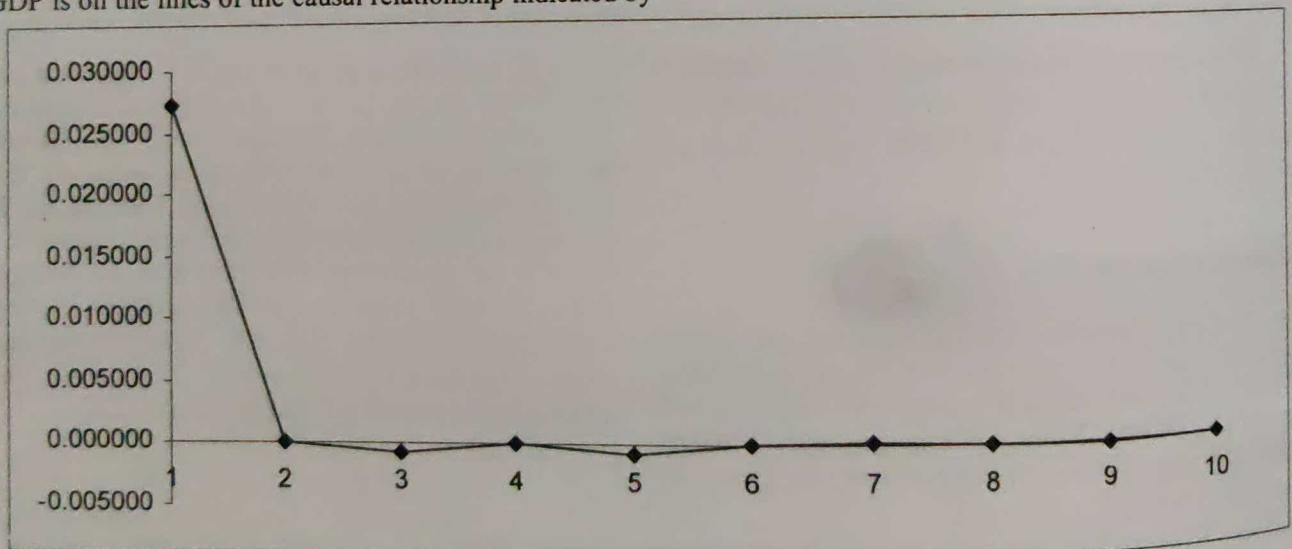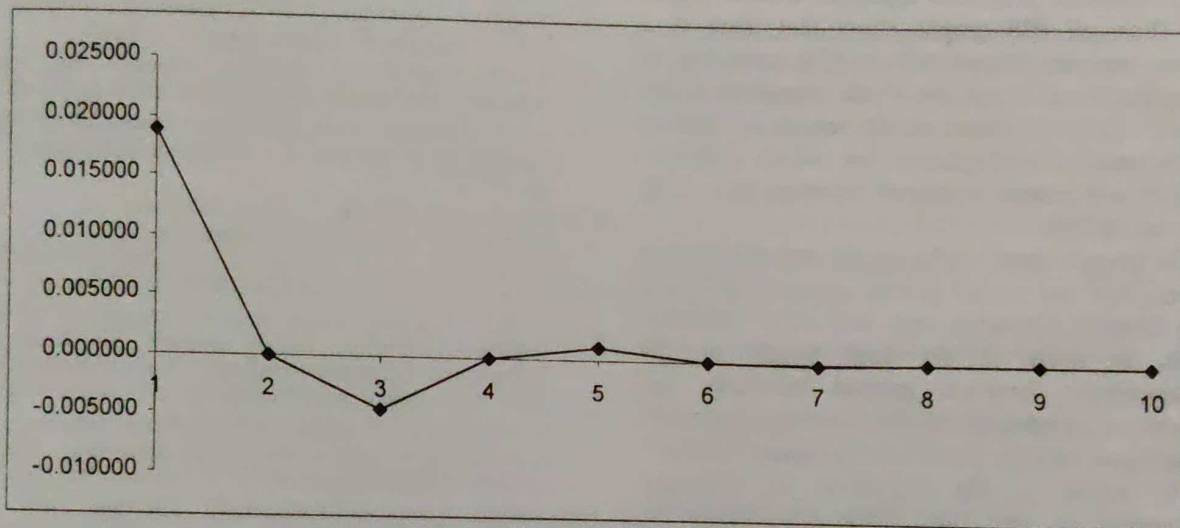

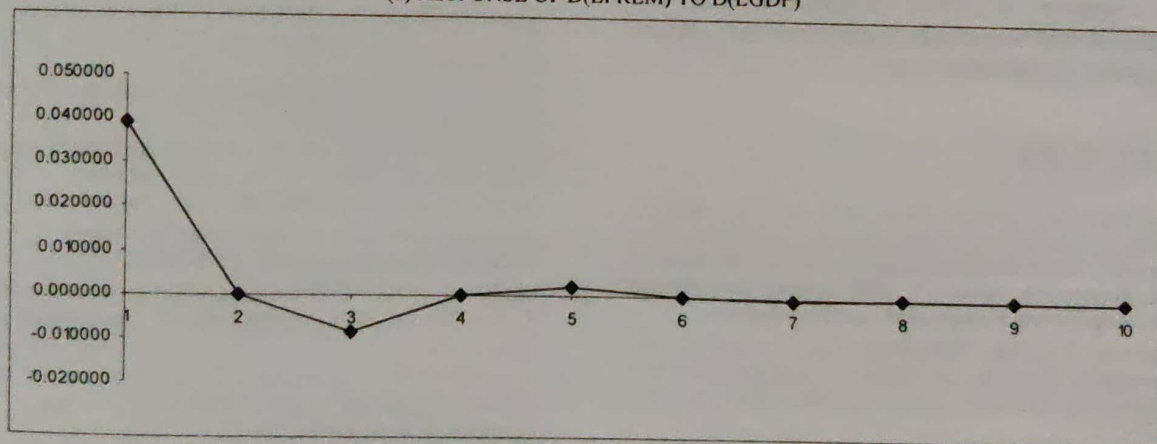(a) RESPONSE OF D(LGDP) TO D(LGDP)
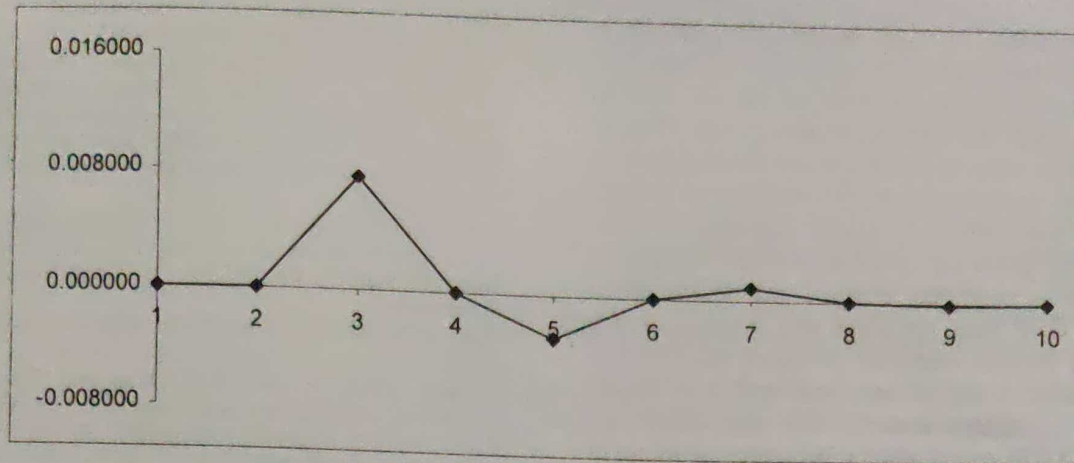
(b) RESPONSE OF D(LGDP) TO D(LPREM)

Figure 6(c) highlights that increase in GDP cause premium to increase only initially and same is indicated by VAR. Figure 6(d), highlights that increase in premium cause premium to increase initially but dies out soon.

(c) RESPONSE OF D(LPREM) TO D(LGDP)

(d) RESPONSE OF D(LPREM) TO D(LPREM)

Figure 6: Impulse Response Function Graphs

CONCLUSION

The analysis unveiled that economic development indicators like industrial production, exports, number of registration of vehicles and human development index are strongly correlated with fire insurance, marine insurance, motor insurance and mediclaim insurance premium respectively. The research paper discerns the causal relationship between the general insurance premium and GDP by employing Granger Causality test. Analysis reveals that there exists unidirectional causality from general insurance premium to GDP. Johansen Co-integration test applied on GDP and general insurance premium divulges that there exists no long term relationship between the two variables. Further,

the result obtained by VAR indicates that growth in GDP causes premium to increase only in short run. The effect of increase in premium can be seen to positively affect the GDP only after a year. This is quite intuitive also as the economic development is not affected immediately by the increase in general insurance but shows a lagged response. IRFS extracts that given the positive impulse (shock) of GDP; GDP is positively effected and decays down gradually. GDP does not show any response to the impulse of general insurance premium initially, but increases after a lag of one year and then finally decays in oscillatory manner. IRF also infers that impulse of GDP causes general insurance premium to increase only for a short period. Further, impulse of general insurance premium also results in increase of general insurance premium, again for a short period only. Thus, all IRF graphs show that there is a transient response immediately or after some lag on the application of a positive shock (impulse) which gradually dies out. These results are in accordance with Johansen Co-integration test which indicates that GDP and general insurance premium lacks long term relationship.

The present paper works out the interrelationship between GDP and overall general insurance premium using Granger Causality test and other statistical models. In order to get deep insight on the interdependence between general insurance and economic development of the country, industrial development, exports, human development index etc. can be taken as the indicators of economic development on one side, while considering the various categories of general insurance such as fire insurance, marine insurance, export insurance, health insurance etc. on the other side.

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