

# A Framework for assessing performance sensitivity of select KPIs for General Insurance companies in India using Risk Management Dashboard Approach

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## ABSTRACT

Operational efficiency plays a crucial role in the functioning of a company. It drives the factors that lead to growth, profitability and sustainability. These form the basis for performance metrics known as the key performance indicators (KPIs). KPIs bridge the gap between the idea of performance and a means to measure the same. This paper concentrates on building a framework that evaluates the performance of a company using these KPIs in the following stages.

Stage1: Defining the KPIs. In this stage, we define the indicators that measure performance and those that impact performance. For those variables impacting performance, we propose whether their relationship with the performance is positive, negative or indeterminate.

Stage2: Data extraction. This stage is about extracting the data from the public disclosures of the companies to calculate the indicators that have been established in stage 1.

Stage 3: Measuring the KPIs. Having the KPIs and the data in place, we formulate a means to quantify them so that they can be carried forward into the model in which they must be fit.

Stage 4: Arriving at the sensitivity of the performance with respect to the KPIs. Once a model is fit, the outputs will give us the sensitivity of the KPIs measuring the performance relative to those impacting the performance.

Stage 5: Reflecting the results in a risk management dashboard for making appropriate executive decisions.

In this work, at a company level, the analysis was carried out for three different non-life insurers in India. The analysis was also done across the companies i.e., at an industry level. For this, we included six different non-life insurers in India. The period of investigation was from 2010-11 Q1 to 2018-19 Q2. Using the stated approach, we reported the results obtained in the form of a risk management dashboard which provided a platform to compare the performance across different companies in the industry.

From the dashboard we inferred that the value of  $R - squared$  is high for the individual companies and low for the companies combined. However, for all the results, p-value for the t-test on parameters is high. This means that we have no sufficient evidence to reject the null hypothesis that the

corresponding independent variable plays no role in estimating the outcome under the model. The error terms for the individual companies pass the test of normality as given by Shapiro-Wilk test.

## KEY WORDS

Key Performance Indicators, Operational Efficiency, Panel Data, Sensitivity of Performance, Dashboard, Unexpected Inflation, Interest rate change, Interest rate level, Equity returns, Underwriting cycle, Company size, Reinsurance dependence, Leverage, Affiliated investments, Solvency margin, Stability of underwriting operation, Liquidity, Stability of asset structure, Underwriting profits, Insurer type.

## 1 Introduction

When dealing with operational efficiency it is necessary to convert abstract ideas and qualitative aspects of performance into those that can be gauged mathematically. As we progress through the paper we will see how this can be done using metrics called Key Performance Indicators (KPIs). KPIs measure the performance of a given process which is being monitored. There are different KPIs which monitor a company's performance. They depend on the industry, the line of business, geographical locations and many other factors. In this work we consider about 18 KPIs that have been referred from (Shiu, 2004). These are broadly divided into two categories: three of which measure the performance and the remaining 15 impact the performance of the company at different levels of operations. This establishes the relationship between these two categories of the KPIs and will enable us to actually see the sensitivity of the performance of the company with regard to each of the KPIs considered. In this work, at a company level, the analysis was carried out for three different non-life insurers in India. The analysis was also done across the companies i.e., at an industry level. For this, the analysis was carried out for six different non-life insurers in India. Using the approach stated in the methodology, we reported the results obtained in the form of a risk management dashboard which provided a platform to compare the performance across different companies in the industry.

This research work is organized into 10 sections. Section 2 explains the motivation behind this work and presents potential benefits. Section 3 explains the concept of the Key performance indicators (KPIs) and outlines a methodology to obtain these KPIs for a company. Section 4 depicts the framework for assessing the performance sensitivity of select KPIs for General Insurance companies using Risk Management Dashboard Approach. It then defines the KPIs considered in this work and also gives the mathematical formulae to calculate the same. Section 5 tabulates the results of this work. It presents the results of the industry as a whole, as well as that of the individual companies to enable comparison. It also elucidates the limitations of this work. Section 6 highlights the benefits of incorporating the results in a risk management dashboard. Section 7 discusses the conclusions based on the results. Section 8 indicates the future work that will be carried out. Section 9 acknowledges the various experts, contributors and the infrastructure provided by SSSIHL. Section 10 provides all the references used in this paper.

## 2 Motivation

The insurance industry acts as a cushion for every economy. It is therefore important for the industry to function in an effective and efficient manner so as to ensure the smooth running of the economy. In the

developed economies the GDP penetration of the insurance industry is about 8% as per the reports of (Gonzalez, 2018). When we talk about the Indian insurance industry we are looking at a composition of 59 insurance companies of which 24 are in the life insurance business and 35 are involved in the non-life sector. These include both public sector and private companies. India is an emerging insurance market in the world, where in the penetration of the Insurance sector in the form of premiums make about 3.69% of the country's GDP. The insurance industry in India has seen a slow yet a steady growth with time, from making about 2.71% of the GDP from premiums in 2001 to about 3.69% in the year 2017. The Indian insurance sector is expected to attain a market of \$280 billion by the end of the financial year 2020. These are the figures obtained from ([www.ibef.org](http://www.ibef.org)). In such a scenario it is expected that the industry operates at a high level of efficiency to meet the demands of the economy. Having a dashboard which compares the operational efficiency across companies using the KPIs will facilitate the key stakeholders to make appropriate decisions. This forms the rationale behind this work.

### **3 The Key Performance Indicators (KPIs)**

KPIs act as a heart for every report in the process of decision making. They help measure the performance of objectives both quantitatively and qualitatively. They form basis for projecting the trends based on the current performance and the external environment. They act as indicators with regard to a company's performance inside a report. They can be discrete, continuous, categorical and many more, depending on the underlying performance being monitored. We monitor a company's performance in different fronts in order to improve the operational efficiency of the company. The KPIs enable the company to closely monitor the areas where the performance needs to be improved.

#### **3.1 The process of obtaining the KPIs**

Firstly, list the main operations of the business. Under each operation, know what are the steps/stages involved. For each of these steps, it is necessary to identify the various risks that can be present. Since we are targeting performance improvements, it is ideal that we deal with only downside risks. Once we have the risks in place, we require a parameter that measures the risk. This step is crucial as only risks that can be measured can be dealt with using actuarial or statistical models. Having come up with the parameters, it is essential to check if the parameters are present in the public disclosures of the companies. If a parameter isn't present, then the information isn't public and hence leads to difficulty in extracting information. Having the parameters in place, they can be grouped together to form the Key Performance Indicators. These determine the relationship between a company's operations and its performance. Now, the KPIs we obtained will be of two broad categories - ones obtained from the best practices around and the ones obtained from the data available. They can also be put into the following two categories: company specific variables and economic variables. KPIs will form the set of explanatory variables for the variables that measure performance.

## 4 A framework for analyzing the sensitivity of the performance

This section concentrates on developing a holistic framework for analyzing the sensitivity of the performance with respect to the individual KPIs. This will be done for both individual firms as well as the industry as a whole. The framework for assessing the performance sensitivity of select KPIs for General Insurance companies using Risk Management Dashboard Approach is depicted in the Figure 1.

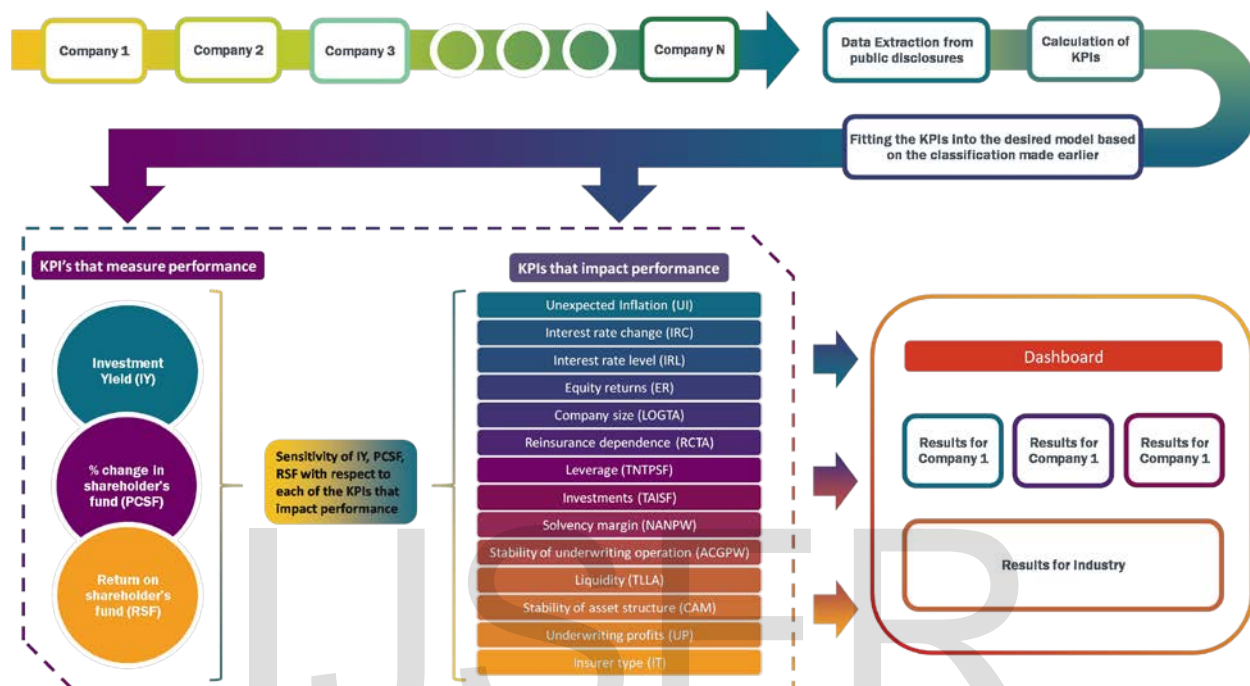


Figure 1: The framework for assessing the performance sensitivity of select KPIs for General Insurance companies using Risk Management Dashboard Approach

The following sub sections explain the framework in detail.

### 4.1 Selected companies for pilot study

When considering the Indian scenario, it essential to note that the IRDAI is the governing body for the insurers in India and all must report their public disclosures to the IRDAI. For the purpose of conducting a pilot study, we selected six companies from the non-life sector in India, namely:

- Aditya Birla Health Insurance
- Apollo Munich
- Bajaj Allianz
- Cholamandalam
- Cigna TTK
- General Insurance Corporation of India

It is important to note that the framework applies in general to all the companies and can be extended from the work done on the above companies.

## 4.2 The Independent Variables

The KPIs as mentioned earlier are those variables that have a direct impact on the company's performance. It is now necessary to describe what these KPIs are and what their relationship with the performance is. The Table 1 lists the variables, what operations or items in the disclosures stand affected and what is the relationship with the performance.

Table 1 : KPIs and their relationship with performance

S No.	Determinants of performance	What stand affected	Relation with performance
1	Unexpected Inflation	Claims Expenses Provisions	Negative
2	Interest rate change	Assets Liabilities Claim costs	Depends on the duration of assets and liabilities - Reddington's immunization theory
3	Interest rate level	Investment earnings	Positive
4	Equity returns	Investment earnings	Positive
5	Underwriting cycle	Underwriting profit	Indeterminate
6	Company size	Costs(due to economies of scale)	
7	Reinsurance dependence	Profits	Negative
8	Leverage	Equity	Positive until the optimum capital structure is reached, negative thereafter
		Debt	
9	Affiliated investments	Insolvency risk increases	Negative
10	Solvency margin	Reserves	Positive
11	Stability of underwriting operation	Premium rates	No prior expectation
12	Liquidity	Investments/Assets	Positive
13	Stability of asset structure	Assets	Positive
14	Underwriting profits		Positive
15	Insurer type	Business mix	Indeterminate

The above variables impact the performance directly. Their relationship with performance as stated above is only hypothesized and must be checked with suitable tests. The items that stand affected are those operations which must be acted upon based on the magnitude of the influence of the corresponding variable on the performance. We now explain each of the variables in detail and derive the methods of calculating these variables.

The variables mentioned can be broadly divided into two categories: Economic variables and Company specific variables. While the economic variables remain fixed for all the companies in a country, company specific variables vary across companies depending on its operations and performance.

#### 4.2.1 Unexpected Inflation (UI)

While a small degree of inflation boosts profits, unexpected inflation is that portion of inflation which hasn't been accounted for and hence can hamper the same. Hence it is reasonable to expect that it has a negative impact on the performance. The calculation of the unexpected inflation is given by:

$$UI = \text{Inflation rate} - \text{Interbank rate}$$

#### 4.2.2 Interest rate change (IRC)

The valuation of assets and liabilities of a company depend on the interest rates prevailing in the economy and are sensitive to small fluctuations therein. However, their impact on the performance cannot be directly captured as they depend on duration and convexity as well. These are given by Reddington's immunization conditions. The formula for the interest rate change is given by:

$$UI = \text{Inflation rate} - \text{Interbank rate}$$

#### 4.2.3 Interest rate level (IRL)

The interest rate level here refers to the bond yields offered by the government for long term bonds which are sold in open market operations conducted by the central bank, in case of India, Reserve Bank of India (RBI). The level of interest rates in the economy has an influence on the investment earnings. Higher interest rates boost the investment returns of the companies and hence have a positive impact on performance. They are measured as follows:

$$IRL = \text{Indian govt. 10 yr bond yield}$$

#### 4.2.4 Equity returns (ER)

Equities or shares are a form of investment that provide high returns and capital gains, but are subject to market risk. This is due to the volatility of the assets that render their prediction extremely difficult. Companies capitalize on this risk by use of active investment strategies that deviate from the benchmark index set by the management. Hence it is clear that an increase in the value of the equities or shares affects performance positively. The equity returns obtained can be measured based on any of the stock exchange data available.

$$ER = \text{Index of equity returns}$$

The company specific variables listed in the above table include the following:

#### 4.2.5 Company size (LOGTA)

The general connotation is that companies that are bigger perform better. But what does it mean to be big? To put it simply the company has more assets. More assets mean more sources of income. And more sources of income means greater profits which further means greater performance. This quantity is measured using the total assets of the company as follows:

$$LOGTA = \log_{10} TA$$

where ,

$$TA = \text{Total Assets}$$

#### 4.2.6 Reinsurance dependence (RCTA)

When accepting a risk, every insurance company seeks to do one of the following:

- Reject the risk
- Accept and retain the risk
- Accept and share the risk
- Transfer the risk

It is in the context of sharing or transferring the risk that reinsurance comes into picture. Reinsurance can be taken as a treaty or a facultative coverage. The kind of reinsurance can be proportional or an excess of loss basis or a combination. It can also have multiple layers. The nature and type of reinsurance to be selected depends on the needs of the insurer. Thus by opting for reinsurance the insurer can reduce his risk and operate efficiently. However, reinsurance also involves cost and this bites into the profits of the company. Hence as more risk is passed on to the reinsurer, it reduces the profits and hence has a negative relationship with the performance. This measured is captured as

$$RCTA = \frac{RC}{TA}$$

where,

$RC =$  Reinsurance ceded

$TA =$  Total Assets

#### 4.2.7 Leverage (TNTPSF)

It is a common practice in the insurance companies to maintain a reserve for any possible future claims that may arise. This practice is known as reserving. Reserves and provisions are a portion of the company's profit. Since the insurance companies hold these funds, they must provide for the policyholders in other forms, which come as discounts offered in premiums. An example of this includes the No-claims discount policies. A company in this process must seek to optimize its capital structure or financial leverage which is the ratio of debt to equity. A company's leverage will have a positive effect on the performance until it reaches its optimum capital structure and thereafter it will see a downturn. This leverage is measured as follows:

$$TNTPSF = \frac{TNTP}{SF}$$

where,

$TNTP =$  Total net technical provisions

$SF =$  Shareholder's funds

#### 4.2.8 Investments (TAISF)

Investments include those made in various government securities, debentures or bonds, other approved securities, etc. It is necessary to differentiate between investments and affiliated investments. Affiliated investments are those that are made in a subsidiary of the company. Therefore, depending on whether the investments are affiliated or non-affiliated the performance of the company is affected differently. The variable that measures investments is calculated as follows:

$$TAISF = \frac{TAI}{SF}$$

where,

$TAI =$  Total affiliated investments <sup>1</sup>

<sup>1</sup> In this paper we use investments instead of total affiliated investments due to the lack of availability of the former.

### 4.2.9 Solvency margin (NANPW)

Solvency is a measure of how solvent a company is. By solvent, we mean that a company's assets exceed its liabilities. The greater the margin, the greater is the ability of the firm to meet its long-term liabilities. Solvency is an indicator of the financial strength of a company. This makes it clear that the performance of a company has a direct association with the solvency. Here, the solvency margin is captured by the formula

$$NANPW = \frac{NA}{NPW}$$

where,

$NA = \text{Net assets}$

$NPW = \text{Net premiums written}$

### 4.2.10 Stability of underwriting operation (ACGPW)

Underwriting operations of a business determine the progress of a company and its development. But, it is not always the case that an increase in the underwriting operations leads to greater business and vice-versa. In fact, another factor that is closely associated with the underwriting operations of a business is the underwriting cycle. When the underwriting cycle is rated soft, the insurers are ready to accept more business and hence the coverage offered increases, which automatically pushes the premiums lower. When the underwriting cycle is hard, the case is exactly the opposite, i.e. coverage provided by the insurers is lesser as they are already exposed widely to the risk forces from the market. Subsequently, the premiums charged escalate. Therefore, the relationship between the stability of the underwriting operation and the performance of the company cannot strictly take one side. The stability of the underwriting operation is measured as:

$$ACGPW = \frac{NPW_t - NPW_{t-1}}{NPW_{t-1}}$$

### 4.2.11 Liquidity (TLLA)

While solvency speaks about how healthy a business is in the long run, liquidity talks about the financial well-being in the short run. When we say that an asset is liquid, it means that it can be converted to cash immediately with almost zero cost. Examples include cash, bank balances, short term investments, shares, etc. A company that is liquid will be able to meet its day-to-day obligations and hence give a satisfying service to both its suppliers and the customers. Hence it is natural that it has a positive relationship with the performance. It is calculated as a ratio of the total liabilities to liquid assets.

$$TLLA = \frac{TL}{LA}$$

where,

$TL = \text{Total liabilities}$

$LA = \text{Liquid assets}$

### 4.2.12 Stability of asset structure (CAM)

Asset structure of an organization is the distribution of various classes of assets that the organization holds. Stability of this structure means that there is no drastic change in the asset structure year to year. Suppose that there is a significant change, it would mean less if attributed to regulatory change. Else, it throws a red flag about the company's financial position. Hence, we would expect that a company's asset structure stability is directly linked to the increase in performance. This is expressed as follows:

$$CAM = \frac{\sum_{k=1}^n P_k}{n}$$

where

$$P_k = 100 \frac{A_t^k - A_{t-1}^k}{A_{t-1}^k}, k = 1, 2, \dots, n$$



$A_t^k = \text{Value of asset } k \text{ at time } t$

In other words, the formula basically expresses the average of the percentage change in the various asset accounts, here, we choose them to be cash, property, equities, bonds, other assets, prepayments, etc.

### 4.2.13 Underwriting profits (UP)

Underwriting profits of an insurer refer to the profits that arise from the core business activity, i.e. premiums and claims. It is the difference between the premiums received from various customers and the claims incurred along with the expenses involved in both the stages. High underwriting profits of a company imply that the company is able to manage its risks efficiently. And this efficiency is what a company seeks. Hence, there exists a positive relationship between the company's underwriting profits and the performance. It is calculated as follows:

$$UP = NPE - NCI - NOE + AD - CTP - IPUR + OTI$$

where

$NPE = \text{Net premiums earned}$

$NCI = \text{Net claims incurred}$

$NOE = \text{Net operating expenses}$

$AD = \text{Adjustments for discounting}$

$CTP = \text{Changes in technical provisions}$

$IPUR = \text{Increase in provision for unexpired risks}$

$OTI = \text{Other technical income}$

### 4.2.14 Insurer type (IT)

Every non-life insurer can be classified into one of the four categories mentioned below:

- Specialist general insurer
- Multi-line company (combining risks)
- Composite firm (both life and non-life)
- Reinsurer

A specialist general insurer is a firm that offers insurance cover for risks other than life. It is also known as property and casualty. It comprises of fire, marine, motor, travel, health and house insurance and many more.

A multi-line insurer is one who combines risks and offers products that cater to various needs. An example would be to bundle motor and health insurance under one product. The combined product costs lesser and is much more attractive. But, it makes the prediction of risk more complex.

A composite firm is one that operates in both the life and non-life areas. It has advantages of cross-selling general insurance products to the policyholders already having a life insurance contract.

A reinsurer is a company whose customers are insurance companies. As mentioned earlier, insurers sometimes take upon risks that they may want to share or transfer. The reinsurers aid the insurers in such a process.

From observation of the performance of a company, it is not clear as to whether a certain type of insurer has higher performance ability than the others. Hence, the relationship with performance is indeterminate. This variable is measured as a factor variable as it is an attribute. It is given by:

$$IT1 = \begin{cases} 1, & \text{if multi-line general insurer} \\ 0, & \text{otherwise} \end{cases}$$

$$IT2 = \begin{cases} 1, & \text{if composite insurer} \\ 0, & \text{otherwise} \end{cases}$$

$$IT3 = \begin{cases} 1, & \text{if reinsurer} \\ 0, & \text{otherwise} \end{cases}$$

### 4.3 The dependent variables

Throughout the discussion in the previous section, we have come across the relationship of the independent variable at hand with performance, whether positive or negative. We have so far defined what those variables are and how they impact performance. The question now arises as to what it means when we say that a company is performing well. How is the performance going to be measured? In this section, we define three variables that we will be monitoring to track performance. These depend on the aforementioned variables and hence are called dependent variables:

#### 4.3.1 Investment yield (IY)

Let us start with a situation.

*Situation 1*

Suppose that we have invested a sum of `1000 in a security. How is it that we measure whether the security is performing well or not? Let us say after one year, its value is `1100. Then we can say that we have had a gain of `100 or a gain of 10% on the initial amount. This percentage increase in the value of the security is known as yield. This when applied to a bundle of investments is called as investment yield. Since insurance companies invest their incomes in various classes of assets, the performance of these assets is a proxy for the performance of the company. We measure the investment yield as follows:

$$IY = 100 \frac{NII}{0.5 \times (TA_t + TA_{t-1})}$$

where,

$NII =$  Net investment income

$TA_t =$  Total assets at time  $t$

#### 4.3.2 Percentage change in the shareholders' funds (PCSF)

In general, a company's performance is reflected in its share prices. Rising share prices are seen as a positive performance measure for the company. It also indicates growth. Therefore, by analyzing a company's share price in the market, one can draw inferences about how smoothly a company is functioning. But, the share prices of the company also depend on the demand and supply of the shares in the market. Hence, in order to obtain a more realistic alternate, a company can use the shareholder's funds. This will not be inflated by factors that are not related to a company's performance. The following is the way we measure PCSF:

$$PCSF = 100 \frac{SF_t - SF_{t-1}}{SF_{t-1}}$$

where,

$SF_t =$  Shareholder's funds at time  $t$

#### 4.3.3 Return on shareholder's funds (RSF)

There is another way to look at the performance of a company. Consider Situation 1 again. Suppose that we have sold the security after one year at a price of `1300. Then, we have earned a profit of 300 on the security. This is the return obtained on the security. This can be measured as a percentage of the initial value. In this case, return on the shareholder's funds is measured as:

$$RSF = 100 \frac{PBD}{0.5 \times (SF_t + SF_{t-1})}$$

where,

$PBD =$  Profits before tax and dividend

## 4.4 Data

Each company is mandated by IRDAI to make available their financial statements known as public disclosures. These are documents that contain information regarding the company's performance and are used by various stakeholders and are available on ([www.irdai.gov.in](http://www.irdai.gov.in)). The data contains 42 NL-schedules, few of which include Profit/ Loss account, Balance sheets, Premiums schedule, Claims schedule, Board of Directors schedule, Geographic areas of operation, etc. A company must publish all the 42 schedules at the end of each quarter of a financial year that spans from 1<sup>st</sup> April to 31<sup>st</sup> March. This data for each company, each quarter is available on the website of IRDAI.

This data can be used to extract the various items that are used to calculate the variables defined in the sections above.

## 4.5 Methodology

The empirical framework that will be considered is that of a linear regression model. This can be further classified as the following:

1. Ordinary least squares
2. One-factor fixed effects model
3. Random effects model

Since we have data of different companies over time, it is essential that we perform a panel data analysis.

The aim of the analysis is to find a relationship between the dependent variables and the independent variables. This takes the form of a linear regression model to start off with. Then, under each of the methods mentioned above, modifications to the parameters as per the model can be applied accordingly. The following are the equations defining each model:

Let's say that we have a dependent variable  $Y$  and  $n$  independent variables  $X_k$ ,  $k = 1, 2, 3, \dots, n$ .

Then suppose we have observed  $T$  data points of  $Y$ ,  $X_k$ ,  $k = 1, 2, 3, \dots, n$  for each of the companies  $i = 1, 2, 3, \dots, N$ .

Then we have

*Model 1*

$$Y_{i,t} = \alpha + \sum_{k=1}^n \beta_k X_{i,t,k} + \epsilon_{i,t}; \quad t = 1, 2, 3 \dots T$$

*Model 2*

$$Y_{i,t} = \alpha_i + \sum_{k=1}^n \beta_k X_{i,t,k} + \epsilon_{i,t}; \quad t = 1, 2, 3 \dots T$$

*Model 3*

$$Y_{i,t} = \alpha_i + \sum_{k=1}^n \beta_k X_{i,t,k} + \epsilon_{i,t}; \quad t = 1, 2, 3 \dots T$$

Model 1 is the ordinary least squares model in which the intercept parameter is constant for all companies. Model 2 is the one-factor fixed effects model which assumes that the intercept parameter varies across companies, but is constant over time. Model 3 assumes that the intercept parameter varies across time and is also a random variable with mean 0 and variance, a constant. A question arises about what the intercept parameter is and what is the significance of the assumptions under each of the models. Consider a simple case of regression where we want to regress the values of  $Y$  with respect to the values of  $X$  as given in Table 2:

Table 2 : Observed values of  $Y_t$  and  $X_t$

$t$	$Y_t$	$X_t$
1	5	1
2	6	2
3	7	3
4	8	4
5	9	5
6	10	6

Here, we see that  $Y$  varies linearly with  $X$ . So, we arrive at  $Y = X$ . But, this doesn't give the desired relationship. This means that there is some unobserved variation in  $Y$  which isn't being captured by  $X$ . By adding the constant 4, we see that the equation  $Y = X + 4$  explains the relationship more precisely. This constant is what is known as the intercept term and accounts for the unobserved variation of  $Y$ . Hence in the above models it is the way the unobserved variation is modeled that makes the difference. While Model 1 assumes that the unobserved variation is captured entirely by a single factor,  $\alpha$ , Model 2 and Model 3 assume that this unobserved variation is dependent on the company as well. Hence we have  $\alpha_i, i = 1, 2, 3, \dots N$ . The error parameter has the following assumptions.

$$E[\epsilon_{i,t}] = 0$$

$$Var[\epsilon_{i,t}] = \sigma_\epsilon^2$$

## 4.6 Implementation

The whole of the framework, starting from data extraction to the fitting of models was implemented in python. A sample code is given in Figure 2:

```

from linearmodels import PooledOLS
from linearmodels import PanelOLS
from linearmodels import RandomEffects

Y = D_Variables.IY
X = I_Variables.filter(['UI', 'IRC', 'IRL', 'ER', 'RCTA', 'TNTPSF', 'TAISF', 'NANPW', 'TLA', 'CAM', 'UP'], axis=1)
#X = Data.filter(Include, axis=1)
X = sm.add_constant(X, has_constant='add')
#print(X)
Model = PanelOLS(Y, X, entity_effects=True)
Fit1 = Model.fit()
print(Fit1.entity_info)
Fit1
    
```

Figure 2: Sample code

## 4.7 Removing redundant KPIs

We first collect all the independent variables and perform a regression of each of these variables with regard to others. Upon doing this, we get an idea about if this variable is being explained by the combination of other variables. If it does, then it will not make sense to have that particular variable among the independent ones. Hence, it is filtered out and the analysis will be carried out without this variable. The factor we use for measuring the dependency is variance inflation factor.

## 5 Results

We now present the results of the analysis. Table 3 depicts the estimated sensitivity of performance with respect to each KPI for the industry i.e., combined data of companies. Table 4 depicts the estimated sensitivity of performance with respect to each KPI for individual companies.

Individual company data analysis has been performed for only those companies having more than 30 data points.

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Table 3 : Estimated sensitivity of performance with respect to each KPI for the industry i.e., combined data of companies

S.NO.	Determinants of performance <sup>2</sup>	Variable	Industry(Fixed) <sup>3</sup>		
			IY <sup>4</sup>	PCSF <sup>5</sup>	RSF <sup>6</sup>
1	Unexpected inflation	UI	-0.0338	-0.026	-0.0039
2	Interest rate change	IRC	0.0788	-0.0018	0.0486
3	Interest rate level	IRL	0.008	-0.0005	-0.008
4	Equity returns	ER	-0.083	0.0429	-0.0586
5	Underwriting cycle	UC1			
		UC2			
		UC3			
6	Company size	LOGTA	0.2672	-0.1769	0.465
7	Reinsurance dependence	RCTA	-0.0219	-0.0028	0.0641
8	Leverage	TNTPSF	-0.0908	-0.0128	0.1139
9	Affiliated investments	TAISF	0.0543	-0.0338	0.4364
10	Solvency margin	NANPW	0.0916	0.068	0.1051
11	Stability of underwriting operation	ACGPW			
12	Liquidity	TLLA	0.0468	0.0915	0.0236
13	Stability of asset structure	CAM	-0.0223	0.0084	-0.0234
14	Underwriting profits	UP	0.1548	0.0074	0.1342
15	Insurer type	IT1			
		IT2			
		IT3			

<sup>2</sup> Those variables that face issues of multicollinearity or independence issues have been removed from the model.

<sup>3</sup> Industry data modeled by one-factor fixed effects model as discussed in One-factor fixed effects model

<sup>4</sup> Investment yield

<sup>5</sup> Percentage change in shareholder's funds

<sup>6</sup> Return on shareholder's funds

Table 4: Estimated sensitivity of performance with respect to each KPI for individual companies

Determinants of performance <sup>7</sup>	Apollo Munich			Cholamandalam			GIC of India		
	IY	PCSF	RSF	IY	PCSF	RSF	IY	PCSF	RSF
UI	0.0301	-1.2848	2.4892	-0.2509	0.4461	-0.6887	0.0227	-0.0233	-15.1521
IRC	0.1442	-0.8574	-4.3439	0.7859	-0.8558	-2.555	0.0005	0.0128	-0.7298
IRL	0.0838	0.9764	-3.8957	-0.4253	0.3546	-5.6918	0.0226	-0.1611	-12.5288
ER	0.00001214	-0.0008	0.0016	-0.0007	-0.0004	-0.0014	0.00001083	0.0048	-0.0088
UC1	6.6199	-63.5716	477.9967	-36.5052	-79.1459	-180.8559	0.0023	-0.0131	-1.3919
UC2	-8.323E-14	8.912E-13	-6.459E-12	2.093E-13	4.067E-13	9.875E-13	-2.846E-18	1.073E-16	-6.084E-16
UC3	-1.647E-13	1.66E-12	-1.229E-11	2.213E-13	4.946E-13	1.114E-12	-1.384E-19	-1.039E-16	2.629E-15
LOGTA	-1.9535	16.3843	-137.6777	18.2309	36.8283	93.3598	0.0187	-0.1092	-11.1913
RCTA	3.5502	52.9458	-167.1889	-7.4625	12.8552	-8.6073	0.00003068	0.0006	-0.0409
TNTPSF	0.5581	0.6916	-10.5075	0.8566	-2.5746	-1.4067	-0.0049	0.6359	-16.6164
TAISF	-0.5118	3.2542	10.0706	-0.0161	-0.1848	-0.4876	-0.0017	-1.0731	7.0058
NANPW	0.0732	6.7283	-2.7245	8.2641	2.3265	16.6563	-0.001	-0.0292	1.5069
ACGPW	0.05	1.0913	10.9136	7.5737	-3.4302	15.317	2.323E-17	-4.851E-16	1.559E-14
TLLA	-0.1801	2.5796	-14.635	-0.0573	-0.0114	-0.0295	0.0127	-0.2305	-3.5835
CAM	-0.0073	0.3427	-0.3851	-0.0007	-0.0059	-0.0027	0.0003	-0.0066	0.0326
UP	2.427E-08	-0.000001418	0.000007688	0.000001386	-0.00000048	0.000002485	9.77E-09	8.706E-09	0.000001647
IT1	0	0	0	-36.5052	-79.1459	-180.8559	0	0	0
IT2	0	0	0	0	0	0	0	0	0
IT3	0	0	0	0	0	0	0.0023	-0.0131	-1.3919
R-squared	0.844	0.523	0.738	0.59	0.56	0.885	0.613	0.93	0.396

<sup>7</sup> Since it is individual companies, the model used is OLS as discussed in Ordinary least squares

## 5.1 Inferences

Inferences that we can draw from the results are as follows:

- It is clear that the  $R^2$  value is high for the individual companies and low for the companies when combined. This talks about how much percentage of variation of the observed dependent variable is explained by the model.
- However, for all the results, the p-value for the t-test on parameters is high. This means that we have no sufficient evidence to reject the null hypothesis that the corresponding independent variable plays no role in estimating the outcome under the model.
- The error terms for the individual companies pass the test of normality as given by Shapiro-Wilk test.

## 5.2 Limitations of the model

The results of the model presented above can be interpreted keeping in mind the various limitations that the model carries. They include:

- Less number of data points: The data has been collected from only six companies and a total of 152 data points are available after dropping the extreme values. This is too small a dataset to draw conclusions from.
- Short period of investigation: The time range for the data is from 2010-11 Q1 to 2018-19 Q2. This period is too small for some of the economic variables to change. Also, for such a short a short period the time effects are nil, i.e. all the variation is absorbed by the other variables.
- Information availability: Not all information is available in the public disclosures. Due to these certain assumptions had to be made to proceed with the analysis. The assumptions may be faulty.
- The derivation of KPIs: The KPIs are obtained from the paper (Shiu, 2004) which speaks of the determinants for the general insurance companies of UK. Direct application to the Indian market may not yield the desired results.





## 8 Future work

The paper gives a broad framework for the analysis of the KPIs for the individual companies as well as the industry. With this framework available, the data from the other companies in the non- life sector can be obtained and fitted under this framework. Thorough investigation of the results will suggest how effective the framework that has been designed is. This can be done by various statistical tests. Also, once the model is fitted to all the companies, we must test for the hypothesized effects that were stated in Table 1. Based on the tests performed, we can extend the framework to the life sector as well with changes being made in the KPIs accordingly if the results are positive. Else, we can restructure the KPIs, add new ones, and remove those that are unnecessary or redefine the existing ones so as to fit the Indian scenario. A full-fledged dashboard can be built that monitors the regular progress of the sensitivity of the company's performance as well as the performance of the industry with respect to the individual KPIs. The dashboard's features can be enhanced to include predictive capabilities using actuarial and data science techniques.

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## 10Bibliography

- [1] Gonzalez, R. (2018, July). A work in progress. *The Actuary, The magazine of the Institute and Faculty of Actuaries* , pp. 23-25.
- [2] <https://www.ibef.org>. (n.d.). Retrieved from <https://www.ibef.org/industry/insurance-sector-india.aspx>
- [3] Shiu, Y. (2004). DETERMINANTS OF UNITED KINGDOM GENERAL INSURANCE. 1080-1097.
- [4] [www.irdai.gov.in](http://www.irdai.gov.in). (n.d.). Retrieved from [https://www.irdai.gov.in/ADMINCMS/cms/NormalData\\_Layout.aspx?page=PageNo765&mid=31.2](https://www.irdai.gov.in/ADMINCMS/cms/NormalData_Layout.aspx?page=PageNo765&mid=31.2)
- [5] Baltagi, B.H. (1995). *Econometric analysis of panel data*. Wiley, U.S.A.
- [6] Booth, P., Chadburn, R., Cooper, D., Haberman, S. & James, D. (1999). *Modern actuarial theory and practice*. Chapman & Hall, U.K. McGraw-Hill, U.K.
- [7] Browne, M.J. & Hoyt, R.E. (1995). Economic and market predictors of insolvencies in the property-liability insurance industry. *The Journal of Risk and Insurance*, 62, 309-327.
- [8] Canadian Institute of Actuaries (1998). Standard of practice on dynamic capital adequacy testing (in effect January 1, 1999). This document is available at [http://www.actuaries.ca/publications/sop\\_\\_e.html](http://www.actuaries.ca/publications/sop__e.html)
- [9] DFA model: a case study. *Casualty Actuarial Society Forum*, 53-118.
- [10] Enz, R. & Karl, K. (2001). Profitability of the non-life insurance industry: it's back-to-basics time. *Swiss Re. Sigma*, 5, 1-37.
- [11] Greene, W.H. (2000). *Econometric analysis* (fourth edition). Prentice Hall, U.S.A.
- [12] Gujarati, D.N. (1995). *Basic econometrics* (third edition). McGraw-Hill, U.S.A.
- [13] Neter, J., Wasserman, W. & Kutner, M.H. (1989). *Applied linear regression models* (second edition). Irwin, U.S.A.
- [14] Pesaran, H., Smith, R. & Im, K. (1996). Dynamic linear models for heterogeneous panels. In *the econometrics of panel data*. Edited by Mañ tyá s, L. & Sevestre, P. (second revised edition). Kluwer Academic Publishers, The Netherlands.